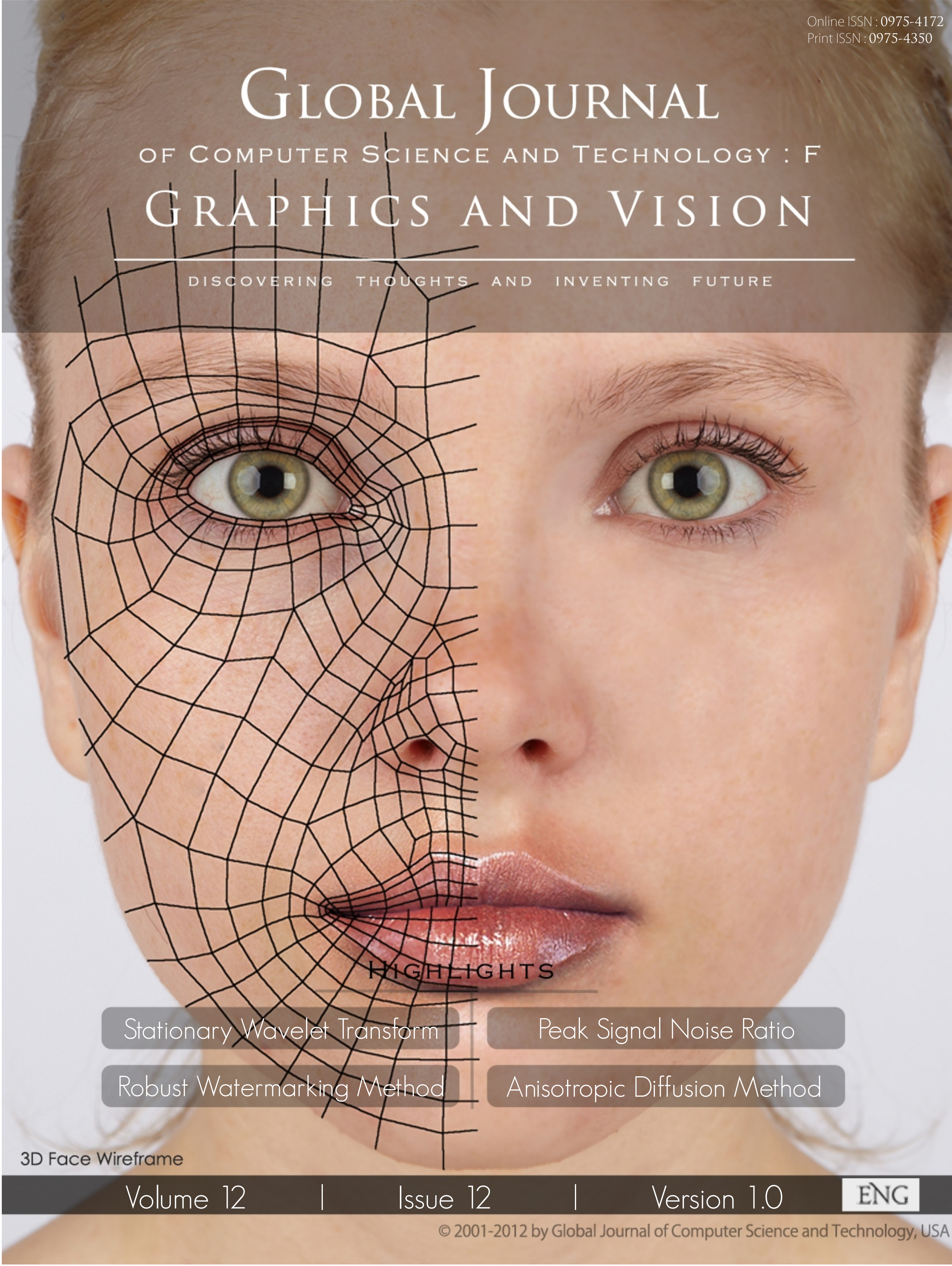
Online ISSN : 0975-4172
Print ISSN : 0975-4350

Global Journal

of Computer Science and Technology : F

Graphics and Vision

DISCOVERING THOUGHTS AND INVENTING FUTURE



HIGHLIGHTS

- Stationary Wavelet Transform
- Peak Signal Noise Ratio
- Robust Watermarking Method
- Anisotropic Diffusion Method

Volume 12 | Issue 12 | Version 1.0 ENG

Global Journal of Computer Science and Technology: F
Graphics & Vision

Global Journal of Computer Science and Technology: F
Graphics & Vision

Volume 12 Issue 12 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: Global Association of Research

Open Scientific Standards

Publisher's Headquarters office

Global Journals Inc., Headquarters Corporate Office, Cambridge Office Center, II Canal Park, Floor No. 5th, ***Cambridge (Massachusetts)***, Pin: MA 02141 United States
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Association of Research, Marsh Road, Rainham, Essex, London RM13 8EU
United Kingdom.

Packaging & Continental Dispatching

Global Journals, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investers@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Editorial Board Members (HON.)

Contents of the Volume

i. Copyright Notice
ii. Editorial Board Members
iii. Chief Author and Dean
iv. Table of Contents
v. From the Chief Editor's Desk
vi. Research and Review Papers

1. 3D Interfaces for Real Time Monitoring of Radwaste Storage. *1-5*
2. 3D Wavelet Transformation for Visual Data Coding with Spatio and Temporal Scalability as Quality Artifacts: Current State of the Art. *7-21*
3. Performance Analysis of Intensity Averaging by Anisotropic diffusion Method for MRI Denoising Corrupted by Random Noise. *23-29*
4. Robust Watermarking Method for Color Images Using DCT Coefficients of Watermark. *31-34*
5. An Impressive Method to Get Better Peak Signal Noise Ratio (PSNR), Mean Square Error (MSE) Values Using Stationary Wavelet Transform (SWT). *35-40*
6. Performance Analysis of Modified Lifting Based DWT Architecture and FPGA Implementation for Speed and Power. *41-50*

vii. Auxiliary Memberships
viii. Process of Submission of Research Paper
ix. Preferred Author Guidelines
x. Index

Global Journal of Computer Science and Technology
Graphics & Vision
Volume 12 Issue 12 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

3D Interfaces for Real Time Monitoring of Radwaste Storage

By Gianfranco Vecchio & Paolo Finocchiaro
Istituto Nazionale di Fisica Nucleare

Abstract - This paper describes the design and development of a 3D interface in the framework of an application for the monitoring of a radioactive waste storage. It focuses on the description of software solutions by integrating different technologies. We used only free and open-source libraries to develop the 3D environment that were subsequently integrated into the existing web application developed used Java Server Faces. In order to implement 3D graphics we used Away3D, an open source 3D graphics engine for Adobe Flash, written in ActionScript 3 and runnable in every browser that utilizes Adobe Flash Player.

Keywords : Radiation monitoring, Radioactive waste, Interactive systems, Graphics Animation, Graphical models.

GJCST-F Classification: I.2.10

3D INTERFACES FOR REAL TIME MONITORING OF RADWASTE STORAGE

Strictly as per the compliance and regulations of:

3D Interfaces for Real Time Monitoring of Radwaste Storage

Gianfranco Vecchio [α] & Paolo Finocchiaro [σ]

Abstract - This paper describes the design and development of a 3D interface in the framework of an application for the monitoring of a radioactive waste storage. It focuses on the description of software solutions by integrating different technologies. We used only free and open-source libraries to develop the 3D environment that were subsequently integrated into the existing web application developed used Java Server Faces. In order to implement 3D graphics we used Away3D, an open source 3D graphics engine for Adobe Flash, written in ActionScript 3 and runnable in every browser that utilizes Adobe Flash Player.

IndexTerms : Radiation monitoring, Radioactive waste, Interactive systems, Graphics Animation, Graphical models.

I. Introduction

This document wants to show a new useful way to display information from data collected in a harsh environment. An electronic system for radioactive waste monitoring was developed at INFN-LNS laboratory, as part of DMNR project [1]. It consists of a network of sensors deployed around radwaste drums for the continuous detection of radiation [2]. The sensors employed so far, specially developed for this case, are made of plastic scintillating fibers whose light is readout by means of pairs of Silicon Photomultipliers (SiPM). A counting system based on FPGA boards handles the data flow coming from groups of these sensors and sends it to the front-end of the application. A relational database system is used to store the historical data, and a dynamical web application was developed to explore the database and display the corresponding data in graphical form.

To improve the view of the storage following a database query we developed a 3D scene that shows the status of the whole plant at a glance [3], [4]. We developed two kinds of 3D scenes: a representation of the whole plant with the possibility to navigate through the drums, and the detailed view of a single structure of three drums with fiber sensors around them. In this document we are going to describe a setup with up to three drums inside tower-like structures and arranged in chessboard fashion.

The first scenario is used to investigate the status of the repository in a user-selected time range, and to inspect every single drum by virtual navigation through the plant using mouse and keyboard, as shown in Fig. 1.

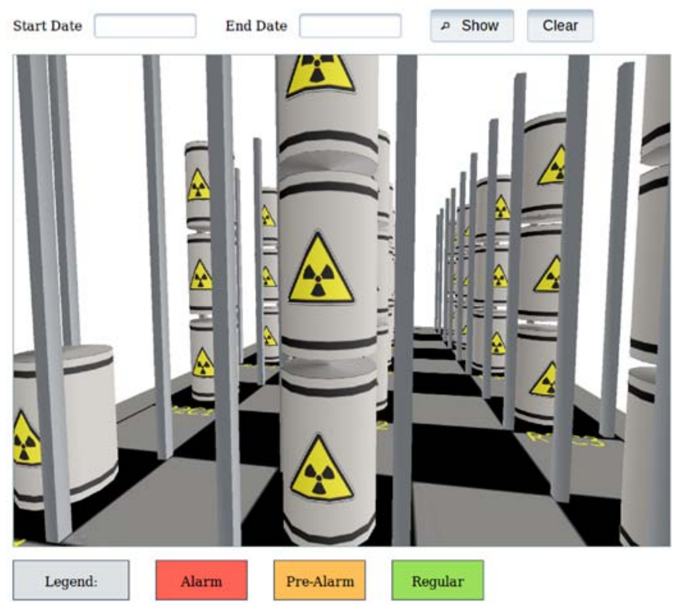


Fig. 1 : 3D view of radioactive waste repository

Once the user fills the date textboxes data coming from the database will color the drums in red, orange or green according to the corresponding alarm condition (Fig. 2).

Should there be no data in the database for the chosen time range, the drum will be drawn as grey. The colored drums can be clicked on by the user, in order to have a detailed view of its status (i.e. of all the sensors surrounding it).

The second scenario represents the detail of a single box containing the drum clicked in the previous scenario. It also draws the fiber sensors around each drum (four horizontal fibers in this sample case), and the interactivity consists on the possibility to rotate the tower to gain visual access to all the fibers and their alarm status. Clicking on a fiber one can get the plot of its counting rate in the time range selected. If one clicks on a drum the collective plot for the four fibers of that drum is shown in the same chart (Fig. 3).

Moreover, clicking on a drum a polar chart of the counting rate for each sensor will be shown, along with a chart indicating maximum, minimum and average counting rate values.

Author α σ : INFN Laboratori Nazionali del Sud, via S. Sofia 62, 95125 Catania, Italy.
E-mail α : vecchio@lns.infn.it
E-mail σ : finocchiaro@lns.infn.it

Global Journal of Computer Science and Technology (F) Volume XII Issue XII Version I Year 2012
1

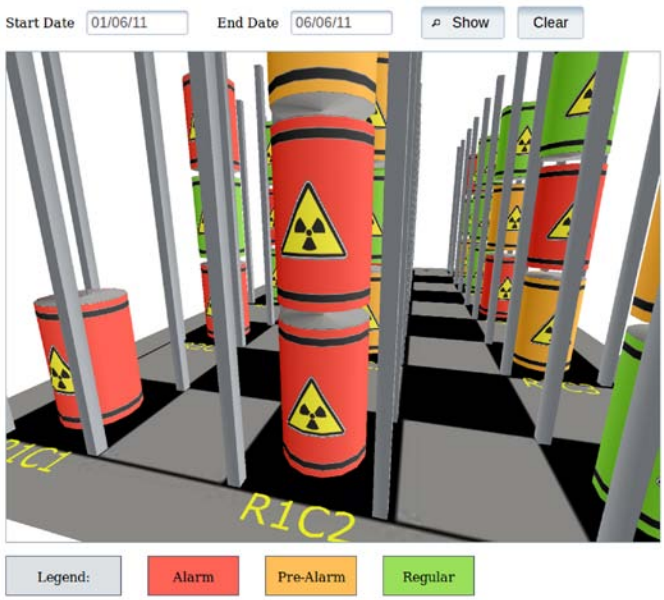


Fig. 2 : 3D view of radioactive waste plant after database query

II. Away3D, a Library for Adobe Flash to Create the Storage Plant

In order to simulate the environment that we have to monitor as well as possible, we chose Adobe Flash for its powerfulness in the creation of complex interactive animations. Away3D [5]-[8] is a 3D graphic engine written for Adobe Flash platform in ActionScript 3 [9] originally derived from Papervision3D. It was designed to be fast and extensible and allows the easy creation of various 3D objects with the use of its graphics primitives. Working on 3D coordinates and leveraging the object oriented nature of the language, we were able to build a realistic scene of our plant. We developed our project with Flash Develop [10], an open-source Integrated Development Environment to write and to compile Action Script code and to create Shockwave Flash objects (SWF).

The navigation inside the nuclear repository is done by means of a camera, defined by Away3D, moved using mouse and keyboard. Away3D offers several different types of camera, that represent the viewer's position in space relative to the rest of the scene. For the scene representing the whole storage we used the default *Camera3D* that produces a standard front-facing perspective projection of the scene. Thanks to event handles and objects like *MouseEvent3D* and *KeyboardEvent*, we were able to add some interactivity and better user experience. Hence, like in a computer game, by using the mouse and the arrow keys (or W-A-S-D keys) one can walk and look around every drum inside the environment.

As for the scene regarding the single tower box, which can be rotated using the mouse, we employed a different camera, the *HoverCamera3D,* that allows the user to navigate each side of the box only changing some properties like distance and rotation angles.

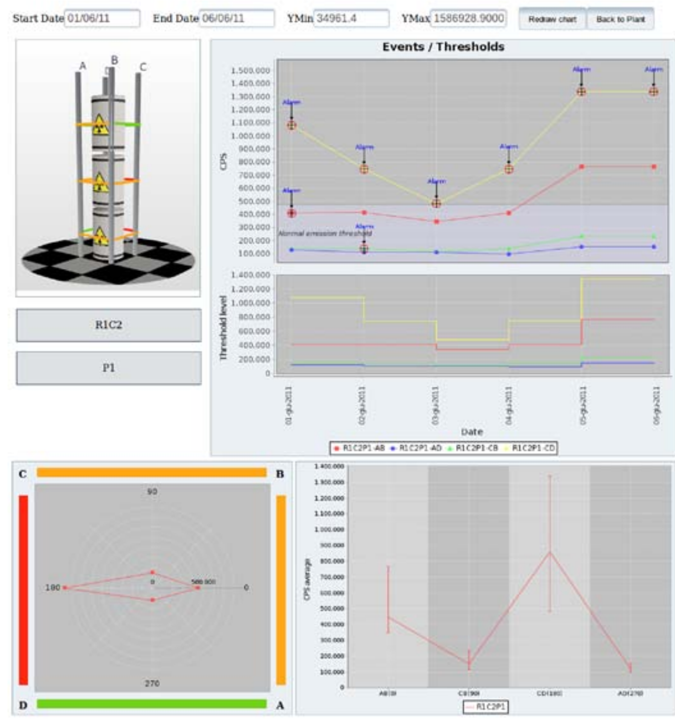


Fig. 3 : 3D view of a box with detail of the four sensors. Clicking on a fiber or on a drum one can view the global counting rate chart

Each object rendered to the scene was built from geometric elements like triangles and line segments. To make this mesh more realistic we had to build images to be set in the material property of each element. To make towers, drums and fibers we used the same Away3D primitive, the *Cylinder*, and then we used different material for every type of element.

Fig. 4 shows the result of the storage plant before the application of materials in each element. We can see only the mesh that was used to build every object made by triangles and line segments, showed by default in different color by the 3D graphic engine.

Furthermore, we were able to write text inside the interactive scenes, embedding the font inside an SWF object. We used text for orientation purposes and to view the ID of each element.

Finally, the possibility to pass some parameter to external resources, was achieved thanks to flash class *ExternalInterface* that enables straightforward communication between ActionScript and SWF containers, that in our case consisted of the XHTML page with JavaScript:

```
ExternalInterface.call("javascript_function_to_call", parameters_to_pass_to_javascript);
```

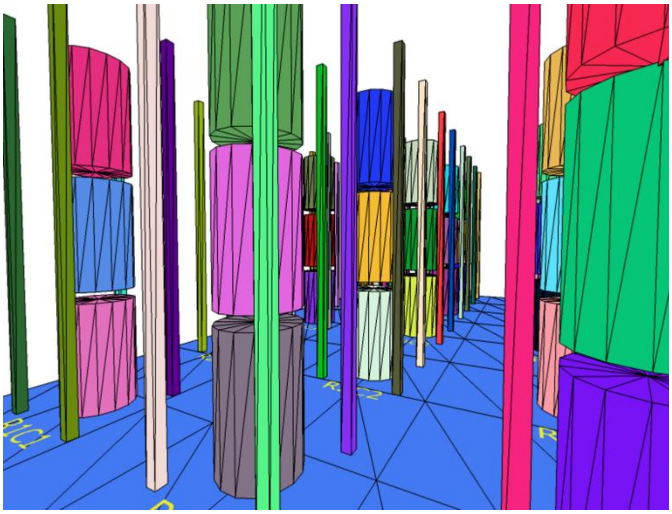


Fig. 4 : Mesh of elements inside the storage plant

III. Integration Between Different Technologies: Adobe Flash and Java Server Faces

The most complex task was represented by the encapsulation of the flash object inside the existing Java Server Faces [11], [12] project and the data exchange between the two different technologies [13]. The elements in the storage plant have to change according to the data coming from the database. Our web application contains a Java classes (the Managed Beans) that encapsulate the state of an object, and then stores all the data coming from the database after a user query. To pass data between Managed Beans and

composite components, introduced after 2.0 version of JSF. These allow to create reusable components and to embed external objects easily.

In our application we defined two composite components, one for each SWF object. They are simply XHTML files, implemented in JSF fashion, containing an interface and an implementation. JSF uses namespaces to include new tags to be used in the XHTML page, and for composite components the namespace is:

```
xmlns:cc="http://java.sun.com/jsf/composite"
```

The interface contains configurable features, like input and output data, whereas the implementation contains JSF tags needed to build the new component.

Inside the interface we declared variables that are needed to pass parameters between applications through the *attribute* tag:

```
<cc:attribute name="drums">
```

In the implementation, instead, we embedded the flash object thanks to JavaScript and the open source script *SWFObject* [14]. It offers methods to insert flash contents in HTML and XHTML pages, using only a small JavaScript file. It is more optimized and flexible than any other currently available method for the insertion of flash content and it is easy to use. Indeed, we need to use only this function to embed our SWF object:

```
swfobject.embedSWF(swfUrl, "800", "600", "11.1.0", flashvars);
```

This method accepts as parameters the URL of an SWF file, the size of the window that will show the flash content, the flash player version, and the *flashVars* variables that include data from Managed Bean.

Fig. 5 shows the schematic approach of this integration, describing the use and the configuration of composite components.

In order to use a composite component we only need to declare a namespace with the name of the directory that contains it:

```
xmlns:cc="http://java.sun.com/jsf/composite/flash"
```

and just a line is needed to embed it in our code and to pass the parameters in the classic JSF notation:

```
<cc:plant id="plant" drums="#{event3d.drums}"
    camera="#{event3d.cameraCoordinates}">
```

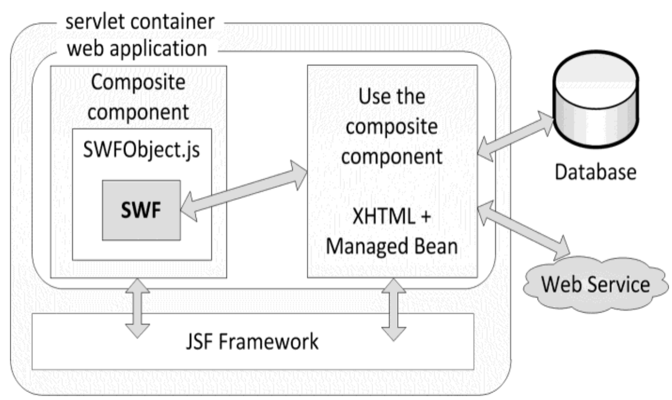


Fig. 5 : Scheme of the use and configuration of composite components

The flash object needs dynamic data to work that come from the database. As seen before, they will be passed to the flash object by means of *flashVars* variables. The attributes *drums* and *camera*, in the code shown above, are declared in the interface section of composite component and they will be used in the implementation code and inside the definition of flashVars variable:

```
var flashVars = {drums: "${cc.attrs.drums}", camera: "${cc.attrs.camera}"};
```

In order to retrieve these data, on the flash application side, we need to use only the *LoaderInfo* class from *flash.display* package:

```
var input:String = LoaderInfo(this.root.loaderInfo).parameters.drums;

var data : Array = input ? input.split(/[^a-zA-Z0-9\-]+/) : [];
```

Hence, the data structure coming from flashVars variable, will be decrypted as a string, that we changed into an array structure for convenience.

To interact with the flash object, clicking on a fiber or on a drum, we needed the implementation of a bidirectional communication system, then of parameter passing between a flash object and a managed bean. For this reason we used JavaScript like an interface between the two different technologies. As seen in the II Chapter, with ActionScript 3 we only need to use the *ExternalInterface* class to call the JavaScript function that resides in the implementation section of composite component:

```
ExternalInterface.call("clickPlant", drums, camera
Coordinates);
```

We pass two parameters to the JavaScript function: the ID of the clicked drum and the current camera coordinates to retain the position and orientation of the camera after navigation. Finally, these parameters will be associated to managed bean attributes through hidden input text called by JavaScript:

```
clickPlant = function(drum, camera){
        document.getElementById("${cc.clientId}:for
m:drumSelected").value=drum;
        document.getElementById("${cc.clientId}:for
m:cameraCoordinates").value=camera;
}
<h:form id="form" style="display:none">
        <h:inputHidden                id="drumSelected"
value="#{event3d.drumSelected}"/>
<h:inputHidden              id="cameraCoordinates"
value="#{event3d.cameraCoordinates}"/>
</h:form>
```

At this point, with managed bean attributes set, we can show the charts related to the clicked drum or fiber in the traditional manner in JSF paradigm.

IV. Conclusion and Prospects

In this paper we presented a new candidate system to show and to monitor a radioactive waste storage plant with 3D graphics interactions. It is useful to have a simulated perception of the waste storage at a glance, and a realistic way to see the elements that belong to the repository.

We investigated how to take advantage of new features in JSF 2.0, as composite components, and integrate Flash into our JSF application. These new capabilities in JSF free us from the need to take care about data encoding and decoding for transfer. Furthermore, to pass variables and parameters we used JavaScript variables and methods, that allow an easy way to exchange data between JSF and Flash.

Finally, to embed the flash content we used SWFObject, that detects the Flash Player version and determines whether Flash content or alternative content should be shown, to prevent outdated Flash plugins to break Flash content. It offers a simple way to embed Flash content and it is more optimized and flexible than any other Flash Player embed method around.

The future work will consist of the graphic representation of different sectors of larger repositories, to be shown dynamically depending on the user selection. Moreover, we will investigate about additional graphical improvements, especially with the use of the new release of *Away3D*, the version 4.0, which will completely support the release 11 of Adobe Flash Player. Indeed, the latest version of this plugin allows to take full advantage from graphic acceleration of the Graphics Processing Unit, releasing the CPU from such a heavy computational task.

A possible improvement will consist in correlating the virtual navigation procedure with a real inspection performed by means of a robotic arm, currently under development, equipped with a CCD color camera and a spectroscopic gamma ray detector [15].

A pilot DMNR system, which will include the 3D virtual navigation interface described in this paper, is going to be installed soon for tests in a real radioactive waste storage site.

V. Acknowledgment

We are indebted with L. Cosentino, A. Pappalardo and S. Scirè for their constant support and encouragement. Special thanks to S. Cavallaro, S. Pulvirenti, E. Furia and B. Diana for the fruitful discussions.

References Références Referencias

1. P. Finocchiaro, et al., "DMNR: a new concept for real-time online monitoring of short and medium term radioactive waste" in *Radioactive Waste: Sources, Types and Management*, Nova Science Publishers, in press.
2. Predisposal Management of Low and Intermediate Level Radioactive Waste, *IAEA Safety Guide*, WS-G-2.5.
3. Chengjie Gu, Shunyi Zhuang, Zailong Zhang, and Pan Wang, "Virtual Interactive Online Exhibition Architecture in E-Commerce based on Flash 3D and Flex", *2nd International Conference on e-Business and Information System Security*, May 2010.
4. Wenshan Hu, Hong Zhou, and Qijun Deng, "Design of web-based 3D control laboratory", *2nd International Conference on Intelligent Control and Information Processing (ICICIP),* July 2011.
5. Away3D. Available: http://away3d.com
6. R. Bateman, R. Olsson, "The Essential Guide to 3D in Flash", Friends of ED, June 2010.
7. M. Casperson, "Away3D 3.6 Essentials", PACKT, February 2011.
8. M. Ivanov, "Away3D 3.6 Cookbook", PACKT, June 2011.

9. Adobe, “Adobe Flex 3 Programming ActionScript 3”, 2008. Available: http://livedocs.adobe.com/flex/3/progAS_flex3.pdf
10. FlashDevelop. Available: http://www.flashdevelop.org/
11. D. Geary, C. Horstmann, “Core JavaServer Faces (3rd ed.)”, Prentice hall, June 2010.
12. Java Server Faces Technology. Available: http://www.oracle.com/technetwork/java/javaee/javaserverfaces-139869.html
13. Re Lai, “Using Adobe Flex and JavaFX with JavaServer Faces 2.0”, March 2011. Available: http://www.oracle.com/technetwork/java/lai-flex-javafx-jsf-301278.html
14. SWFObject. Available: http://code.google.com/p/swfobject/
15. Carlotta Scirè Scappuzzo, “Studio di un sistema robotizzato per il monitoraggio di depositi di scorie radioattive”, unpublished. Available: http://www. lns.infn.it/index.php?option=com_docman&task=doc_download&gid=244&Itemid=143

This page is intentionally left blank

Global Journal of Computer Science and Technology
Graphics & Vision
Volume 12 Issue 12 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

3D Wavelet Transformation for Visual Data Coding with Spatio and Temporal Scalability as Quality Artifacts: Current State of the Art

By Shaik. Jumlesha & Dr.Ch.Sathyanarayana
Jawaharlal Nehru University - Hyderabad

Abstract - Several techniques based on the three–dimensional (3-D) discrete cosine transform (DCT) have been proposed for visual data coding. These techniques fail to provide coding coupled with quality and resolution scalability, which is a significant drawback for contextual domains, such decease diagnosis, satellite image analysis. This paper gives an overview of several state-of-the-art 3-D wavelet coders that do meet these requirements and mainly investigates various types of compression techniques those exists, and putting it all together for a conclusion on further research scope.

Keywords : Discrete Cosine Transform, Discrete Wavelet Transform, Image Compression, spacio scalability, temporal scalability.

GJCST-F Classification: I.2.10

3D WAVELET TRANSFORMATION FOR VISUAL DATA CODING WITH SPATIO AND TEMPORAL SCALABILITY AS QUALITY ARTIFACTS CURRENT STATE OF THE ART

Strictly as per the compliance and regulations of:

3D Wavelet Transformation for Visual Data Coding with Spatio and Temporal Scalability as Quality Artifacts: Current State of the Art

Shaik. Jumlesha [α] & Dr.Ch.Sathyanarayana [σ]

Abstract - Several techniques based on the three–dimensional (3-D) discrete cosine transform (DCT) have been proposed for visual data coding. These techniques fail to provide coding coupled with quality and resolution scalability, which is a significant drawback for contextual domains, such decease diagnosis, satellite image analysis. This paper gives an overview of several state-of-the-art 3-D wavelet coders that do meet these requirements and mainly investigates various types of compression techniques those exists, and putting it all together for a conclusion on further research scope.

Keywords : Discrete Cosine Transform, Discrete Wavelet Transform, Image Compression, spacio scalability, temporal scalability.

I. Introduction

In various image and video applications compression is indispensable to guarantee interactivity during the streaming and consultation in particular about huge volume of medical images, for probing context-dependent full visual structures and/or quantitative analysis of the measurements. As a consequence, trading-off visual quality and/or implementation difficulty against bit-rate introduces exact constraints. On one hand, it is unbearable to drop any information when handling context exact visual data such as medical data.

On the other hand, a model likes progressive data transmission [52] and, thus, naturally support for lossy coding is equally important. This methodology allows for example to prioritize low-resolution edition of the requested motion based or still visuals and to increasingly filter the resolution of the visualized data by move additional data. This scalability mode is often referred to as resolution scalability. In a quality scalability scheme, the visual media is decoded instantaneously to the complete resolution but with a reduced visual quality. Additionally, by choose regions that are applicable for the context such as diagnosis—i.e., the regions-of-interest (ROIs)—parts of the image can be assess in a very early transmission stage at full quality. Meanwhile, the background information will be further developed.

Author α : Associate Professor in Cse Kkcw,Puttur,Chittore(dt).
E-mail : ahmedsadhiq@gmail.com
Author σ : Associate Professor in Cse & Hod Jntu Kakinada.
E-mail : chsatyanarayana@yahoo.com

Moreover, it should be clear that we target best rate-distortion presentation over the complete range of bit-rates that is demanded by the application. For example, JPEG2000 [53] (based on the wavelet transform) clearly outperforms its predecessor PEG [based on the discrete cosine transform (DCT)] [54] at low bit-rates and has as a significant property its lossy-to-lossless coding functionality; that is the ability to start from loss density at a very high density ratio and to increasingly refine the data by sending detail information, finally up to the stage where a lossless decompression is obtained.

Systems based on technologies other than the wavelet transform have been proposed, but they only partially assist the requested set of functionalities. Nonetheless, those techniques do superb for the subclass of applications they are designed for. Examples are context-based predictive coding (CALIC) [55] for lossless compression and region-based coding for very low bit-rate coding. Although these coders are competitive in their application domain, they lack support for the other functionalities.

Additionally, the increasing use of three-dimensional (3-D) imaging modalities, like magnetic resonance imaging (MRI), computerized tomography (CT), ultrasound (US), single photon emission computed tomography (SPECT), and positron emission tomography (PET) triggers the require for capable techniques to transport and store the associated volumetric data. In the classical approach, the image volume is careful as a set of slices, which are consecutively compressed and accumulate or transmitted. Since modern transmission techniques need the use of concepts like rate scalability, quality scalability, and resolution scalability, multiplexing mechanisms require to be introduced to select from each slice the right layer(s) to support the actually essential quality-of-service (QoS) level. However, a disadvantage of the slice-by-slice mechanism is that potential 3-D correlations are ignored.

II. Quality Artifacts for Visual Data Coding

In the applications of distributing motion based visuals such as video streaming or still visuals such as volumetric image sets over networks, distributing server has to deal with different network environments and client devices. The very diverse connection in mixed networks, ranging from hundreds of mega-bps to a number of tens of kilo-bps, and the fluctuations in bandwidth, need that video bit-streams are flexible in adapting itself to dynamic channel during transmission. The different client devices, with their different display capabilities and their computational and memory limitations, also need that bit-streams are flexible in decoding resolution and complexity. For these reasons, in recent years, apart from continuously improving the density effectiveness of non scalable video coding, a lot of research efforts have been paid to providing different scalabilities as quality artifacts in compressed bit-stream, including spatial resolution, frame rate, quality and temporal scalabilities.

Among several scalable video coding schemes, some based on three-dimensional wavelet transform have concerned much attention [56],[57],[21],[20], [60]. In these schemes, wavelet filtering is useful in both spatial and temporal directions. The multi resolution property of wavelet representation makes it a nature solution for spatial-temporal resolution scalability. The resolution scalability is usually realized by dropping needless sub bands. Hence the fallowing two considered as quality artifacts for 3D wavelet based coding strategies.

1. Spatial scalability
2. Temporal scalability

III. Spatial Scalability as Quality Artifact for 3D Wavelet Coding

Spatially scalable or hierarchical video coders generate two bit-streams: a base layer bit-stream, which represents low-resolution pictures, and an improvement layer bit-stream, which provides additional data wanted for reproduction of pictures with full resolution. A significant feature is that the base- layer bit-stream can be decoded separately from an enhancement layer. Therefore, low-resolution terminals are capable to de-code only the base-layer bit-stream in order to display low-resolution pictures. Such density techniques are of great interest recently, because of growth of communication networks with different transmission bit rates [62]-[65]. Moreover, scalable transmission is useful in error-prone environments where base-layer packets are well secluded against transmission errors and losses, while the security of the enhancement layer packets is lower. In such a system, a receiver is able to copy at least low-resolution pictures if quality of service decreases.

There were several attempts to develop spatially scalable coding of video. The proposed schemes were based on pyramid decomposition [61] or sub-band/wavelet decomposition [62], [63], [65]. Among different proposals, the latter approach should be considered especially promising. The idea is to divide each image into four spatial sub-bands. The sub-band of lowest frequencies comprises a base layer, while the other three sub-bands are jointly transmitted in an improvement layer (Fig. 1). Nevertheless, this approach often leads to allotment of much higher bit rates to a base layer than to an improvement layer, which is disadvantageous for practical applications. Recently, Benzler [66] has proposed to keep away from this problem by combining spatial and SNR scalability and abandon the obligation of the full MPEG-compatibility in the base layer. Here, our goal is to use a fully MPEG-compatible coder in the base layer. For the essential codecs, spatio-temporal scalability is proposed [67], [68]. Here, a base layer corresponds to the bit-stream of the pictures with compact both spatial and temporal resolutions. Therefore, in the base layer, the bit rate is decreased as compared to a encoder with spatial scalability only. Now, it is easy to get the base layer bit rate equal or even less than that of the development layer. The development layer is used to transmit the information required for restoration of the full spatial and temporal resolution.

Embedding of sub-band decomposition into a motion-compensated encoder leads to in- or out-band motion reparation performed on individual sub-bands or on the whole image, respectively. The latter will be used here, because some experimental results show that it is more capable [62], [63], [65].

Here, the term of spatio-temporal scalability is proposed for a functionality of video compression systems where the base layer corresponds to pictures with compact both spatial and temporal resolution. An improvement layer is used to transmit the information required for return of the full spatial and temporal resolution.

The authors have already considered two basic approaches related to spatio-temporal scalability [67], [68]. The first approach exploits 3-D sub-band analysis while the second approach is based on B-frame data partitioning.

a) *First Approach*

The input video sequence is analyzed in a 3-D separable filter bank, i.e., there are three successive steps of analysis: temporal, horizontal, and vertical. For temporal analysis, very simple linear-phase two-tap filters are used similarly as in other papers on three-dimensional sub-band coding [69], [70]

$$H(z) = 0.5.(1 \pm z^{-1})$$

Where "+" and"-"correspond to low- and high pass filters, respectively. This filter bank has a very simple implementation, wants to store one frame only and exhibits small group delay.

Temporal analysis results in two sub-bands L_t and H_t of low and high temporal frequencies, respectively. In both sub-bands, the temporal sampling frequency is compact by factor two. Therefore, these two sub-bands correspond to two video sequences with compact frame frequency. The two sub-bands are separated into four spatial sub-bands (LL, LH, HL, and HH) each. For spatial analysis, both horizontal and vertical, independent FIR filters are used. The 3-D analysis results in eight spatio-temporal sub-bands (Fig. 2). Three high-spatial-frequency sub-bands (LH, HL and HH) in the high-temporal-frequency sub-band H_t are discarded, as they correspond to the information being less applicable for the human visual system.

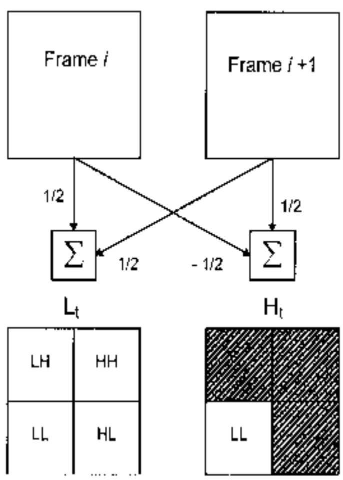


Fig. 2 : 3-D sub-band analysis

According to the experimental authors' tests for 720 x 576 progressive 50-Hz test sequences, it reduces PSNR often to about 32-33 dB, and has unimportant control on subjective quality of the decoded video. Thus, five sub-bands are encoded:

- In a base layer—the spatial sub-band LL of the temporal sub-band L_t ;
- The improvement layer includes the spatial sub-bands LH, HL, and HH from the temporal sub-band L_t and the spatial sub-band LL of the temporal sub-band H_t .

b) Second Approach

In the second alternative, the technique employs data structures already designed for standard MPEG-2 coding. Reduction of temporal resolution is obtained by elimination of each second frame. It is unspecified that groups of pictures (GOPs) consist of even number of frames. Moreover, it is unspecified that each second frame is a B-frame, i.e., it can be removed from a sequence without moving the decoding of the remaining frames.

Reduction of spatial resolution is obtained by use of sub-band decomposition. Suitable design of the filter bank results in negligible spatial aliasing in the LL sub-band, which constitutes the base layer. Unfortunately the technique does not provide any means to suppress temporal aliasing. The effects of temporal aliasing are like as those related to frame skipping in hybrid encoders.

The base-layer data are used to create low-quality images; therefore, it is sensible to perform more rough quantization here than in the improvement layer. On the other hand, quality of the sub-band LL is strongly related to the quality of the full sized picture. The small quality of the LL sub-band restricts the full-sized picture quality to a relatively low level, in spite of the amount of information in the remaining sub-bands. Therefore, it is important to transmit additional information ΔLL in the improvement layer. This information is used to get better quality of the sub-band LL when used to synthesize full-sized images in the improvement layer.

IV. Temporal Scalability as Quality Artifact for 3D Wavelet Coding

Temporally scalable video coders can be classified intone of two types depending on the manner in which temporal redundancy is exploited. The first is the motion-compensated analytical coder (e.g. MPEG, [71]), and the second is the sequential sub band coder both without ([72], [73]) and with ([74], [75]) motion compensation (MC). The coding competence and the degree of temporal scalability are a function of size of a group-of-frames (GOF), defined as the number of successive frames that can be decoded separately from the rest of the video sequence. Temporal scalability is achieved by decoding subsets of the GO consisting of equally-spaced frames.

MCP exploits temporal redundancy by forming a(closed loop) prediction of the current frame via MC from a reference frame. The coding competence of MCP is needy on the success of the MC. Good MC considerably increases the association coefficient among pixels, which then yields less energy in the residual. Temporal scalability from MCP video is provided by strategic placement of orientation frames and selective decoding of frames. Recursive prediction with a GOF of length allows lower frame rates of ½, ¼, 1/2v. The result is a simple temporal sub sampling of the original sequence.

Temporal sub band coders and motion-compensated TSB coders exploit redundancy by applying a sub band or wavelet analysis in time. The most usually used filters are the 2-tap Haar wavelet filters applied hierarchically, which result in GOFs with lengths that are powers of 2.Temporal scalability is provided by decoding and synthesizing chosen temporal sub bands.

To include block-based motion recompense with TSB, MC is performed on individual blocks prior to each application of the low-pass filter and therefore local motion of different objects in a scene can be compensated well. To make sure inversion ability of the wavelet transform, MC must be full-pel. The resulting scene-aligned pixels are temporally sub band filtered. However, regions of pixels can now be precious by the occlusion problem which occurs when a one-to-one correspondence among pixels in two frames does not exist in the MC operation. These regions must be especially coded. The standard solution issue analytical coding to maintain reconstruct capacity for these pixels [4]. Regions in the prior frame not found in the present frame are placed in the low-pass sub-band and coded directly. Regions in the current frame not found in prior frame are subtracted from a prediction and placed in the high-pass sub band. Since quantization occurs after forming the temporal sub band representation, such coding is efficiently an open-loop prediction system.

An important difference between MC-TSB and MCPc ding is the effects of full- pel and half-pel MC. MC can be considered as preprocessing previous to temporal sub-band filtering. While the temporal sub band filtering (and predictive coding for covered/uncovered pixels) is invertible, the preprocessing step must also be invertible to allow exact synthesis of the original frames in the absence of quantization. Inverting capacity is only provided by full-pel motion compensation.

V. Nomenclature of 3-D Wavelet Coding

a) 3-D DCT Coding

The first coder introduced in the 3-D test bed is a JPEG-alike, 3-D DCT-based coder. This coder was designed in order to have a good reference for DCT-based systems. The 3-D JPEG-based coder is composed of a DCT, followed by a scalar quantize and finally a combination of RLC and adaptive arithmetic encoding. The basic principle is simple: the volume is separated in cubes of 8x 8 x 8 pixels (N=8) and each cube is separately3-D DCT-transformed, similar to a classical JPEG-coder.

Thereafter, the DCT-coefficients are quantized using a quantization matrix. In order to derive this matrix, one has to consider two options. One option is to construct quantization tables that create an optimized visual quality based on psycho-visual experiments. It is valuable mentioning that JPEG uses such quantization tables, but this approach would need complicated experiments to come-up with sensible quantization tables for volumetric data. The simplest solution, adopted in this work, is to create a uniform quantization matrix—as reported in[76], [77], and [78]. This option is motivated by the fact that uniform quantization is optimum or quasi-optimum for most of the distributions [79]. Actually, the uniform quantizer is optimum for Laplacian and exponential input distributions; otherwise the differences with respect to an optimal quantizer are marginal [79]. A second option involving quantizes that are optimal in rate-distortion sense is discussed elsewhere [80].

$$DCT(u) = \sum_{x1=0}^{N-1}\sum_{x2=0}^{N-1}\sum_{x3=0}^{N-1} f(x)\prod_{i=1}^{3} C(u_i)\cos[\frac{(2x_i+1)\pi}{2N}u_i]$$

With

$$C(u_i) = \begin{cases} \sqrt{\frac{1}{N}} u_i = 0 \\ \sqrt{\frac{2}{N}} u_i > 0 \end{cases}$$

The quantized DCT-coefficients are scanned using a 3-Dspace-filling curve, i.e., a 3-D instantiation of the Morton-curve[81], to allow for the alignment of zero-valued coefficients and, hence, to get better the performance of the RLC. This curve was opted for, due to its simplicity compared with that of 3-D zigzag curve [82]. The nonzero coefficients are encoded using the same classification system as for JPEG. The coefficient values are grouped in 16 main magnitude classes (ranges), which are subsequently encoded with an arithmetic encoder [83]. Finally, the remaining bits to refine the coefficients within one range are added without further entropy coding.

The adopted entropy coding system is partially based on the JPEG architecture [54], although the Huffman coder is replaced by an adaptive arithmetic encoder [83]. Consequently, the big look-up tables mentioned in annex K of the standard [54] are extra and moreover, adaptive arithmetic encoding tends to have a higher coding efficiency. The dc coefficients are encoded with a predictive scheme: apart from the first dc coefficient, the entropy coding system encodes the difference between the current dc coefficient and the previous one. For this distinction, the range is determined and encoded with an arithmetic encoder that has a dc model supporting16 ranges. Simply transmitting the remaining bits of the coefficient refines the range specification without any further entropy coding. The latter is possible since the probability distribution of all possible values can be seen as uniform, hence, entropy coding will not be capable to further reduce the bit consumption.

The ac coefficients are encoded by specifying first the amount of zeros preceding the encoded symbol, i.e., the run. The runs of zeros are encoded using an arithmetic encoder with a separate model. Runs of up to 15 zeros are supported. Note that to indicate the situations in which 16 or more zeros precede a important coefficient, an extra symbol “OVF” (overflow) is used. After encoding this symbol, the remaining zeros are directly encoded to avoid confusing situations involving a succession of several OVF encodings. Finally, the range of the encountered important symbol is encoded, using an arithmetic encoder with a similar (AC) model as in the case of the dc coefficients, followed by the essential refinement bits.

b) The 3-D Wavelet Transform

Before describing in the following sections the proposed 3-Dwavelet-based techniques, it is significant to notice that these techniques support lossless coding, all the necessary scalability modes as well as ROI coding and this is a important variation with respect to the 3-D DCT-technique presented above, which is not able to provide these features.

For all the 3-D wavelet-based coders included in this study, a common wavelet transform module was designed that supports lossless integer lifting filtering, as well as finite-precision floating-point filtering. A mixed selection of filter types and a different amount of decomposition levels for each spatial direction (x-, y-, or z-direction) are supported by this module. This allows for adapting the size of the wavelet pyramid in each spatial way in case the spatial resolution is limited.

For example, fewer levels will be required along the slice axis if the amount of slices or the resolution along the axis is limited. The supported lossless integer lifting filters include the (S+P), (4,2), (5,3), and (9,7) integer wavelet transforms. This selection is based on current publications [85], [86], as well as investigations performed in the context of the JPEG2000 compression standard.

A typical problem encountered with 3-D lossless integer wavelet transforms is the complexity wanted to make them unitary, which is not the case for floating-point transforms. This property is essential in order to achieve a good lossy coding performance. By calculating the L2 norm of the low- and high-pass filters, the normalization factors can be determined. In two dimensions, this is not a problem, since the typical scaling factors to obtain a unitary transform are about powers of two [87].

However, in three dimensions, the problem pops up again and it only disappears if one takes care that the sum of all decompositions influencing each individual wavelet coefficient (i.e., decompositions in both slice directions and in the axial direction) is an even number. Hence, some proposals have been formulated [88], [89] that make use of a wavelet packet transform [90] to achieve this goal, while assuming that the L2-based normalization factors for the supported kernels scale-up $\sqrt{2}$ with for the low-pass and $\frac{1}{\sqrt{2}}$ for the high-pass kernels. In practice this seems to be an acceptable approximation. Nevertheless, in the presented study, whenever possible, unitary transforms will be used (and it will be explicitly mentioned if not).

c) 3-D SPIHTs

In the test set of wavelet coders, a 3-D SPIHT encoder [91] was included as a reference. An early version of this coder [89] has already established to beat the performance of a context-based octave zero-tree coder [85]. The source code was made presented by the authors so it could be equipped with the proposed wavelet transform front-end.

The SPIHT implementation in this study uses balanced 3-Dspatial orientation trees. Therefore, the same number of recursive wavelet decompositions is necessary for all spatial orientations. If this is not respected, several tree nodes do not refer to or be linked with the same spatial location and, as a result, the dependencies among different tree-nodes are destroyed and, hence, the compression performance is reduced. Thus, a packet-based transform is not working to obtain a unitary transform with this embedded coding system. Therefore, the SPIHT coder was equipped with a no unitary transform. It is, however, worthwhile mentioning that solutions have been proposed utilizing unbalanced spatio-temporal orientation trees in the context of video coding [92].

The examined 3-D SPIHT algorithm [91] follows the same procedure as its 2-D homologous algorithm, with the exception that the states of the tree nodes—each embracing eight wavelet coefficients are encoded with a context-based arithmetic coding system during the significance pass. The selected context models are based on the significance of the individual node members, as well as on the state of their descendents. Consequently, for each node coefficient four state combinations are possible. In total 164 different context models are used.

d) Cube Splitting (CS)

The CS technique is derived from the 2-D SQP coder proposed in Section II-C. In the context of volumetric encoding, the SQP technique was comprehensive to a third dimension: from square splitting toward CS. CS is applied on the wavelet image in order to isolate smaller entities, i.e., sub cubes, possibly containing important wavelet coefficients.

During the first significance pass $Sp^{\max}$, the significance of the wavelet image (volume) W is tested for its highest bit plane $p^{\max}$ with the significance operator σ^{p}. If $\sigma^{p^{\max}}$ (W)=1, the wavelet image W is spliced in eight sub cubes (or octants), $Q_b^{p^{\max}}(k^q, v^q/2), 1 \le q \le 8,$ with top-left coordinates $k^q = (k_1^q, k_2^q, k_3^q)$ and of size $v^{\frac{q}{2}} = (v_1^{\frac{q}{2}}, v_2^{\frac{q}{2}}, v_3^{\frac{q}{2}})$. The descendent "significant" cube (or cubes) is (are) then more spliced until the significant wavelet coefficients

Global Journal of Computer Science and Technology (F) Volume XII Issue XII Version I Year 2012

$\sigma^{p^{\max}}$ (w(k)) =1are isolated. Thus, the significance pass $Sp^{\max}$ registers sub cubes and wavelet coefficients, newly identified as important, using a recursive tree structure of octants. The result is an octtree-structured description of the data meaning against a given threshold. As might be noticed, equal significance weights are given to all the branches. When a important coefficient is isolated, also its sign for which two code symbols are conserved is immediately encoded. When the complete bit-plane is encoded with the significance pass $Sp^{\max}$, p is set to $p^{\max}$-1 and the refinement pass R $p^{\max}$-1 is initiated for this bit-plane, refining all coefficients marked as significant in the octtree.

Thereafter, the significance pass is restarted to update the octtree by identifying the new significant wavelet coefficients for the present bit-plane. During this stage, only the before non significant nodes, i.e., $\sigma^{p+1}(Q(k^q, v^q / 2^j)) == 0, 0 < j \le J$, are checked for significance and the important ones, i.e. $\sigma^{p+1}(Q(k^q, v^q / 2^j)) == 1$,are unnoticed since the decoder already received this information. The described procedure is frequent, until the complete wavelet image W is encoded, i.e., p=0 or until the desired bit-rate is obtained.

To encode the generated symbols professionally, a context-based arithmetic encoder was integrated. The context model is simple. For the significance pass four context models are distinguished, namely one for the symbols generated at the intermediate cube nodes, one for the pixel nodes having no significant neighbors for the earlier threshold, one for the pixel nodes having at least one significant neighbor for the earlier threshold and finally one for encoding the sign of the isolated significant pixel nodes. Only two contexts are used for the refinement pass: one for the pixel nodes having no significant neighbors for the earlier threshold, one for the pixel nodes having at least one important neighbor for the previous threshold.

Other 2-D techniques, like NQS [84] and sub band block(SB) SPECK [59], have been proposed that use similar quadtree decomposition techniques. These coders divide the wavelet space in blocks and activate for each block disjointedly a quad-tree coding mechanism. In case of SB-SPECK, the block sizes are also depending on the sub band sizes, forcing each block to reside in one sub band. Each block is individually encoded and thereafter an EBCOT-alike rescheduling takes place to restore the scalability functionality. SB-SPECK was also partially extended to 3-D i.e., 3-D SB-SPECK coding [59] by equipping the coder with a 3-D wavelet transform front-end. The transform is activated on discrete chunks of slices [groups of frames (GOFs)], to maintain the accessibility of the data (typical GOF sizes are 8, 16, or 32 planes). The option is not implemented in the coders we designed. SB-SPECK does not use arithmetic encoding. However, the 3-D SB-SPECK coder delivers competitive results and we will refer to it whenever possible.

e) Three-Dimensional QT-L

The QT-L coder has also been extended toward 3-D coding. The octtrees corresponding to each bit-plane are constructed following a similar strategy as for the CS coder. However, the partitioning process is limited in such a way that once the volume of a node $V_n = \prod_{i=1}^{3} v^q / 2^j, 0 < j \le J$, becomes smaller than a predefined threshold V_{th}, the splitting process is stopped and the entropy coding of the coefficients within such a significant leaf node $\sigma^p(Q(k^q, v^q / 2^j)) = 1$is activated. Similar to the 2-D version, the octtrees are scanned using depth-first scanning. In addition, for any given node, the eight descendant nodes are scanned using a 3-D instantiation of the Morton-curve [81]. For every bit-plane, the coding procedure consists of the non significance, importance and modification passes adapted for 3-Dcoding; also, for the maximum bit-plane, the coding process consists of the significance pass only. Notice that the sum number of neighbors N_{tot} in (2) is set to 26 in 3-D coding.

f) 3-D CS-EBCOT

The CS-EBCOT coding [58] join the principles utilized in the CS coder with a 3-D instantiation of the EBCOT coder [43]. In the next paragraphs the interfacing of the CS coder with a edition of EBCOT modified to 3-D is discussed.

To begin with, the wavelet coefficients are separation EBCOT-wise in separate, uniformly sized cubes, called code-blocks. Normally, the first size of the code-blocks is 64x64x64 elements. Additional sizes (even different ones for every dimension) can be chosen, depending on the image characteristics and the request requirements. The coding module CS-EBCOT again consists of two major units, the Tier 1 and Tier 2 parts.

The Tier 1 of the proposed 3-D coding architecture is a hybrid module joins two coding techniques: CS and fractional bit-plane coding by context-based arithmetic encoding. The Tier 2 part is equal to the one used in the 2-D coding system.

1. CS: The CS pass S is resulting from the CS technique presented in Section III-D. In the proposed coding system, the CS is useful on the individual code-blocks in arrange to separate smaller entities, i.e., sub cubes, possibly containing major wavelet coefficients. The least sub cube size

that is supported is 4x 4 x 4.We will refer to these least sub cubes as the leaf nodes.

During the initial CS pass $Sp_i^{\max}$, the importance of code-block B_i is tested for its maximum bit-plane $p_i^{\max}$ with the significance operator σ^p. If $\sigma^{p_i^{\max}}(B_i)$ = 1, the code-block B_i is join until the important leaf nodes $Q_b^{p_i^{\max}}(k^q, v^q/2^G)$ are isolated, where G state the highest total of CS levels. When every significant leaf nodes are isolated, the fractional bit-plane coding part is activated for the present bit-plane and only for the important leaf-nodes.

When the total bit-plane is encoded utilizing the fractional bit-plane coding, p_i is set to $p_i^{\max}$ -1 and the succeeding CS pass, $s_i^{\max}$ -1 is activated. The explain procedure is repetitive, until the total block is encoded, i.e., $p_i = 0$. Due to the limited quantity of code-symbols and their allocation, arithmetic coding is not useful.

2. Fractional Bit-Plane Coding: The fractional bit-plane coder encodes just those leaf nodes that have been recognized as important throughout the CS pass. Three passes are defined per bit-plane like in the 2-D case: the importance transmission pass, the magnitude refinement pass and the normalization pass. Moreover, these coding passes call numerous coding operations (primitives), i.e., the ZC, SC, MR, and RLC primitives. These primitives enable the choice of suitable3-D situation models for the successive arithmetic coding or RLC stages. The chosen adaptive arithmetic encoder is based on an implementation by Said and Pearlman of the algorithm proposed by Witten et al. [45], which is equal to those utilized in the earlier state encoders.

The data exist in in each leaf-node is scanned applying as lice-by-slice scanning pattern. Inside one slice the pattern is equal to the JPEG2000 scanning: the vowels are read in-groups of four vertically associated voxels. When a total slice is stripe-wise processed, the subsequent segment is processed.

The fractional coding passes perform in an equal way as for the original EBCOT execution. However, the chosen neighborhood Θ_k refers now to the twenty-six voxels approximately the voxel being coded (i.e., the immediate neighbors). For every bit-plane, sequentially the significance propagation pass, the MR pass, the CS pass and the normalization pass are called, excluding for the first bit-plane where the initial two passes are discarded.

3. Coding Primitives: As for EBCOT, four coding primitives are defined to support the encoding procedure in the dissimilar coding passes: the ZC primitive, the RLC primitive, the SC, and the MR primitive. For arithmetic encoding, the context-model choice is based on the condition of the adjacent voxels of the voxel being encoded, i.e., the preferred neighborhood and the sub band type in which the voxel is situated. The preferred neighborhood Θ_k is separated in 7 orthogonal subsets according to their position to the voxel [58], [80]. Every coding primitive has got its individual look-up table to identify the probability model that has to be utilized by the arithmetic coder for a identified situation state [58], [80]. Additionally, we have to state that the complexity of this part of the coding engine increases heavily compared with the original 2-D implementations, appropriate to the enlarged preferred neighborhood (from 8 to 26 neighbors)and, consequently, the augmented complexity of the look-up tables[58].
4. Tier 2—Layer Formation: The followed process, i.e., PCRD optimization [43], is equal to the original one. However, we have to state one feature that is of key importance. The PCRD routine allocates compensating for the fact that a no unitary transform has been used. By accurate the calculated distortions for each pass n_i with a scaling factor ζb_i , the coding method will execute as if a unitary transform was used (or approximated when using integer powers of $\sqrt{2}$).Hence, the distortion will be currently described by:

$$D_i^{n_i} = \zeta b_i \sum_{k \in B_i} (S_i^{n_i} t[k] - s_i[k])^2$$

Where $s_i[k]$ indicate the magnitude of element k in code-block B_i and $S_i^{n_i}[k]$ provide the quantized illustration of that element connected with truncation point n_i . This improvement allows support for a unitary transform without obstructing the possibility of lossless coding, a difficulty that does occur with classical zero tree-based coders. The original 2-D algorithms maintain multiple components (e.g., color), but this feature is not retained in the future 3-D implementation. Hence, only gray-scale images (volumes) are supported. Nevertheless, the dissimilar bit-stream chunks are currently grouped into separate packets, every packet contributing to one quality layer and one resolution level. The code-block addition information is again encoded by means of the tag-tree concept. The only alter that has been complete was extending the tag-tree idea to the third dimension, i.e., moving from a quad tree structure to an octtree structure.

VI. Current State of the Art

Matching Pursuits (MP) has been recognized as an useful technique of over entire transform coding for 2D images, originally for 2D motion compensated residuals by Neff and Zakhor [12], and additional recently extended to still images by the application of a spatial wavelet transform [13] and the utilize of additional effective dictionaries and embedded coding [14]. The addition of MP to three dimensions is natural, as has been established [15]. However MP is a computationally strong method and the utilize of 3D bases increases this cost significantly. In this context Yuan Yuan[1] proposed a novel 3D WAVELET VIDEO CODING WITH REPLICATED MATCHING PURSUITS. The model can be briefed in figure 1 and description follows

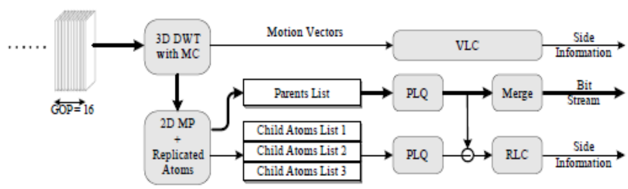


Figure 1 : 3D Replicated Matching Pursuits Scheme for Video Coding

Replicated MP coding is shown in Figure 1. For a group of 16 input frames, the motion compensated 3D DWT is implemented subsequent the scheme of Taubman and Secker [5A, 6A]. The related motion vectors are coded as side information by a Variable Length Code (VLC). This movement overhead affects the low down bit rate performance of all video coded by related schemes. The MP algorithm is useful to the 3D Group of Temporal Pictures (GOTP) using the Intra 8 Codebooks of Monro [14]. The benefit of 3D RMP is that the collection of Child atoms related with a Parent can provide up to three times the image power of the Parent alone, but expenses on average less than 30% of the bits to code in this implementation. MP is a computationally costly algorithm, with the best inner product over the entire data set with all bases in the dictionary essential for selecting each atom.

Sun et al[2] proposed a novel content adaptive rate-distortion optimization scheme, which might effectively differentiate texture region, edge region and flat region by means of directional field technique. There have been numerous efforts in the past trying to include perceptual procedures into video encoding. In [16], the focus was mostly on determination of suitable quantization steps with sub-band Just Noticeable Distortion (JND). In recent H.264/MPEG-4 advanced video coding standard, maximum coding efficiency is achieved by introducing the rate distortion optimization (RDO) procedure to provide the best coding outcome by maximizing image quality and minimizing data rate at the same time. In [17], a new adaptive RDO scheme has been proposed which exploits motion and texture masking property to correct the Lagrangian multiplier and achieves generally bit rate reduction by allowing additional distortion in the less noticeable background random texture area. The RDO technique is also an significant part in wavelet-based scalable video coding (SVC) scheme that is presently under examination by MPEG-21, Part 13 [18]. The SVC scheme requires an embedded bit stream to be formed from which bit streams with different bit rate, resolution and frame rate could be extracted with reasonably fine quality. Here in this job sun et al proposed an effective directional field based visual significance map in the context of capturing the features associated to pre attentive processing such as edges and curves. Based on the visual significance map, the regions with additional pre-attentive features are likely to get more distortion-reduction by assigning a smaller Lagrangian multiplier. Rate balance was also measured as a factor and attempted to attain by assigning a relatively larger Lagrangian multiplier to the random texture area so that additional distortion is permitted without noticeable visual degradation to the image. Since HVS is also sensitive to distortions in flat regions, a little Lagrangian multiplier was also used for flat regions.

Seran et al[3] proposed a 3D BASED VIDEO CODING to carry out the two-dimensional spatial filtering initial and then perform motion-compensated temporal filtering by lifting in the Over total Discrete Wavelet Transform domain. In practice essentially the three-dimensional wavelet decomposition can be performed in two ways: two-dimensional spatial filtering followed by temporal filtering (2D+t) [19, 20, 21] or, temporal filtering followed by two-dimensional spatial filtering (t+2D) [22, 23, 24]. In this work, Seran et al[3] proposed a new temporal filter set to reduce delay in 3D wavelet based video coding, that attempted to increase performance at par with existing longer filters. In this proposal the filter set haven't include any boundary effects at the group of frames (GOF). The length of the GOF can differ from five to any number of frames depending on interruption requirements. This proposed model also illustrated a novel technique of assigning priorities to temporal sub-bands at dissimilar levels to manage distortion fluctuation inside a GOF.

Mavlankar et al[4] considered a multiple description (MD) video coding scheme based on the motion compensated (MC) lifted wavelet transform, which is to carry out the temporal decomposition of a collection of pictures and then make multiple descriptions for every temporally transformed frame. The benefit of basing MD video coding on motion-compensated lifted 3D wavelet decomposition is that it does not need any difference control similar to in a hybrid codec which was earlier achieved by distribution drift compensation data. Earlier to this proposal an important number of MD coding schemes for video have been proposed (e.g., [25], [26], [27]). Most of the proposals for MD video believe the usual hybrid video coding structure with motion compensated prediction and DCT as their major building blocks. In difference the model proposed by Mavlankar et al a multiple explanation video coding scheme that is based on a video encoder that uses the recently emerging motion compensated lifted 3D wavelet change as its basis [27], [28], [29], [30]. Since recursive temporal prediction is restoring by a motion-compensated transform, it also remove the dependency quantization framework which is an inherent part of hybrid video codecs. In usual hybrid codecs quantization is fixed in the recursive prediction loop, whereas in 3- D wavelet codecs quantization and spatial encoding are applied following the temporal decorrelation of a group of pictures (GOP). Figure 2 shows our proposed MD video codec which is based on MC lifted wavelet change. This scheme expands the Drift Compensation Multiple Description Video Codec (DC MDVC) proposed for a hybrid video codec in [31] to MC-lifted 3-D wavelet coding.

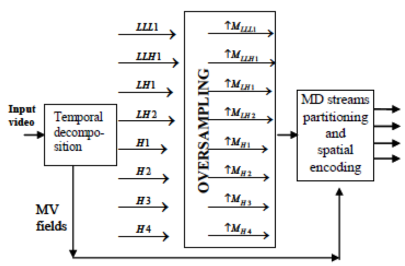


Figure 2 : Overview of the proposed MD coding scheme

A huge benefit of employing the 3-D wavelet scheme is that there is not require to send additional drift compensation data. DC MDVC has to send the drift compensation data to compensate for difference between the recursive predictions loops at the encoder and the decoder in case of loss. In fact the number of drift compensation streams rose exponentially with the total amount of descriptions. It is (2N- 2), where N is the total number of descriptions. This can be simply understood by considering that a drift compensation stream has to be formed for each scenario excluding when all or no descriptions are received.

Seran et al[5] focused on the difficulty of controlling unpredictable variation of distortion in 3D coders, which aimed at exploring the MCTF filter properties and we present an entire analysis of the filter and mathematical derivations. The temporal wavelet filter properties are recognized to be a main factor contributing to distortion variation. The problem of controlling the temporal distortion fluctuations has been addressed in a little design [32], [33]. In [32], distortion variation control is considered for the bi-directional unconstrained motion compensated temporal filtering and the distortion in the decoded frame is expressed as a function of the distortions in the reference frames at the equal temporal level. In [33], the association among the distortion in temporal wavelet subbands and the reconstructed frames are study for the modified 5/3 filter (ignoring sqrt(2)). Based on the association, a distortion ratio model is theoretically developed and an easy rate control algorithm is used to place priorities for the temporal subbands according to the distortion ratio.

The association among the distortion in the reconstructed frames and the filter coefficients study by seran et al[5]. On this foundation, scaling coefficients for the filter are calculated to control the distortion fluctuation. In this circumstance the model proposed by seran et al [5] considered the mainly popular bi-orthogonal 5/3 filter and quoted that this model can be directly extended for additional longer filters.

Zefeng Ni et al[6] proposed and develops a 3D wavelet codec based on MCTF and JPEG2000 for a novel advance for stable quality aimed bit allocation between T-bands for the applications of adaptive stored video streaming. The reconstructed structure is divided into dissimilar groups according to the types of their related temporal bands. We suggest an estimated mathematical model to describe the relationship between the T-band distortions and the distortions of the reconstructed frames. Since we consider stored video in this investigation, we can offline produce the model parameters. Throughout the online transmission period, given the existing network bandwidth, we initial perform the conventional JPEG2000-like optimum truncation. After that, a two-step process is used for reducing the PSNR fluctuation, where the fundamental idea is to alter the energy gains to balance the dissimilar contributions from diverse types of T-bands and then more or less equally allocate distortion among the Tbands at the identical level. Along with model proposed by Zefeng Ni et al[6], little of the articles[34], [35], [36], [37] in latest literature have looking into that how to assign bits to every temporal band (T-band) so that definite degree of stable quality can be achieved. Although the difficulty of stable quality aimed bit distribution has been well calculated for conventional hybrid codecs [38, 39], it is still an open question for MCTF based codecs. In the popular MC-EZBC codec [34], the authors suggest to discontinue bit plane scanning of every the GOPs at the identical fractional bit plane. However, it can only help accomplish similar distortion among T-bands, which does not lead to stable quality in reconstructed frames. This is because the distortion in T-bands propagates unequally into reconstructed frames, which is hard to model mathematically. In [35, 36], in order to smooth PSNR performance, an optimized quantization step is obtained by analyzing the motion performance throughout the temporal filtering. In [37], the authors suggest to utilize an adaptive update step for the temporal filtering. Compared with conventional implementation, these technique indeed help dropping the serious PSNR fluctuation in reconstructed frames.

However, they did not clearly address the problem of bit allocation among T-bands.

Yongjian Man et al[7] presented a new 3D-WT algorithm for video coding, which can considerably decrease the processing memory and attain a high coding presentation. This paper is organized as follows: in section 2, we explain the traditional 3D-WT algorithm and its shortage. According to the decomposition structure, the model proposed is dissimilar from traditional 3D wavelet coding. As the input sequence for the proposed new 3D wavelet decomposition structure is based on numerous groups, for every group, only the little frequency frame is remained in processing memory for the final temporal decomposition. According to the analysis of the proposed model, only the high frequency frames are exported following temporal decomposition, while the low frequency frame remains in memory for every group.

Yu Liu et al [8] projected an expansion to the lifting-based activity threading procedure from the frame-based coding to the object-based coding, involved by the inimitable compensation of the object-based coding that do not survive in other coding proposal. Object-based coding allows convenience and impressionability of object within a video series, and allows the organization of video content to endure the process of attainment, editing and allocation, which is useful for content-based search and recovery in MPEG-7. As an substitute to established video coding normal, 3D wavelet video coding has conventional much awareness recently. A main benefit of 3D wavelet video coding is that it can supply complete spatio-temporal-quality scalability with non-redundant 3D sub-band disintegration. In 3D wavelet video coding, action reimbursement is regularly integrated into the sequential wavelet make over to accomplish competent coding routine, leading to a class of algorithms normally called as activity rewarded sequential sieve (MCTF). Previous to this occupation, Xu et al. [40] projected a motion yarn (MT) technique that employs longer wavelet filter to develop the long-term association across border along movement route. The aim of MT is to shape as lots of long clothes as likely since too much small gear will considerably augment the figure of reproduction borders. Luo et al. [41] planned an advanced MT method to reduce the numeral of many-to-one drawing pixels and non-referred pixels in the innovative MT. though the trouble of frontier effects grounds by the truncation of many-to-one drawing case in the inventive MT can be well explain by the advanced MT, the non referred pixel case, which is allocate to use the action vector from neighboring movement strand in the higher MT, is not well resolve since the allocate movement vector may be not precise or even mistaken for non-referred pixel and may source some poverty on coding presentation.

Due to the boundary effects in spatial and sequential wavelet reconstruction, these artificial limitations will mortify greatly the coding recital. Consequently, it is improved to solve the problem of border line property, which survive in spatial and sequential makeover of object-based system concurrently, in a unified structure.

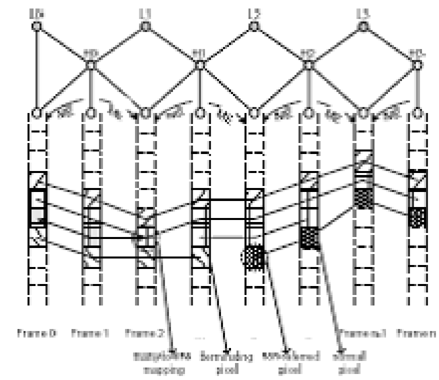


Fig. 3 : The object-based motion threading technique with lifting structure

To obtain more accurate proposal trajectory of each pixel and the functionality of object-based coding with illogical province of support, the object-based action threading with the exciting structure is projected, as shown in Fig.3. The object-based motion yarn using exciting structure aims to condense boundary possessions of synthetically terminating/emerging outfit in the preceding MT procedure.

Chen-Wei Deng et al[9] projected a new structure for scalable video convention. A mesh-based activity inference model is calculated and functional in this proposal, which engender a continuous proposal field. The earthly relationship is broken by Barbell thrilling [42]. In 3D wavelet video coding, wavelet change are exploit temporally across frames, and straight and up and down with each border, correspondingly. [34], [44] perform motion-compensated sequential strain (MCTF) in the inventive spatial field pursue by a spatial change on each sequential sub band. This is typically denote as a t+2D scheme. This preceding work was principally in the framework of a slab activity model, which poorly represent complex motion in real video sequences. Y. Andreopoulos et al [45] pertain spatial convert before the sequential one, which is typically referred to as 2D+t method. 2D+t can answer the spatial scalability concert issues of t+2D, but it experience from the shift-variant natural history of the DWT. [46] is a 2D+t+2D scheme. In such structure, spatial balance description of video succession are acquire opening from the superior resolution, while the coding system include inter scale prediction (ISP) machine in organize to develop the multiscale symbol idleness [8A]. These formats have archetypal inadequacy of over absolute change [47], the regulations competence is hard to achieve.

With reference to the limits claimed touching the representation [34], [44], [45], [46], [48] Chen-Wei Deng et al [9] projected a novel scalable 3D wavelet video coding support, which is a t+2D scheme. A mesh-based motion model is incorporated into the planned scaffold, which is helpful to perk up solidity concert. In totaling, due to the fact that different temporal sub bands have different characteristics, two different wavelet system algorithms were planned for the low and high-pass activist sub bands, correspondingly.

Ke Xu[10] planned a novel scheme that is forced by circulated cause system to correct the errors of momentous division in 3D wavelet video tributary. In this projected replica Extra in rank is engender by Wyner-Ziv codec and is throw to the decoder. While errors occur, the relevant parts in the same frames from EZBC decoder are used as side in sequence to decipher the Wyner-Ziv bits to construct a refined substitution of the dishonored ones. to terminate the rest parts of these border are shared with superior parts from the Wyner-Ziv portrayal to yield a correct succession.

Later to this application Sehoon Yea et al[49]planned a motion reimbursement entrenched zero-block coder (MC-EZBC) and shows that MC-EZBC can achieve higher concert evaluate with H.264 at a high rate. Furthermore, it is easy to extract the various rates, declaration and eminence succession from the raw video succession in decoder. However, MC-EZBC is still disposed to errors and encodes the variously noteworthy parts uniformly. A number of scheme, such as Auto Repeat demand (ARQ) or Forward Error improvement codes (FEC) or grouping of both can be used to truthful errors in conjecture.

FEC methods are shaped by adding together extra ensure bits in the facade of the packet to check the error bits and moderate the likelihood of error. While, they can neither acceptable the fracture errors nor inefficiently adapt to the guide. ARQ scheme can progress the quality of decode movies by a response guide to send the lost packet again. Nevertheless, it is very disposed to time stoppage. Time delay will be engorged if the waterway is concerned by noises more commonly.

Both FEC and ARQ applied in established codec can be engaged in MC-EZBC shielding the bit tributary supposedly. Nevertheless, the decoder of MC-EZBC can work well within at least 4 frames indoors, so the importance is more time delay. Recently, Wyner-Ziv coding has been planned on error rigidity [50], [51]. They encode the source using established codec and Wyner-Ziv codec, which is used to suitable the errors in other report in that order. Ke Xu[10]extensive the same idea to 3D wavelet coding.

Nobuhara et al[11] planned A video coding method using max-plus algebra based three dimensional wavelet convert (3DMP-Wavelets) . The recompense of MP wavelets those definite by max-plus algebra are

a. Since no hovering point calculation is requisite, the addition speed of MP-Wavelets is high.
b. Since no duplication operation is required, MPWavelets are hardware implementation oriented.
c. Since the problem of round-off errors is completely eliminated, MP-Wavelets are appropriate for digital watermarking, i.e., they be applied to exclusive rights fortification.

Hence 3DMP-Wavelets computational charge is very small since no balanced point calculations are done, max is computationally less expensive than the sum, and sum is computationally less costly than the product. The projected 3DMP-wavelets do better than a three dimensional linear wavelet in terms of velocity of the computation. Also, 3DMP-wavelets are hardware accomplishment oriented. This stimulates their study, mostly in view of some watch applications. It is easy to observe that in observation request it is important to have cheap strategy that can program a video succession at a low cost with rational eminence.

VII. Conclusion

This paper has provided a picture of various tools that have been designed in recent literature for visual data compression, in particular 3D wavelet transformation and coding. It has focused on multi-resolution representations with the use of the wavelet transform and its extensions to handle motion and ROI in visual sequences. For image compression, WT based approaches are showing quite competitive performance due to the energy compaction ability of the WT to handle piecewise polynomials that are known to well describe many natural images. In video sequences, the adequacy of such model falls apart unless a precise alignment of moving object trajectories can be achieved. This might remain only a challenge, since as for any segmentation problem; it is difficult to achieve it in a robust fashion, due to the complex information modeling which is often necessary. Most of the models studied in this paper are not generalized in the context of quality artifacts. Hence it remain an issue and providing research scope to identify the effective lifting schemes and 3D wavelet coding models in the context various contextual parameters such as region of interest, motion in streaming visuals and quality artifacts such as spatial scalability and temporal scalability.

References Références Referencias

1. Yuan Yuan; Monro, D.M.; , "3D wavelet video coding with replicated matching pursuits," Image Processing, 2005. ICIP 2005. IEEE International

Conference on , vol.1, no., pp. I- 69-72, 11-14 Sept. 2005 doi: 10.1109/ICIP.2005.1529689

2. Sun, Y.; Pan, F.; Kassim, A.A.; , "Perceptually adaptive rate-distortion optimization for variable block size motion alignment in 3D wavelet coding," Acoustics, Speech, and Signal Processing, 2005. Proceedings. (ICASSP '05). IEEE International Conference on , vol.2, no., pp. ii/929- ii/932 Vol. 2, 18-23 March 2005 doi: 10.1109/ICASSP.2005.1415558
3. Seran, V.; Kondi, L.P.; , "3D based video coding in the overcomplete discrete wavelet transform domain with reduced delay requirements," Image Processing, 2005. ICIP 2005. IEEE International Conference on , vol.3, no., pp. III- 233-6, 11-14 Sept. 2005 doi: 10.1109/ICIP.2005.1530371
4. Mavlankar, A.; Steinbach, E.; , "Multiple Description Video Coding Using Motion-Compensated Lifted 3D Wavelet Decomposition," Acoustics, Speech, and Signal Processing, 2005. Proceedings. (ICASSP '05). IEEE International Conference on , vol.2, no., pp. 65- 68, March 18-23, 2005 doi: 10.1109/ICASSP.2005.1415342
5. Seran, V.; Kondi, L.P.; , "New Scaling Coefficients for Biorthogonal Filter to Control Distortion Variation in 3D Wavelet Based Video Coding," Image Processing, 2006 IEEE International Conference on , vol., no., pp.1873-1876, 8-11 Oct. 2006 doi: 10.1109/ICIP.2006.313101
6. Zefeng Ni; Jianfei Cai; , "Constant Quality Aimed Bit Allocation for 3D Wavelet Based Video Coding," Multimedia and Expo, 2006 IEEE International Conference on , vol., no., pp.1657-1660, 9-12 July 2006 doi: 10.1109/ICME.2006.262866
7. Yongjian Man; Lehua Wu; Shibiao He; Yongjun Gu; , "A New Video Coding Based on 3D Wavelet Transform," Intelligent Systems Design and Applications, 2006. ISDA '06. Sixth International Conference on , vol.2, no., pp.359-363, 16-18 Oct. 2006 doi: 10.1109/ISDA.2006.253862
8. Yu Liu; Feng Wu; King Ngi Ngan; , "3D Object-based Scalable Wavelet Video Coding with Boundary Effect Suppression," Circuits and Systems, 2007. ISCAS 2007. IEEE International Symposium on , vol., no., pp.1755-1758, 27-30 May 2007 doi: 10.1109/ISCAS.2007.378011
9. Chen-Wei Deng; Bao-Jun Zhao; , "Scalable 3D wavelet video coding scheme," Signal Processing, 2008. ICSP 2008. 9th International Conference on , vol., no., pp.68-71, 26-29 Oct. 2008 doi: 10.1109/ICOSP.2008.4697070
10. Ke Xu; Sheng Fang; Zhe Li; , "Error Protection of 3D Wavelet Video Streaming Using Wyner-Ziv Video Coding for Lossy Network Transmission," Multimedia Information Networking and Security, 2009. MINES '09. International Conference on , vol.2, no., pp.222-225, 18-20 Nov. 2009 doi: 10.1109/MINES.2009.207
11. Nobuhara, H.; Tanabata, T.; Ono, M.; Bede, B.; , "3D-wavelet decomposition based on max-plus algebra and its application to video coding," Communications and Information Technologies (ISCIT), 2010 International Symposium on , vol., no., pp.292-295, 26-29 Oct. 2010 doi: 10.1109/ISCIT.2010.5664855
12. R. Neff and A. Zakhor, “Very low bit rate video coding based on matching pursuits”, IEEE Trans. Circuits and Systems for Video Tech., vol. 7, pp. 158–171, 1997.
13. Y. Yuan and D. M. Monro, “Improved matching pursuits image coding”, Proc. IEEE Int. Conf. Acoustics, Speech, Signal Process., (ICASSP 2005), Philadelphia, March 2005.
14. D. M. Monro, “Basis picking for matching pursuits image coding”, IEEE Int. Conf. Image Process. (ICIP2004), Singapore, October 2004.
15. A. Rahmoune, P. Vandergheynst and P. Frossard, “MP3D: highly scalable video coding scheme based on matching pursuit” IEEE Int. Conf. Acoustics Speech Signal Process., (ICASSP 2004), Montreal, May 2004.
16. C.-H. Chou and C.-W. Chen, “A perceptually optimized 3-d subband image codec for video communication over wireless channels,” IEEE Trans. Circuits Syst. Video Technol. 6(2), pp. 143-156, 1996.
17. Chun-Jen Tsai, Chih-Wei Tang, Ching-Ho Chen, and Ya-Hui Yu, “Adaptive Rate-distortion Optimization using perceptual Hints”, 2004 IEEE International Conference on Multimedia and Expo (ICME’2004), Taipei, Taiwan, June 27th – 30th, 2004.
18. ISO/IEC JTC 1/SC 29/WG 11N6520, Scalable Video Model 2.0, July 2004, Redmond, WA, USA
19. Y. Wang, S. Cui, and J. E. Fowler, “3D video coding using redundant-wavelet multihypothesis and motioncompensated temporal filtering,” in Proceedings of the IEEE International Conference on Image Processing, Barcelona, Spain, 2003, vol. 2, pp. 755–758.
20. Xin Li, “Scalable video compression via overcomplete motion compensated wavelet coding,” Signal Processing: Image Communication (special issue on”Subband/Wavelet Interframe Video Coding”), vol. 19, pp. 637–651, August 2004.
21. Y. Andreopoulos, A. Munteanu, J. Barbarien, M. van der Schaar, J. Cornelis, and P. Schelkens, “In-band motion compensated temporal filtering,” Signal Processing: Image Communication (special issue on ”Subband/Wavelet Interframe Video Coding”), vol. 19, pp. 653–673, August 2004.
22. D. Taubman and A. Zakhor, “Multirate 3-D subband coding of video,” IEEE Transactions on Image Processing, vol. 3, pp. 572–588, Sept. 1994.

23. S. T. Hsiang and J. W. Woods, "Embedded video coding using motion compensated 3-D subband/wavelet filter bank," in Proceedings of the Packet Video Workshop, Sardinia, Italy, May 2000.
24. A. Golwelkar and J. Woods, "Scalable video compression using longer motion compensated temporal filters," in Proc. SPIE VCIP, 2003, vol. 5150, pp. 1406–1416.
25. I.V. Bajic, J.W. Woods, "Domain-Based Multiple Description Coding of Images and Video," IEEE Transactions on Image Processing Vol. 12, No. 10, Oct. 2003.
26. J.G. Apostolopoulos, "Reliable Video Communication over Lossy Packet Networks using Multiple State Encoding and Path Diversity," Proc. Visual Communications and Image Processing, pp. 392-409, Jan. 2001.
27. A.A. Mavlankar, "Robust Video Communication using motion-compensated lifted 3-D wavelet coding," Master's Thesis, Technische Universität München, Sept. 2004.
28. B. Pesquet-Popescu, V. Bottreau, "Three-dimensional lifting schemes for motion compensated video compression," Proc. IEEE Int. Conference on Acoustics, Speech and Signal Processing, Vol. 3, Salt Lake City, UT, 2001, pp. 1793–1796.
29. L. Luo, J. Li, S. Li, Z. Zhuang, Y.-Q. Zhang, "Motion compensated lifting wavelet and its application in video coding," Proc. IEEE International Conference on Multimedia and Expo, Tokyo, Japan, 2001, pp. 481–484.
30. A. Secker, D. Taubman, "Motion-compensated highly scalable video compression using an adaptive 3D wavelet transform based on lifting," Proc. IEEE Int. Conference on Image Processing, Vol. 2, Thessaloniki, Greece, 2001, pp. 1029– 1032.
31. N. Franchi, M. Fumagalli, R. Lancini, "Multiple Description Coding For Scalable and Robust Transmission over IP," Proc. of 13th Packet Video Workshop, Nantes, France, Apr. 2003.
32. A. Munteanu, Y. Andreopoulos, M. van der Schaar, and J. Cornelis, "Control of the distortion variation in video coding systems based on motion compensated temporal filtering," Proceedings of the ICIP, vol. 2, pp. 62–64, 2003.
33. V. Seran and L. P. Kondi, "Distortion fluctuation control for 3D wavelet based video coding," Proceedings of SPIE VCIP, Jan. 2006.
34. P. Chen and J. W. Woods, "Bidirectional MC-EZBC with lifting implementation," IEEE Trans. Circuits Syst. Video Technol., vol. 14, no. 10, pp. 1183–1194, Oct. 2004.
35. K. Hanke, J. R. Ohm, and T. Rusert, "Adaptation of filters and quantization in spatio-temporal wavelet coding with motion compensation," Proc. Picture Coding Symposium (PCS), pp. 49–54, 2003.
36. T. Rusert, K. Hanke, and J. R. Ohm, "Transition filtering and optimized quantization in interframe wavelet video coding," Proc. Visual Communication and Image Processing (VCIP), pp. 682–393, 2003.
37. A. Mavlankar, S. E Han, C. L. Chang, and B. Girod, "A new update step for reduction of PSNR fluctuations in motioncompensated lifted wavelet video coding," Proc. IEEE Int. Workshop on Multimedia Signal Processing (MMSP), 2005.
38. X. M. Zhang, A. Vetro, Y. Q. Shi, and H. Sun, "Constant quality constrained rate allocation for FGS-coded video," IEEE Trans. Circuits Syst. Video Technol., p. 121C130, Feb. 2003.
39. J. Cai, Z. He, and C. W. Chen, "A novel frame-level bit allocation based on two-pass video encoding for low bit rate video streaming applications," accepted by Journal of Visual Communications and Image Representation.
40. J. Xu, Z. Xiong, S. Li and Y.-Q. Zhang, "Three-dimensional embedded subband coding with optimized truncation (3D ESCOT)", Applied and Computational Harmonic Analysis, pp.290-315, 2001
41. L. Luo, F. Wu, S. Li, Z. Xiong, Z. Zhuang, "Advanced motion threading for 3D wavelet video coding ", Signal Process.: Image Comm., vol. 19, no 7, pp 601-616, 2004.
42. R. Xiong, F. Wu, J. Xu, S. Li, and Y.-Q Zhang, "Barbell lifting wavelet transform for highly scalable video coding", in Proc. PCS, San Francisco, CA, Dec. 2004, pp.237-242.
43. D. Taubman, "High performance scalable image compression with EBCOT," IEEE Trans. Image Processing, vol. 9, pp. 1158–1170, July 2000.
44. K. Ho and D. Lun, "Efficient wavelet based temporally scalable video coding", in Proc. Int. Conf. Image Process, New York, USA, Aug. 2002, pp.881-884.
45. Y. Andreopoulos, A. Munteanu, G.V.D. Auwera, J. Cornelis, and P. Schelkens, "Complete-to-overcomplete discrete wavelet transforms: Theory and applications", IEEE Trans. Signal Process, vol. 53, No. 4, 2005, pp.1398-1412.
46. "Scalable Video Model v2.0 ISO/IEC JTC1/SC29/ WG11", 69th MPEG Meeting, Redmond, WA, USA, Tech. Rep. N6520, Jul. 2004, ISO/MPEG Video.
47. Nicola Adami, Alberto Signoroni, and Riccardo Leonardi, "State-of-the-art and trends in scalable video compression with wavelet-based approaches", IEEE Trans. Circuits Syst. Video Technol., vol. 17, No. 9, Sep. 2007, pp.1238-1255.
48. G. Rath and C. Guillemot, "Representing laplacian pyramids with varying amount of redundancy", presented at the Eur. Signal Process. Conf, Florence, Italy, Sep. 2006.
49. Sehoon Yea and William. A. Pearlman. "On scalable lossless video coding based on sub-pixel accurate

MCTF," Proceedings of SPIE -- Volume 6077 Visual Communications and Image Processing, 2006
50. A. Aaron, S. Rane, D. rebollo-Monedero, and B. Girod, " Systematic Lossy Forward Error Protection for Video Waveforms," in Proc. IEEE Int. Conf. Image Proc, 2003.
51. J. Wang, A. Majumdar, K. Ramchandran, and H. Garudadri, "Robust video transmission over a lossy network using a distributed source coded auxiliary channel," in Proc. Picture Coding Symposium(PCS),2004.
52. K. H. Tzou, "Progressive image transmission: A review and comparison of techniques," Opt. Eng., vol. 26, pp. 581–589, July 1987.
53. C. Christopoulos, "JPEG2000 Verification Model 8.5,", ISO/IEC JTC1/SC29/WG1, Report N1878, 2000.
54. W. B. Pennebaker and J. L. Mitchell, JPEG Still Image Data Compression Standard. New York: Van Nostrand Reinhold, 1993.
55. X. Wu, "High-order context modeling and embedded conditional entropy coding of wavelet coefficients for image compression," in Proc. 31st Asilomar Conf. Signals, Systems Computers, vol. 2, 1997, pp. 1378–13 827.
56. L. Luo, F. Wu, S. Li, Z. Xiong, Z. Zhuang, "Advanced motion threading for 3D wavelet video coding," Signal Processing: Image Communication, vol. 19, no. 7, pp. 601-616, 2004
57. R. Xiong, F. Wu, S. Li, Z. Xiong, Y.-Q. Zhang, "Exploiting temporal correlation with block-size adaptive motion alignment for 3D wavelet coding," SPIE VCIP2004, vol. 5308, pp 144-155, San Jose, Jan.2004.
58. P. Schelkens, X. Giro, J. Barbarien, and J. Cornelis, "3-D compression of medical data based on cube-splitting and embedded block coding," Proc. ProRISC/IEEE Workshop, pp. 495–506, Dec. 2000.
59. F. W. Wheeler, "Trellis source coding and memory constrained image coding," Ph.D. dissertation, Dept. Elect., Comput. Syst. Eng., Renselaer Polytech. Inst., Troy, New York, 2000.
60. J. C. Ye and M. van der Schaar, "Fully scalable 3D overcomplete wavelet video coding using adaptive motion compensated temporal filtering", Proc. VCIP2003, Vol. 5150, pp. 1169-1180, Lugano, Switzerland, 2003
61. G. Lilienfield and J.Woods, "Scalable high definition video coding," in Proc. SPIE Visual Communication and Image Processing, San Jose, CA, 1998, pp. 158–169.
62. K. Shen and E. Delp, "Wavelet based rate scalable video compression," IEEE Trans. Circuits Syst. Video Technol., vol. 9, pp. 109–122, Feb. 1999.
63. T. Tsunashima, J. Stampleman, and V. Bove, "A scalable motion-compensated subband image coder," IEEE Trans. Commun., vol. 42, pp. 1894–1901, 1994.
64. P.-Y. Cheng, J. Li, and C.-C. Kuo, "Multiscale video compression using wavelet transform and motion compensation," Proc. Int. Conf. Image Processing, vol. 1, pp. 606–609, 1995.
65. U. Benzler, "Scalable multiresolution video coding using sub-band decomposition," in Proc. 1st Int.WorkshopWireless Image/Video Communication, Loughborough, U.K., 1996, pp. 109–114.
66. U. Benzler, "Scalable multi-resolution video coding using a combined subband-DCT approach," in Proc. Picture Coding Symp., Portland, OR, 1999, pp. 17–20.
67. M. Doman´ski, A.Łuczak, S. Mac´kowiak, and R. S´ wierczyn´ski, "Hybrid coding of video with spatio-temporal scalability using subband decomposition," in Proc. Signal Processing IX: Theories and Applications, Rhodes, Greece, Sept. 1998, pp. 53–56
68. "Hybrid coding of video with spatio-temporal scalability using subband decomposition," in Proc. SPIE San Jose, CA, 1999, vol. 3653, pp. 1018–1025.
69. R. Ohm, "Three-dimensional subband coding with motion-compensation," IEEE Trans. Image Processing, vol. 3, pp. 559–571, Sept. 1994.
70. Ch. Podilchuk, N. Jayant, and N. Farvardin, "Three-dimensional subband coding of video," IEEE Trans. Image Processing, vol. 4, pp. 125–139, Feb. 1995.
71. H. Katata, N. Ito, H. Kusao, "Temporal-Scalable Coding Based on Image Content," IEEE Trans. Circuits and Systems for Video Tech., Vol. 7, No. 1, pp. 52-59, Feb. 1997.
72. B.-J. Kim , W. A. Pearlman, "An Embedded Wavelet Video Coder Using Three-Dimensional Set Partitioning in Hierarchical Trees," Proc. IEEE DCC, pp. 251-260, 1997.
73. W. Tan, E. Chang, and A. Zakhor, "Real Time Software Implementation of Scalable Video Codec," Proc. IEEE Int. Conference on Image Proc., vol. 1, pp. 17-20, 1996.
74. J.-R.Ohm, "Three-Dimensional Subband Coding with Motion Compensation," IEEE Trans. Image Processing, Vol. 3, No. 5, pp. 572-588, Sept. 1994.
75. S.-J. Choi, J. W. Woods, "Three-dimensional subband/ wavelet coding of video with motion compensation," Proc. SPIE Visual Communications and Image Processing, 1997.
76. P. Schelkens, J. Barbarien, and J. Cornelis, "Volumetric data compression based on cube-splitting," in Proc. 21st Symp. Information Technology in the Benelux, vol. 21, May 2000, pp. 93–100.
77. "Compression of volumetric medical data based on cube-splitting," in Proc. SPIE Conf. Applications of Digital Image Processing XXIII, vol. 4115, July–Aug. 2000, pp. 91–101.

78. P. Schelkens, X. Giro, J. Barbarien, A. Munteanu, and J. Cornelis, "Compression of Medical Volumetric Data,", ISO/IEC JTC1/SC29/WG1, N1712, 2000.
79. T. Breger, "Optimal quantizers and permutation codes," IEEE Trans.Inform. Theory, vol. 18, pp. 759–765, Nov. 1972.
80. P. Schelkens, "Multidimensional wavelet coding—algorithms and implementations," Ph.D. dissertation, Dept. Electron. Inform. Processing (ETRO), Vrije Univ. Brussel, Brussel, Belgium, 2001.
81. G. M. Morton, A Computer Oriented Geodetic Data Base and a New Technique in File Sequencing. Ottawa, ON, Canada: IBM Ltd, 1966.
82. M. C. Lee, R. K. W. Chan, and D. A. Adjeroh, "Quantization of 3-D-DCT coefficients and scan order for video compression," J. Vis. Commun. Image Representation, vol. 8, pp. 405–422, 1997.
83. I. H. Witten, R. M. Neal, and J. G. Cleary, "Arithmetic coding for data compression," Commun. ACM, vol. 30, pp. 520–540, June 1987.
84. C. K. Chui, R. Yi, and Teralogic Inc., Menlo Park, California, "System and Method for Nested Split Coding of Sparse Data Sets," Patent US:005 748 116A, May 1998.
85. A. Bilgin, G. Zweig, and M.W. Marcelin, "Three-dimensional compression with integerwavelet transform," Appl. Opt., vol. 39, pp. 1799–1814, Apr. 2000.
86. M. Adams and K. Faouzi, "Reversible integer-to-integer wavelet transforms for image compression: Performance evaluation and analysis," IEEE Trans. Image Processing, vol. 9, pp. 1010–1024, June 2000.
87. A. Said andW. Pearlman, "An image multiresolution representation for lossless and lossy compression," IEEE Trans. Image Processing, vol. 5, pp. 1303–1310, Sept. 1996.
88. Y. Kim and W. A. Pearlman, "Lossless volumetric medical image compression," in Proc. SPIE Conf. Applications of Digital Image Processing XXII, vol. 3808, July 1999, pp. 305–312.
89. Z. Xiong, X.Wu, D. Y. Yun, andW. A. Pearlman, "Progressive coding of medical volumetric data using three-dimensional integer wavelet packet transform," in Proc. SPIE Conf. Visual Communications, vol. 3653, Jan. 1999, pp. 327–335.
90. Z. Xiong, K. Ramchandran, and M. T. Orchard, "Wavelet packet image coding using space-frequency quantization," IEEE Trans. Image Processing, vol. 7, pp. 892–898, June 1998.
91. B.-J. Kim andW. A. Pearlman, "Low-delay embedded 3-Dwavelet color video coding with SPIHT," Proc. SPIE, vol. 3309, pp. 955–964, 1998.
92. Y. S. Kim andW. A. Pearlman, "Stripe-based SPIHT lossy compression of volumetric medical images for low memory usage and uniform reconstruction quality," in Proc. ICASSP, vol. 4, June 2000, pp. 2031–2034.

This page is intentionally left blank

Global Journal of Computer Science and Technology
Graphics & Vision
Volume 12 Issue 12 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Performance Analysis of Intensity Averaging by Anisotropic diffusion Method for MRI Denoising Corrupted by Random Noise

By Ms. Ami vibhakar, Mukesh Tiwari, Jaikaran singh & Sanjay rathore
Ragiv Gandhi Technical University

Abstract - The two parameters which plays important role in MRI (magnetic resonance imaging), acquired by various imaging modalities are Feature extraction and object recognition. These operations will become difficult if the images are corrupted with noise. Noise in MR image is always random type of noise. This noise will change the value of amplitude and phase of each pixel in MR image. Due to this, MR image gets corrupted and we cannot make perfect diagnostic for a body. So noise removal is essential task for perfect diagnostic. There are different approaches for noise reduction, each of which has its own advantages and limitation. MRI denoising is a difficult task as fine details in medical image containing diagnostic information should not be removed during noise removal process. In this paper, we are representing an algorithm for MRI denoising in which we are using iterations and Gaussian blurring for amplitude reconstruction and image fusion, anisotropic diffusion and FFT for phase reconstruction. We are using the PSNR(Peak signal to noise ration), MSE(Mean square error) and RMSE(Root mean square error) as performance matrices to measure the quality of denoised MRI .The final result shows that this method is effectively removing the noise while preserving the edge and fine information in the images.

Keywords : MRI, Random noise, iteration, Gaussian blur, image fusion, anisotropic diffusion, PSNR, MSE, Image denoising.

GJCST-F Classification: I.4.3

PERFORMANCE ANALYSIS OF INTENSITY AVERAGING BY ANISOTROPIC DIFFUSION METHOD FOR MRI DENOISING CORRUPTED BY RANDOM NOISE

Strictly as per the compliance and regulations of:

Performance Analysis of Intensity Averaging by Anisotropic diffusion Method for MRI Denoising Corrupted by Random Noise

Ms. Ami vibhakar [α], Mukesh Tiwari [σ], Jaikaran singh [ρ] & Sanjay rathore [ω]

Abstract - The two parameters which plays important role in MRI (magnetic resonance imaging), acquired by various imaging modalities are Feature extraction and object recognition. These operations will become difficult if the images are corrupted with noise. Noise in MR image is always random type of noise. This noise will change the value of amplitude and phase of each pixel in MR image. Due to this, MR image gets corrupted and we cannot make perfect diagnostic for a body. So noise removal is essential task for perfect diagnostic. There are different approaches for noise reduction, each of which has its own advantages and limitation. MRI denoising is a difficult task as fine details in medical image containing diagnostic information should not be removed during noise removal process. In this paper, we are representing an algorithm for MRI denoising in which we are using iterations and Gaussian blurring for amplitude reconstruction and image fusion, anisotropic diffusion and FFT for phase reconstruction. We are using the PSNR(Peak signal to noise ration), MSE(Mean square error) and RMSE(Root mean square error) as performance matrices to measure the quality of denoised MRI .The final result shows that this method is effectively removing the noise while preserving the edge and fine information in the images.

Keywords : MRI, Random noise, iteration, Gaussian blur, image fusion, anisotropic diffusion, PSNR, MSE, Image denoising.

I. Introduction

MRI Stands for Magnetic Resonance Imaging; once called Nuclear Magnetic Resonance Imaging. The "Nuclear" was dropped off about 15 years ago because of fears that people would think there was something radioactive involved, which there is not. MRI is a way of getting pictures of various parts of your body without the use of x-rays, unlike regular x-rays pictures and CAT scans. A MRI scanner consists of a large and very strong magnet in which the patient lies. A radio wave antenna is used to send signals to the body and then receive signals back. These returning signals are converted into pictures by a computer attached to the scanner. Pictures of almost any part of your body can be obtained at almost any particular angle.

Medical information, acquired from MRI and composed of clinical data, images and other physiological signals, has become an essential part of a patient's care for diagnosis in medical field. Over the past three decades, there is a vast development in information technology (IT) & Medical Instrumentation, which has improved the level of medical imaging. This development are Computed Tomography (CT), Magnetic Resonance Imaging(MRI), the different digital radiological processes for vascular, cardiovascular and contrast imaging, mammography, diagnostic ultrasound imaging, nuclear medical imaging with Single Photon.

Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET). All these methods generate good quality of medical image [1] and each has its own specific features corresponding to the physical and physiological phenomena studied, as shown in "Fig.1

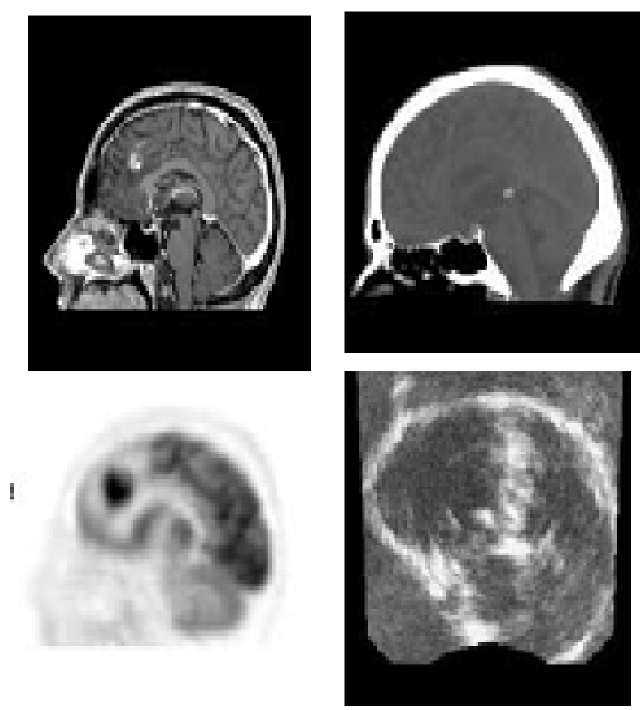


Figure 1 : Sagittal slices of the brain by different imaging modalities: a) magnetic resonance imaging (MRI), b) computed tomography (CT), c) positron emission tomography (PET), d) ultrasound (US)

All medical images contain Random noise. The presence of noise gives an image a mottled, grainy,

E-mail : akvibhakar@aits.edu.in
E-mail : mukesh_79@yahoo.co.in
E-mail : ec.sssist@gmail.com
E-mail : rathore_sanjay1@rediffmail.com

textured, or snowy appearance. Image noise comes from a variety of sources. No imaging method is free of noise, but noise is much more prevalent in certain types of imaging procedures than in others. Noise is also significant in MRI (Medical Resonance Imaging), CT, and ultrasound imaging. In comparison to these, radiography produces images with the least noise. Fluoroscopic images are slightly noisier than radiographic images. The presence of noise degrades the image quality and decreases visibility of lower contrast image. So there is a need for noise removal technique to improve the image quality and to recover the fine details of image which is required for perfect diagnostic. This paper is divided into seven sections. Section one gives idea about MRI and denoising. Section two shows a literature survey .Section three defines implementation of algorithm .Section four and five gives idea about Gaussian blur and anisotropic diffusion. Section six defines pproposed algorithm for denoising while section seven is conclusion

II. Related Work

Various algorithms for image denoising are discussed in [2]. The de-noising of Magnetic Resonance Images using wave atom shrinkage is proposed in [3] and also proved that this approach achieves a better SNR compared to wavelet and curvelet shrinkages. A NL-Denoising method for Rician noise reduction is proposed in [4 & 5].In [6], Total Variation Wavelet-Based technique is used to remove a noise from MR image. The method to improve image quality using adaptive threshold based on contourlet transform is given in [7]. A new filter to reduce random noise in multicomponent MR images by spatially averaging similar pixels and a local principal component analysis decomposition using information from all available image components to perform the denoising process is proposed in [8]. An estimator using a priori information for devising a single dimensional noise cancellation for the variance of the thermal noise in magnetic resonance imaging (MRI) systems called ML estimator has been proposed in [9]. A noise removal technique using 4th order PDE is introduced in [10] to reduce noise in MRI images.. A phase error estimation scheme based on iteratively applying a series of non-linear filters each used to modify the estimate into greater agreement with one piece of knowledge, until the output converges to a stable estimate is introduced in [11].

III. Implementation

Fig. 3 shows the block diagram, gives general idea for MRI denoising using intensity averaging method.

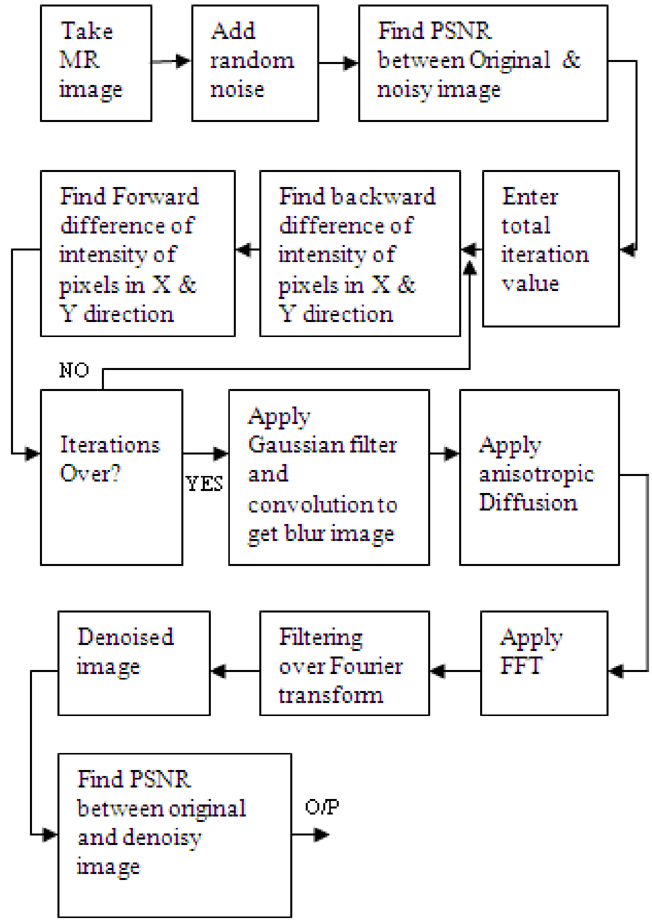


Fig. 3 : Block diagram of intensity averaging algorithm

In proposed algorithm we have taken the image of [fig.2] for evaluating our method. First we will apply amplitude correction on noisy MR image by finding forward and backward difference of intensity of pixels in X and Y direction. This gives average type of value to each pixel and then image is blurred by Gaussian filter and convolution. After completion of this amplitude correction, we apply a phase correction algorithm. Here, we are splitting amplitude corrected image into its red, green and blue band and then we are rotating each band by appropriate amount to correct the phase of MR image. After this, we are applying anisotropic diffusion and FFT to remove the noise from image.

Fig. 2 : MRI of knee

IV. Gaussian Blur

Gaussian blur is also known as Gaussian smoothing used to blur (smooth) the image. Typically it is used to reduce a random noise from the image. Mathemetically, Gaussian blur is equivalent to applying a convolution between image and Gaussian function [12, 13]. Gaussian distribution in 1-D is given as,

$$G(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2\sigma^2}}$$

Where σ is the standard deviation of distribution. In 2-D, an isotropic Gaussian has the form,

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

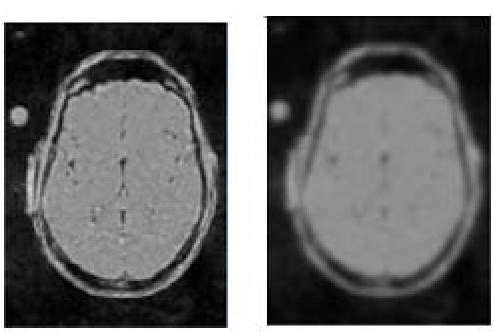
Here, we are producing a discrete approximation of the Gaussian function before we perform the convolution as image is considered as a collection of pixels. Ideally we require an infinitely large convolution kernel because the Gaussian distribution is non-zero everywhere, but in practice we can truncate the kernel as Gaussian distribution in it is effectively zero, more than about three standard deviations from the mean. The degree of smoothing depends on the value of standard deviation. The Gaussian outputs a `weighted average' of each pixel's neighborhood, with the average weighted towards the value of the central pixels. So,

$$I(x,y) = I0(x,y) * G(x,y) \tag{1}$$

I(X,Y)=Gaussian blurred image
I0 (x,y)= Noisy image
G(x,y,t)=Gaussian filter function

This is in contrast to the mean filter's uniformly weighted average.[14] Because of this, a Gaussian provides gentler smoothing and preserves edges better than a similarly sized mean filter. The main problem with Gaussian filter is,

- Loss of fine detail
- Smoothing across boundaries as shown in fig.3.



(a) (b)

Fig. 3 : (a) Before Gaussian blur (b) After Gaussian blur

This problem can be solved by anisotropic diffusion as discussed below.

V. Image Fusion and Anisotropic Diffusion

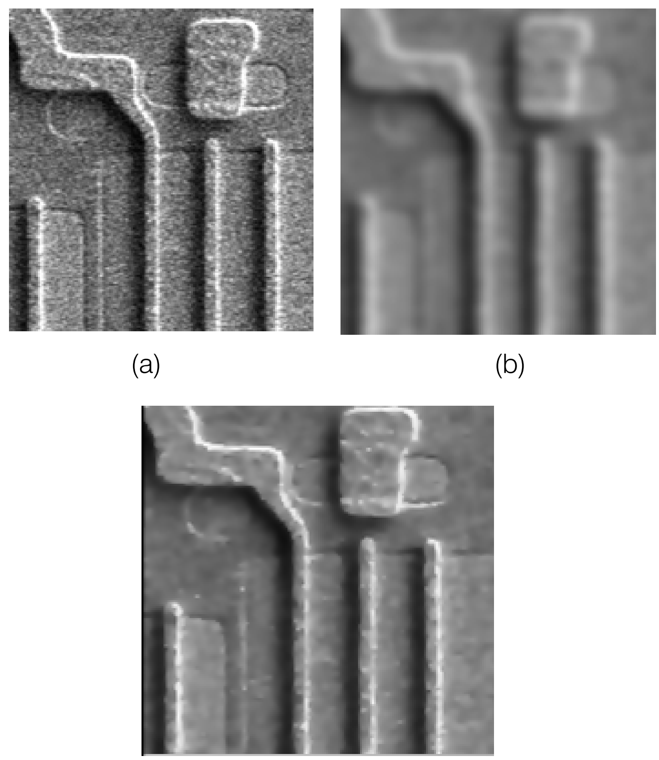
Image fusion describes the concept of combining multiple images into one image which gives more information compared to individual one [15]. Linear diffusion provides over smoothing of image as shown in fig. 3, we will use non-linear smoothing in which each pixel is treated with varying intensity depending on its neighboring value. In general,

if (x,y) is a part of an edge ➔ apply little smoothing
if not a part of an edge ➔ apply full smoothing

This idea can be implemented by using a gradient function as given below.

$$Grad(I) = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}\right)$$

So non linear smoothing gives good intraregion smoothing as well as doesn't do much with interregion smoothing (edges and lines) as shown in fig.4 [16]



(a) (b)

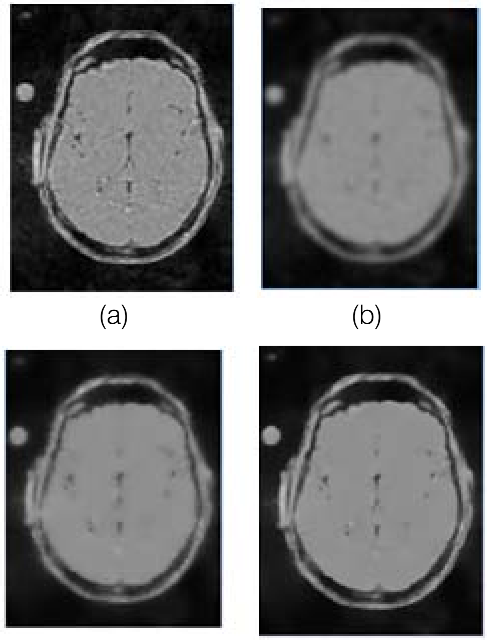
(c)

Fig. 4 : (a) Original image (b) image after linear smoothing (c) image after Non-linear smoothing

This problem can be solved with anisotropic diffusion [17] when equation no.1 can be viewed as heat equation as shown below,

$$It = \Delta I = (Ixx, Iyy)$$

The matter in an image is not heat, but brightness level. So, an image could be generalized to be a surface, where bright spots are "hot" and dark spots are "cold". So the idea is to use a varying size of kernel. Comparison of linear, non-linear and anisotropic diffusion is shown in fig.5



(a) (b) (c) (d)

Fig. 5 : (a) original image (b) image after linear fusion (c) image after non-linear fusion (d) image after anisotropic fusion

VI. Proposed Algorithm

1. I/P Image.
2. Add Random noise
3. Find PSNR between Original and Noisy Image.
4. Steps for applying Magnitude Reconstruction using iteration method on MR image:
    a. Enter iteration value.
    b. Find the backward difference of intensity of pixels in X and Y direction till the iteration ends.
    c. Find the forward difference of intensity of pixels in X and Y direction till the iteration ends.
    d. Find PSNR between Original and Denoisy Image after iteration process [psnr2].
    e. Apply Gaussian filters to blur the image.
    f. Perform convolution.
    g. Find PSNR between Original and Denoisy image after Gaussian blurring. [psnr3].
5. Steps for applying Phase Reconstruction on Noisy MR image.
    a. Apply anisotropic diffusion.
    b. Find PSNR between Original and Denoisy image after iteration Process for Smoothing [psnr4]
    c. Apply FFT on Diffused Image.
    d. Perform the Filtering over Fourier transform.
    e. Find PSNR between Original and Denoisy image after FFT on filtering [psnr5].
    f. Apply Image Sharpening Using Filtering.
6. Denoised Image

Now, we will evaluate the algorithm by taking different values of iterations (A).

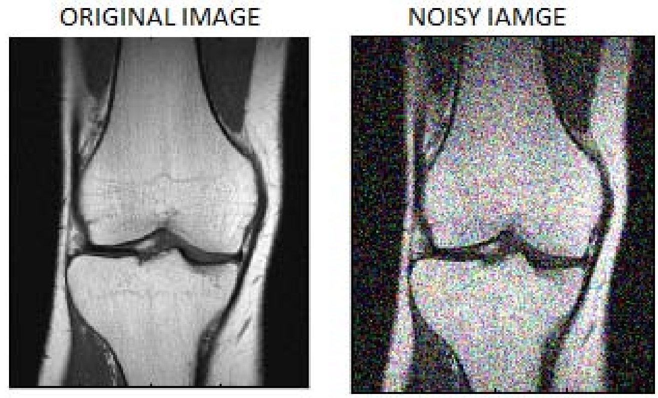
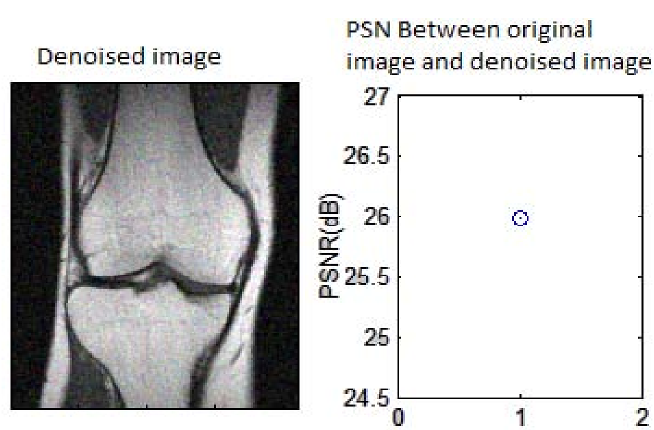


Fig. 6 : (a) Input image (b) Noisy input image

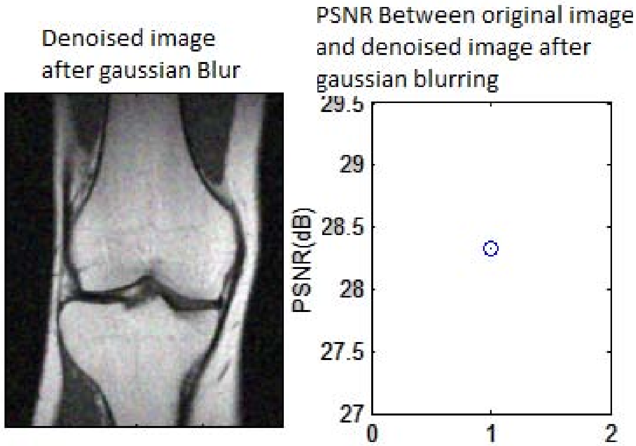
Now apply different values of "A" (no. of iterations) on noisy MR image as shown in fig.6 (b). As the value of "A" increases, we are getting more and more noise removal from noisy image as shown in fig. (7), (8) and (9). We are taking following parameters to evaluate the algorithm.

- Psnr2:- PSNR between Original and Denoisy image after iteration process
- psnr3:- PSNR between Original and Denoisy image after Gaussian blurring Image.
- Psnr4:- PSNR between Original and Denoisy image after iteration process for Smoothing using anisotropic diffusion.
- Psnr5:- PSNR between Original and Denoisy image After FFT on filtering
- Mse2:-Difference between Original and Denoisy image after iteration process
- Mse3:-Difference between Original and Denoisy image after Gaussian blurring Image.
- Mse4:- Difference between Original and Denoisy image after iteration process for Smoothing using anisotropic diffusion.
- Mse5:-Difference between Original and Denoisy image After FFT on filtering.

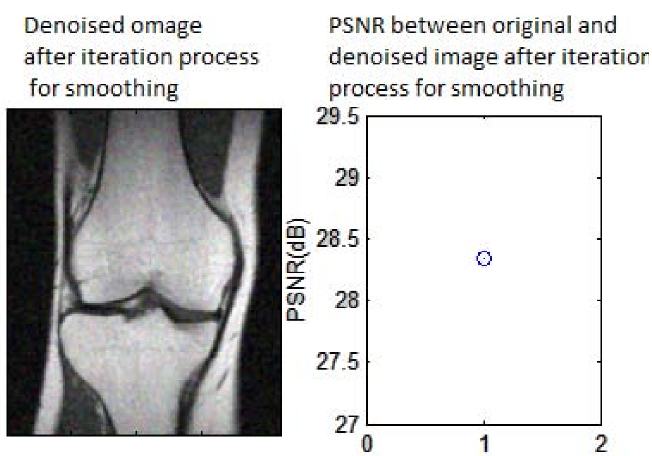
FOR A=10:-



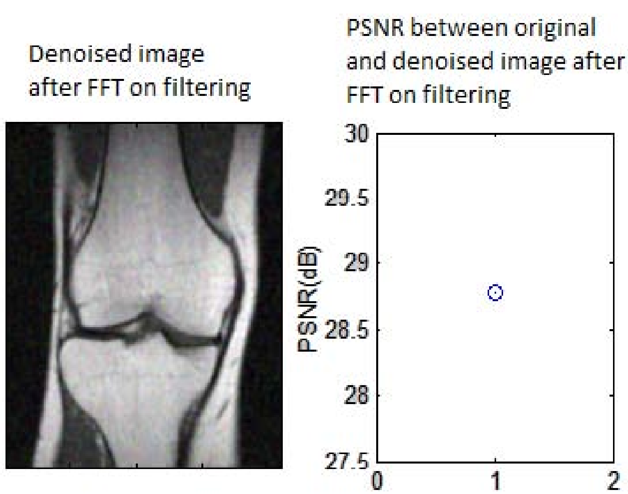
(a) (b)



(c) (d)



(e) (f)



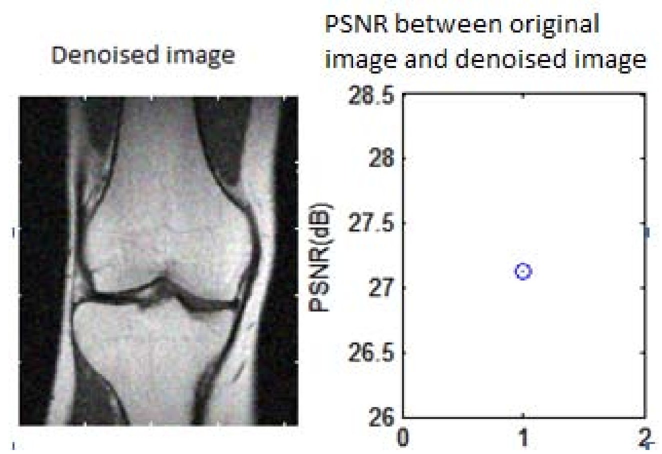
(g) (h)

Fig. 7 : Denoised image after (a) iterations (c) Gaussian blur (e)iteration process for smoothing using anisotropic diffusion (g) FFT on filtering

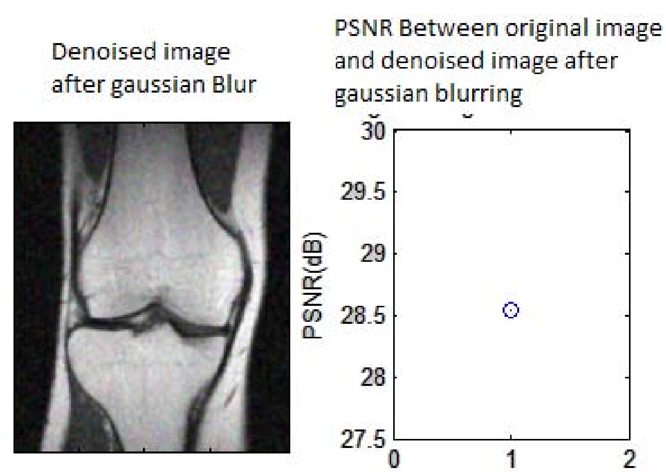
Table 1 : Obtained Result for A=10

Psnr2=25.98	Mse2=15.51
Psnr3=28.35	Mse3=17.86
Psnr4=24.37	Mse4=17.95
Psnr5=28.81	Mse5=18.2

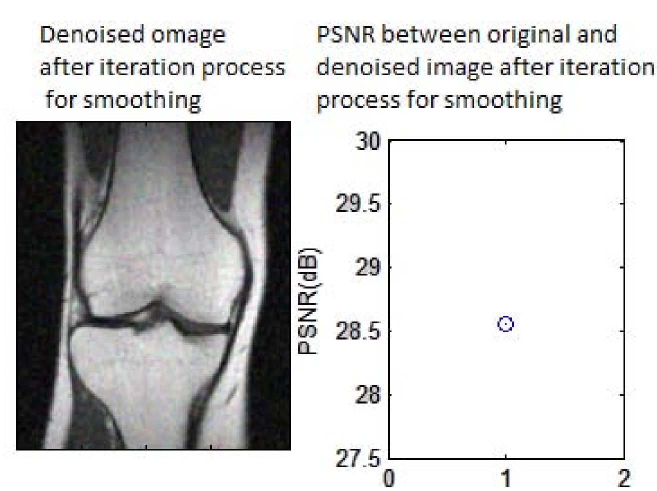
FOR A=15:-



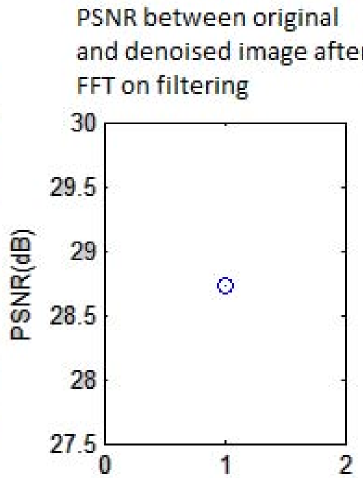
(a) (b)



(c) (d)



(e) (f)



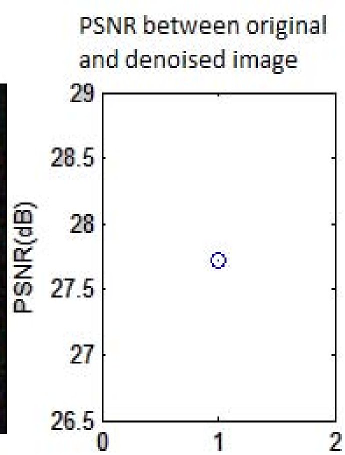
(g) (h)

Fig. 8 : Denoised image after (a) iterations (c) Gaussian blur (e)iteration process for smoothing using anisotropic diffusion (g) FFT on filtering

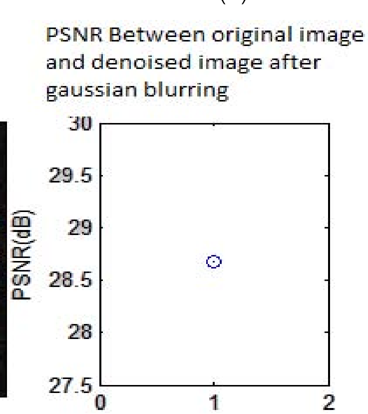
Table 2 : Obtained Result for A=15

Psnr2=27.10	Mse2=16.63
Psnr3=28.53	Mse3=18.06
Psnr4=27.60	Mse4=18.07
Psnr5=28.73	Mse5=18.25

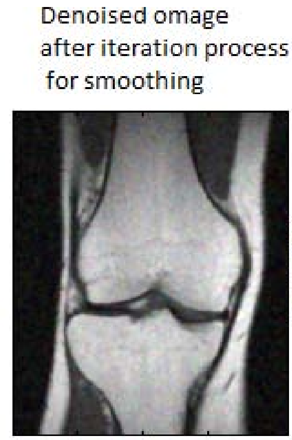
FOR A=20:-

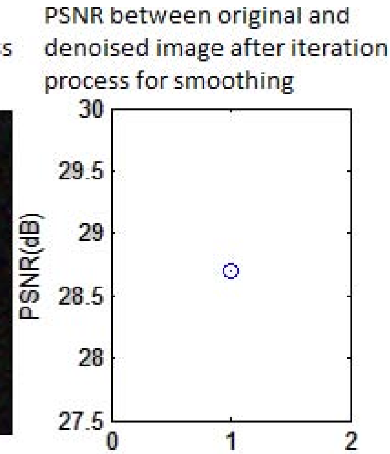


(a) (b)

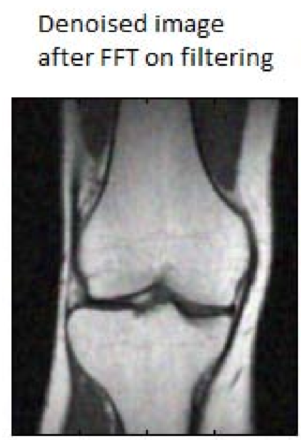


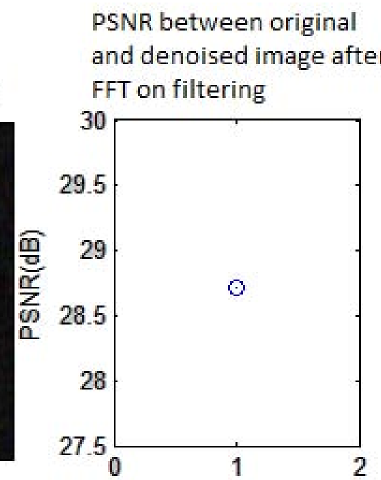
(c) (d)





(e) (f)





(g) (h)

Fig. 9 : Denoised image after (a) iterations (c) Gaussian blur (e)iteration process for smoothing using anisotropic diffusion (g) FFT on filtering

Table 3 : Obtained Result for A=20

Psnr2=27.75	Mse2=17.28
Psnr3=28.69	Mse3=18.22
Psnr4=28.70	Mse4=18.23
Psnr5=28.75	Mse5=18.29

VII. Conclusion

From the above result we conclude that, our algorithm is efficiently removing the noise from MR image. As number of iterations increases ("A"), we are getting more and more improved image. Experimental results show that, we are getting good Result in terms of PSNR and image quality. This algorithm is capable of removing noise from images and at the same time it is preserving fine details of images too. We also conclude that, for large value of iteration (A>25), increment in PSNR is less compared to small values of iterations (A<25).

References Références Referencias

1. Isaac Bankman, "Handbook of Medical Imaging", Academic Press, 2000.
2. Mukesh C. Motwani, Mukesh C. Gadiya, Rakhi C. Motwani and Frederick C. Harris "Survey of Image Denoising Techniques"
3. J.Rajeesh, R.S.Moni, S.Palanikumar & T.Gopalakrishnan "Noise Reduction in Magnetic Resonance Images using Wave Atom Shrinkage" International Journal of Image Processing (IJIP), Volume(4) : Issue(2) 2010 pp: 131-141.
4. Milindkumar V. Sarode, Dr. Prashant R. Deshmukh " Performance Evaluation of Noise Reduction Algorithm in Magnetic Resonance Images " IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 2, March 2011
5. Milindkumar V. Sarode, Dr. Prashant R. Deshmukh "Performance Evaluation of Rician Noise Reduction Algorithm in Magnetic Resonance Images" Journal of Emerging Trends in Computing and Information Sciences Volume 2 Special Issue 2010-11 CIS Journal ISSN 2079- 8407 pp 39-44.
6. YangWang and Haomin Zhou" Total Variation Wavelet-Based Medical Image Denoising" Hindawi Publishing Corporation International Journal of Biomedical Imaging Volume 2006, Article ID 89095
7. S.Satheesh, Dr.KVSVR Prasad," Medical image denoising using adaptive threshold based on contourlet transform", Advanced Computing: An International Journal (ACIJ), Vol.2, No.2, March 2011
8. José V. Manjón, Neil A. Thacker, Juan J. Lull, Gracian Garcia-Martí, Luís Martí- Bonmatí, Montserrat Robles "Multi-component MR Image Denoising" Hindawi Publishing Corporation International Journal of Biomedical Imaging Volume 2009, Article ID 7 56897, 10 pages doi: 10.1155/2009/756897
9. Miguel E. Soto, Jorge E. Pezoa and Sergio N. Torres Thermal Noise Estimation and Removal in MRI: A Noise Cancellation Approach" 2011
10. Marius Lysaker, Arvid Lundervold, and Xue-Cheng Tai " Noise Removal Using Fourth-Order Partial Differential Equation With Applications to Medical Magnetic Resonance Images in Space and Time" IEEE Transactions On Image Processing, VOL. 12, NO. 12, December 2003
11. Dylan Tisdall and M. Stella Atkins" MRI denoising via phase error estimation" Proc. of SPIE Vol. 5747 (SPIE, Bellingham, WA, 2005) 1605-7422/05/$15 · doi: 10.1117/12.595677. pp: 646-654
12. Frederick M. Waltz and John W. V. Miller" An efficient algorithm for Gaussian blur using finite-state machines" SPIE Conf. on Machine Vision Systems for Inspection and Metrology VII, published in Boston, Nov. 1998
13. Gedraite, E.S.; Hadad, M." Investigation on the effect of a Gaussian Blur in image filtering and segmentation" IEEE conference publication held at Zadar, ISSN- 1334-2630, Issue Date : 14-16 Sept. 2011
14. Restrepo, A.; Bovik, A.C." Adaptive trimmed mean filters for image restoration" IEEE Journals and magazines, volume 36, Issue 8, ISSN: 0096-3518, Aug-2002.
15. Qiang Wang; Yi Shen" The effects of fusion structures on image fusion performances", IEEE conference publication, Volume: 1,DOC:- 18-20 May 2004, ISSN: 1091-5281
16. Pietro Perona and Jitendra Malik (July 1990). "Scale-space and edge detection using anisotropic diffusion". IEEE Transactions on Pattern Analysis and Machine Intelligence, 12 (7): 629–639. DOI:10.1109/34.56205.
17. Yu-Li You; Wenyuan Xu; Tannenbaum, A.; Kaveh, M." Behavioral analysis of anisotropic diffusion in image processing" IEEE Journals, Volume: 5 ,Issue 11 ,DOI: 10.1109/83.541424, ISSN : 1057-7149.

This page is intentionally left blank

Global Journal of Computer Science and Technology
Graphics & Vision
Volume 12 Issue 12 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Robust Watermarking Method for Color Images Using DCT Coefficients of Watermark

By R.Eswaraiah & E.Sreenivasa Reddy
Vasireddy Venkatadri Institute of Technology Guntur, India

Abstract - Digital technologies are playing a vital role in the present communication system. This paper presents a robust and secure watermarking method to protect the copyright information of multimedia objects. In the proposed method, Discrete Wavelet Transform and Discrete Cosine Transform are applied on the cover image and then Discrete Cosine Transform coefficients of watermark image are embedded into transformed cover image. The experimental result shows the performance evaluation of the proposed method by the quality metrics as PSNR for watermarked image and NC for extracted watermark image and we have compared the results with the existing transformation methods in frequency domain based on attacks.

Keywords : Discrete Wavelet Transform (DWT);Discrete Cosine Transform (DCT);PSNR(Peak Signal to Noise Ratio);NC (Normalized Correlation)

GJCST-F Classification: I.4.0

ROBUST WATERMARKING METHOD FOR COLOR IMAGES USING DCT COEFFICIENTS OF WATERMARK

Robust Watermarking Method for Color Images Using DCT Coefficients of Watermark

R.Eswaraiah [α] & E.Sreenivasa Reddy [σ]

Abstract - Digital technologies are playing a vital role in the present communication system. This paper presents a robust and secure watermarking method to protect the copyright information of multimedia objects. In the proposed method, Discrete Wavelet Transform and Discrete Cosine Transform are applied on the cover image and then Discrete Cosine Transform coefficients of watermark image are embedded into transformed cover image. The experimental result shows the performance evaluation of the proposed method by the quality metrics as PSNR for watermarked image and NC for extracted watermark image and we have compared the results with the existing transformation methods in frequency domain based on attacks.

Keywords : Discrete Wavelet Transform (DWT);Discrete Cosine Transform (DCT);PSNR(Peak Signal to Noise Ratio);NC (Normalized Correlation)

I. Introduction

Now days the rapid growth of the technology is a cause for the requirement of the protection of copyright information from unauthorized access. Hence an advanced authentication method is essential to the data security. Digital watermarking is one such method that offers data security. At present various kinds of digital watermarking methods are in use to protect the information from unauthorized access. Any security method come under either spatial [1] like LSB or frequency domain [2] like Discrete Wavelet Transform (DWT) [5], Discrete Cosine Transform (DCT) [3], Discrete Fourier Transform (DFT) [6] and the combination of them [7, 8] as well as any method can come under either blind or non blind watermarking. In blind watermarking the cover image is not used to decipher the watermark [3]. The cover image is used to decipher the watermark in the non-blind watermarking [4]. This paper proposes a non blind watermarking method based on the frequency domain. This method uses the transformations to improve the robustness of the system. The necessary features are perceptual quality and robustness to determine the quality of watermarking scheme.

In the frequency domain, DWT decomposes an image into multi-resolution components i.e. horizontal, vertical and diagonal [5] and DCT segregate each block into three frequency sub-bands: low, mid and high [3]. DFT requires an input image that is discrete. Such inputs are often created by sampling a continuous function. But, in this correspondence, DWT- DCT combination [7] and DCT coefficients of watermark are used in the proposed method. It improves all security factors in the data transfer. The strength of this paper is, analysis of the proposed scheme based on the standard metrics such as PSNR and NC and it sustains the general attacks like Gaussian noise, salt & pepper noise, Poisson noise, Gaussian blur, sharpening and common image processing operations like cropping, JPEG compression. The rest of the paper is organized in the following way. Section 2 consists of proposed method. Section 3 holds the description of performance metrics. Results and analysis are illustrated in Section 4.

Author α : Department of CSE Vasireddy Venkatadri Institute of Technology Guntur, India. E-mail : eswar_507@yahoo.co.in
Author σ : Department of CSE Acharya Nagarjuna Univeristy Guntur, India. E-mail : edara_67@yahoo.com

II. Proposed Method

The main aim of the proposed method is to improve the quality of watermarked image and robustness of the watermark. This approach consists of two major processes.

- Applying DWT and DCT on RGB cover image to get transformed image.
- Embed DCT coefficients of watermark image into transformed image.

a) *Watermark Embedding Algorithm*

In watermark embedding process, till now researchers are using either DWT or DCT or both transformations. Here, we are using both DWT and DCT to transform the cover image as transformed image and a new and efficient embedding algorithm which embeds DCT coefficients of watermark image into transformed image to get the watermarked image as shown in Fig 1. It is elucidated in the following way.

Algorithm

Step 1: Consider any color image as cover image denote it by 'I'. Get R, G, B channels of cover image 'I'.

Step 2: Apply DWT to blue channel 'B' to get the multi-resolution sub-bands LL1, HL1, LH1, and HH1. When compared to red and green channels blue channel is more resistant to changes.

Step 3: Apply DWT again to HL1 sub-band of B channel and choose HL2 sub-band.

Step 4: Divide the HL2 sub-band into blocks of size 8×8.

Step 5: Apply DCT to the blocks obtained in step 4.

Step 6: Consider any gray scale image as watermark, denote it by 'w' and then apply DCT to the watermark 'w'.

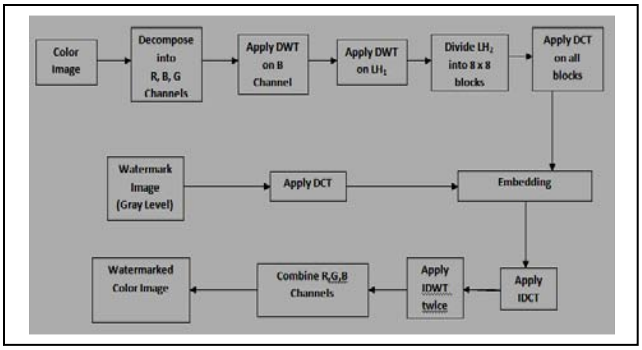


Figure 1 : Watermark embedding process

Step 7: To embed the watermark, select any four coefficients in the mid frequency band of each DCT block of HL2 sub-band.

Step 8: Four DCT coefficients of watermark are stored in each DCT block of HL2 sub-band.

Step 9: The DC component from the DCT coefficients of watermark is normalized before embedding.

Step 10: Apply IDCT to the blocks of HL2 sub-band.

Step 11: Apply IDWT for 2 levels.

Step 12: Combine R, G, B channels to get watermarked image 'WI'.

It helps to improve the copyright protection of the cover image and robustness of the watermark in the watermarked image.

b) *Watermark Extraction Algorithm*

Extraction of watermark image from watermarked image is explained as follows and it is shown in Fig 2.

Algorithm

Step 1: Get R, G, B channels of watermarked image 'WI'.

Step 2: Apply DWT to blue channel 'B' to get the multi-resolution sub-bands LL1, HL1, LH1, and HH1.

Step 3: Apply DWT again to HL1 sub-band of B channel and choose HL2 sub-band.

Step 4: Divide the HL2 sub-band into blocks of size 8×8.

Step 5: Apply DCT to the blocks obtained in step 4

Step 6: Obtain four DCT coefficients of watermark from the four selected coefficients of mid frequency band of each DCT of HL2 sub-band.

Step 7: To get the watermark apply IDCT on the set of DCT coefficients obtained from previous step.

III. Performance Evaluation Metrics

To measure the quality of the watermarked image peak signal to noise ratio (PSNR) is used. The quality of extracted watermark is measured using Normalized Correlation (NC) between the extracted and the original watermark.

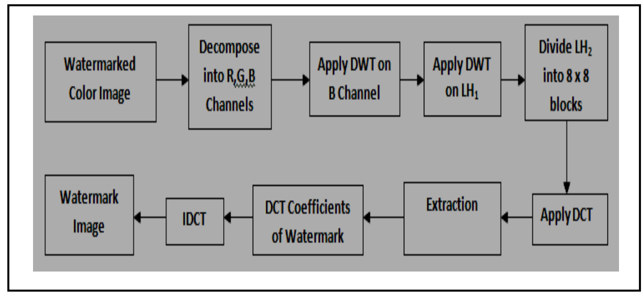


Figure 2 : Watermark extraction process

a) *Peak Signal to Noise Ratio*

It is a metric which is used regularly to find the quality of the watermarked image. It is calculated by considering the following formula

$$\text{PSNR}=\log\frac{(2^n-1)^2}{\text{MSE}}$$

Where n denotes the number of bits used for color representation and MSE refers to the Mean Square Error between original and water marked image and is calculated with the formula.

$$\text{MSE} = \frac{\sum_{R,G,B}\sum_{i=1}^{M}\sum_{j=1}^{N}(\text{I}[\text{i},\text{j}] - \text{I}'[\text{i},\text{j}])^2}{3\text{MN}}$$

Here, M and N are the height and width of image respectively. I[i, j] denotes the (i, j)th pixel value of the original image and I'[i, j] denotes the (i, j)th pixel value of watermarked image.

b) *Normalized Correlation (NC)*

It is one of the metrics used to find the quality of extracted watermark image with respect to the original watermark image. It is found by using the following formula.

$$\text{NC} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} w(i,j)w'(i,j)}{\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N} w(i,j)^{\wedge}2}\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N} w'(i,j)^{\wedge}2}}$$

Here, w(i, j) is the original watermark, w'(i, j) is the extracted watermark.

IV. Results and Analysis

As per this proposed method, a Lena color image of size 512×512 is considered as cover image as shown in Fig. 3 and Fig. 4 is a gray scale image of skeleton with size 32×32 is chosen as watermark.

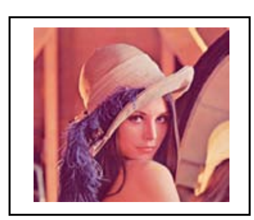


Figure 3 : Original Image

Figure 4 : Watermark image

Figure 5 : Watermarked image

After applying the proposed method the resultant watermarked image is shown as Fig.5.

Table 1 summarizes PSNR value of watermarked image and NC value of extracted watermark image when the watermarked image is not attacked and undergoes any attack like Gaussian noise, salt & pepper noise, Poisson noise, Gaussian blur, sharpening and image manipulation operations like cropping, JPEG compression are applied.

Table I : PSNR and NC values

Attack / Operation	PSNR	NC
No attack	85.76	1.000
Gaussian noise	65.46	0.996
Salt & Pepper noise	65.45	0.998
Poisson noise	85.76	1.000
Gaussian blur	79.18	0.998
Sharpening	68.73	0.995
Cropping	60.28	0.920
JPEG compression	63.45	0.910

Table 2 shows comparison results of the proposed method with the existing transformation methods such as DWT [5], DWT-DCT [9] and Bior [10] based on the NC value between original and extracted watermark when the watermarked image undergoes any attacks.

Table II : Comparison Results

Attack / Operation	DWT	DWT -DCT	Bior	DCT Coeff
Gaussian noise	0.7415	0.993	0.8575	0.996
Salt & Pepper noise	--	0.997	0.8518	0.998
Poisson noise	--	--	0.8567	1.000
Gaussian blur	0.8968	0.997	--	0.998
Sharpening	--	0.992	--	0.995
Cropping	0.9031	0.861	0.8484	0.920
JPEG compression	0.8775	0.756	0.7505	0.910

V. Conclusion

This robust watermarking method is proposed for increasing the security of data hiding as well as quality compared with the existing algorithms. Authenticity is incorporated by embedding the DCT coefficients of watermark image into the transformed image. Experimental results based on attacks confirm that the proposed algorithm performs better than the DWT, DWT-DCT and Bior based scheme and robustness is achieved by hiding DCT coefficients of watermark image in transformed image by the frequency transformations as DWT and DCT.

VI. Acknowledgments

We are very much thankful to the various reviewers who helped us to bring the paper effectively. The valuable suggestions of Dr. Ch.Rupa could not be underestimated in several situations of developing the paper. We sincerely thank our other research friends for giving their precious cautions. For the invaluable research facilities provided by the magnanimous management for achieving the work, we convey our deepest thanks.

References Références Referencias

1. Manik Mondal, Debalina Barik, "Spatial domain robust watermarking scheme for color image," International Journal of Advanced Computer Science, vol.2, no.1, pp. 24-27, Jan 2012.
2. Baisa L. Gunjal, Suresh N. Mali, "Strongly robust and highly secured DWT-SVD based color image watermarking: embedding data in all Y, U, V color spaces," I.J. Information Technology and Computer Science, vol.3, pp. 1-7, April 2012.
3. Zheng Chaomei, Li Yuan, "A blind watermarking algorithm based on DCT for dual color images," International Conference on Computer Science and Network Technology, vol.3, pp. 1690-1694, December 2011.
4. Dharwadkar N.V, Amberker B.B, Gorai A, "Non-blind watermarking scheme for color images in RGB space using DWT-SVD," International Conference on Communications and Signal Processing, pp. 489-493, February 2011.
5. Cheng-qun Yin, Li Li, An-qiang Lv and Li Qu, "Color image watermarking algorithm based on DWT-SVD," Proceedings of the IEEE International Conference on Automation and Logistics, pp. 2607-2611, August 2007.
6. Chengqing GUO, Guoai Xu, Xinxin Niu, Yixian Yang, Yang Li, "A color image watermarking algorithm resistant to Print-Scan," IEEE International Conference Wireless Communications, Networking and Information Security, pp. 518-521, June 2010.
7. Baisa L. Gunjal, Suresh N. Mali, "Secured color image watermarking technique in DWT -DCT domain," International Journal of Computer Science Engineering and Information Technology (IJCSEIT), vol.1, no.3, pp. 36-44, August 2011.
8. Yuping Hu, Zhijian Wang, Hui Liu, Guangjun Guo "A geometric distortion resilient image watermark algorithm based on DWT-DFT", Journal of Software, vol.6, no.9, pp. 1805-1812, September 2011.
9. V.Santhi, Arunkumar Thangavelu, "DC coefficients based watermarking technique for color images

using singular value decomposition," International Journal of Computer and Electrical Engineering, vol.3, no.1, February 2011.

10. K.Ramani, E.V.Prasad, V.lokanadham Naidu, D.Ganesh "Color image watermarking using Bi-Orthogonal wavelet transform", International Journal of Computer Applications, volo.11, no.9, pp. 25-29, December 2010.

Global Journal of Computer Science and Technology
Graphics & Vision
Volume 12 Issue 12 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

An Impressive Method to Get Better Peak Signal Noise Ratio (PSNR), Mean Square Error (MSE) Values Using Stationary Wavelet Transform (SWT)

By N. Naveen Kumar & Dr.S.Ramakrishna
Sri Venkateswara University, Tirupati, India

Abstract - Impulse noise in images is present because of bit errors in transmission or introduced during the signal acquisition stage. There are two types of impulse noise, they are salt and pepper noise and random valued noise. In our proposed method, first we apply the Stationary wavelet transform for noise added image. It will separate into four bands like LL, LH, HL and HH. The proposed algorithm replaces the noisy pixel by trimmed median value when other pixel values, 0's and 255's are present in the selected window and when all the pixel values are 0's and 255's then the noise pixel is replaced by mean value of all the elements present in the selected window. This proposed algorithm shows better results than the Standard median filter (MF), decision based algorithm (DBA). The proposed method performs well in removing low to medium density impulse noise with detail preservation up to a noise density of 70% and it gives better Peak signal-to-noise ratio (PSNR) and mean square error (MSE) values.

Keywords : Peak signal-to-noise ratio (PSNR), mean square error (MSE) values.standard median filter (MF), decision based algorithm (DBA).

GJCST-F Classification: I.4.5

AN IMPRESSIVE METHOD TO GET BETTER PEAK SIGNAL NOISE RATIO PSNR, MEAN SQUARE ERROR MSE VALUES USING STATIONARY WAVELET TRANSFORM SWT

Strictly as per the compliance and regulations of:

An Impressive Method to Get Better Peak Signal Noise Ratio (PSNR), Mean Square Error (MSE) Values Using Stationary Wavelet Transform (SWT)

N. Naveen Kumar & Dr.S.Ramakrishna

Abstract - Impulse noise in images is present because of bit errors in transmission or introduced during the signal acquisition stage. There are two types of impulse noise, they are salt and pepper noise and random valued noise. In our proposed method, first we apply the Stationary wavelet transform for noise added image. It will separate into four bands like LL, LH, HL and HH. The proposed algorithm replaces the noisy pixel by trimmed median value when other pixel values, 0's and 255's are present in the selected window and when all the pixel values are 0's and 255's then the noise pixel is replaced by mean value of all the elements present in the selected window. This proposed algorithm shows better results than the Standard median filter (MF), decision based algorithm (DBA). The proposed method performs well in removing low to medium density impulse noise with detail preservation up to a noise density of 70% and it gives better Peak signal-to-noise ratio (PSNR) and mean square error (MSE) values.

Keywords : Peak signal-to-noise ratio (PSNR), mean square error (MSE) values.standard median filter (MF), decision based algorithm (DBA).

I. Introduction

In the transmission of images over channels, images are corrupted by impulse noise, due to faulty communications. The objective of filtering is to remove the impulses so that the noise free image is fully recovered with minimum signal distortion. Noise removal can be achieved, by using a number of existing linear filtering techniques which are popular due to their mathematical simplicity and the existence of the unifying linear system theory. A new and efficient algorithm Jayaraj etal[1] proposed high-density salt and pepper noise removal in images and videos. The non-linear filter like standard median filter (SMF), adaptive median filter (AMF), decision based algorithm (DBA) and robust estimation algorithm (REA) shows better results at low and medium noise densities. At high noise densities, their performance is poor.

Salt and pepper impulse noise is one commonly encountered noise type during image and video communication. So far the state of the art methods can reasonably restore images corrupted by salt and pepper noise whose level is up to 90%. A novel quadratic type variation formulation of this noise removal problem is reported by wanetal [2]. This approach first uses a simple yet fast method to eliminate all salt-and-pepper noise pixels as well as possibly some clean pixels, then the clean image is efficiently reconstructed from the remaining clean pixels by minimizing a carefully designed functional. Because the functional is quadratic type, fast unconditional convergence is guaranteed.

Recently a new adaptive weight algorithm Jianetal[3] for the removal of salt and pepper noise in. It consists of two major steps, first to detect noise pixels according to the correlations between image pixels, then use Different methods based on the various noise levels. For the low noise level, neighborhood signal pixels mean method is adopted to remove the noise, and for the high noise level, an adaptive weight algorithm is used. A switching bilateral filter (SBF) with a texture and noise detector for universal noise removal is proposed by Tsaietal [4]. Here the operation was performed in two stages: detection followed by filtering. For detection, the sorted quadrant median vector (SQMV) scheme, this includes important features such as edge or texture information. This information is utilized to allocate a reference median from SQMV, which is in turn compared with a current pixel to classify it as impulse noise, Gaussian noise, or noise-free. The SBF removes both Gaussian and impulse noise without adding another weighting function. The range filter inside the bilateral filter switches between the Gaussian and impulse modes depending upon the noise classification result.

To remove salt and pepper noise in video a new algorithm is proposed by Esakkirajan etal [5]. This proposed adaptive decision algorithm first checks whether the selected pixel in the video sequence is noisy or noise free. Initially the window size is selected as 3×3. If the selected pixel within the window is 0's or 255's, and some of other pixels within the window are noise free, then the selected pixel value is replaced by trimmed median value. If the selected pixel is 0 or 255 and other pixel values in a selected window (3×3) all are 0's and 255's, then change the selected window size as 5 × 5, then the selected pixel value is replaced by trimmed median value. In the selected new window (5 × 5), all the elements are 0's or 255's then the processing pixel is replaced by the previous resultant pixel.

A modified simple edge preserved de-noising algorithm to remove salt and pepper noise in digital color images is discussed in [6]. This proposed algorithm has three steps: noisy pixel detection, replacement of noisy pixels, and confirmation by comparing with a threshold. In addition a median filtering is added to improve the quality of the image. It prevents the smoothing of edges in the noise removal process, by predicting the possible edges and taking the mean value from the predicted edge. Furthermore, Rahaman etal. [7] reported a new algorithm to remove Salt and Pepper noise from grayscale images. This is an enhanced adaptive median filtering algorithm which initially calculates median without considering noisy pixels in the processing window. If the noise-free median value is not available in the maximum processing window, the last processed pixel value is used as the replacement. However, in extreme situations such as noise corrupted pure black and white images, a threshold value is used to determine the pixel value.

A new wavelet-based de-noising method for medical infrared images was reported by Rabbani etal [8]. Since the dominant noise in infrared images is signal dependent utilize local models for statistical properties of (noise-free) signal and noise. In this base, the noise variance is locally modeled as a function of the image intensity using the parameters of the image acquisition protocol. In the next step, the variance of noise-free image is locally estimated and the local variances of noise-free image and noise are substituted in a wavelet-based maximum a posterior (MAP) estimator for noise removal.

A methodology based on median filters for the removal of salt and pepper noise by its detection followed by filtering in both binary and gray level images has been proposed by sarath etal [9]. Linear and nonlinear filters have been proposed earlier for the removal of impulse noise; however the removal of impulse noise often brings about blurring which results in edges being distorted and poor quality. Therefore, the necessity to preserve the edges and fine details during filtering is the challenge faced by researchers today. It consists of noise detection followed by the removal of detected noise by median filter using selective pixels that are not noise themselves. The noise detection is based on simple thresholding of pixels.

Impulse noise removal is one of the important image preprocessing techniques since the noise will lead the image processing procedures into an unexpected direction. The candidate-oriented strategy that detects the corrupted pixels (noise candidates) and then updates the intensity value of those pixels can achieve better performance than the brute-force strategy. Recently a novel region feature is presented in Ref.[10] to avoid the misclassification problem. In this method the noise pixels are treated as the small-sized regions, and labeled by the multi-scale connected component labeling algorithm. In this way, the region size can be considered as a clue during the noise detection procedure. This newly developed region feature can be easily utilized to the current noise removal algorithms.

II. Methodology

The proposed image denoising corrupted by salt and pepper noise is built on Stationary wavelet transform. The following section described the Stationary Wavelet Transform (SWT) and Proposed Algorithms.

a) Stationary Wavelet Transform

The SWT provides efficient numerical solutions in the signal processing applications. It was independently developed by several researchers and under different names, e.g. the un-decimated wavelet transform, the invariant wavelet transforms and the redundant wavelet transform. The key point is that it gives a better approximation than the discrete wavelet transform (DWT) since, it is redundant, linear and shift invariant. These properties provide the SWT to be realized using a recursive algorithm. Therefore, the SWT is very useful algorithm for analyzing a linear system. A brief description of the SWT is presented here. Figure shows the computation of the SWT of a signal x(k), whereW_jk, and V_jk are called the detail and the approximation coefficients of the SWT. The filters H_j and G_j are the standard low pass and high pass wavelet filters, respectively. In the first step, the filters H_1 and G_1 are obtained by up sampling the filters using the previous step (i.e. H_j-1 andG_j-1).

III. Proposed Method

The Proposed method shown in Figure 1. In order to overcome the above mentioned difficulties, a new two-stage cascaded filter is proposed in this paper which removes the noise as high as possible, without blurring and retains the fine edge details. The proposed algorithm removes these drawbacks at high noise density. This algorithm processes the corrupted images by first detecting the impulse noise. The processing pixel is checked whether it is noisy or noisy free. That is, if the processing pixel lies between maximum and minimum gray level values then it is noise free pixel, it is left unchanged. If the processing pixel takes the maximum or minimum gray level then it is noisy pixel. It gives better Peak signal-to-noise ratio (PSNR) and image enhancement factor (IEF) values than the existing algorithm.

In adaptive modified filter the pixels are processed using 5 X 5 windows. During processing if a pixel is '0' or '255' then it is processed else it is left unchanged. In decision based algorithm (DBA) the corrupted pixel is replaced by the median of the window. At higher noise densities the median itself will be noisy, and the processing pixel will be replaced by the neighborhood processed pixel. This repeated replacement of neighborhood pixels produces streaking effect. To overcome the above drawbacks, the adaptive modified decision-based unsymmetric trimmed median filter is proposed. The corrupted processing pixel is replaced by a median or mean value of the pixels in the 5 X 5 window after trimming impulse values. The corrupted pixel is replaced by the median or mean of the resulting array. In this, the median value is replaced only when both the processing pixel and all the neighboring pixels are noisy pixels. In other case, if the processing pixel is noisy and all the neighboring pixels are not noisy pixel then the mean value is used for replacement. If the processing pixel itself is not a noisy pixel, then it does not require further processing. Thus the processing pixel value can be modified as median or mean value according to the cases and hence named as adaptive modified decision based unsymmetric trimmed median filter.

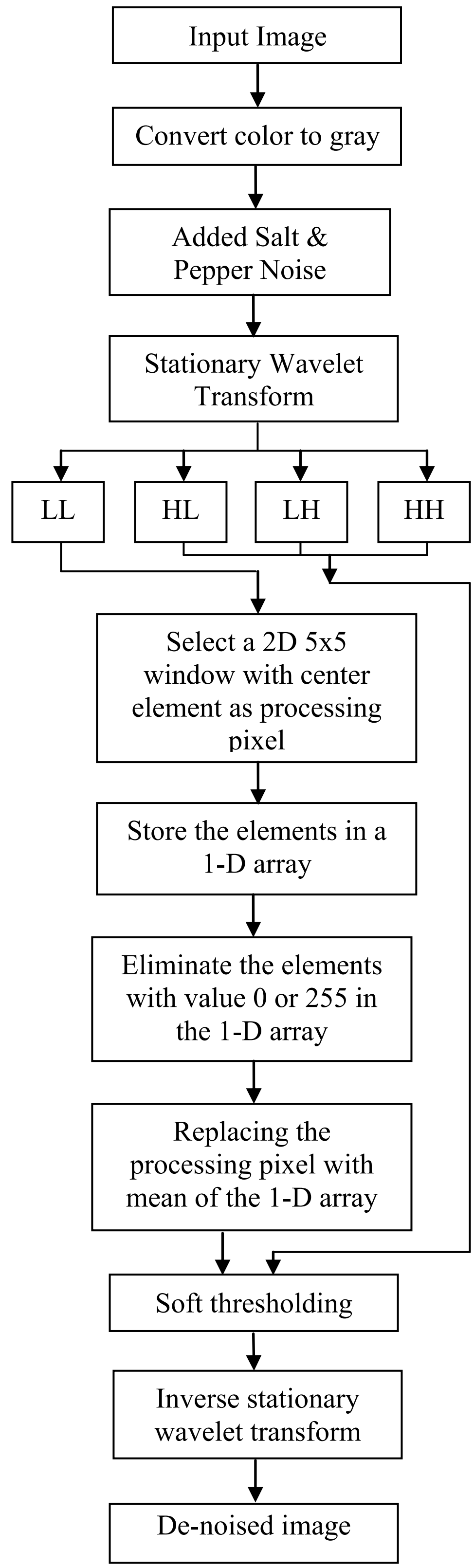


Figure 1 : Block diagram of proposed method

For all higher bands (LH, HL and HH) the de-noising can be achieved by applying a thresholding operator to the wavelet coefficients in the transform domain followed by reconstruction of the signal to the original image in spatial domain. In the proposed method, soft shrinkage and median absolute difference (MAD) are used. The scaled MAD noise estimator is calculated by (6).

$$MAD = \frac{median\ (|X|)}{0.6745} \qquad (1)$$

Where X is the high frequency sub-bands coefficients. From the estimated noise, the non linear threshold T is calculated by equation (2)

$$T = MAD * \sqrt{2logn} \qquad (2)$$

Where N is the size of the high frequency sub-band array. Then the soft thresholding is applied to remove the noise and the soft shrinkage rule is defined by equation (3). Finally, the noise free image is obtained by taking the inverse SWT.

$$\rho_T(x) = \begin{cases} x - T, & if \quad x \geq T \\ x + T, & if \quad x \leq -T \\ 0, & if \quad |x| < T \end{cases} \qquad (3)$$

The noise free sub-bands are extracted using adaptive thresholding. Finally, the noise free image is obtained by taking the inverse SWT using the modified high frequencies sub-bands and the low frequency sub band of SWT.

IV. Algorithm

Step 1: Select 2 -D window of size 5 X 5. Assume that the pixel being processed is P_{ij}.

Step 2: If 0<P_{ij}<255then P_{ij} is an uncorrupted pixel and its value is left unchanged.

Step 3: If P_{ij}=0 or P_{ij}=255 then P_{ij} is a corrupted pixel then two cases are possible.

Case i: If the selected window contain all the elements as 0's and 255's. Then replace P_{ij} with the mean of the element of window.

Case ii: If the selected window contains not all elements as 0's and 255's. Then eliminate 255's and 0's and find the median value of the remaining elements. Replace P_{ij} with the median value.

Step 4: Repeat steps 1 to 3 until all the pixels in the entire image are processed.

Move the window by one step and repeat from step 1 to step 4. The above steps are repeated, until the processing is completed for the entire image.

a) Algorithm description

Each and every pixel of the image is checked for the presence of salt and pepper noise. Different cases are illustrated in this Section. If the processing pixel is noisy and all other pixel values are either 0's or 255's is illustrated in Case i. If the processing pixel is noisy pixel that is 0 or 255 is illustrated in Case ii. If the processing pixel is not noisy pixel and its value lies between 0 and 255 is illustrated in Case iii. If the processing pixel value is 0 or 255, then it is a corrupted pixel and it is processed by two cases:

Case (i): If the selected window contains salt or pepper noise as processing pixel (i.e., 255/0 pixel value) and neighboring pixel values contains all pixels that adds salt and pepper noise to the image. Consider the matrix [0 255 0 0 255 255 0 0 255 0 0 255 255 0 255 0 255 0 0 0 255 0 255 255 0 255]. Since all the elements surrounding Pij are 0's and 255's. If one takes the median value it will be either 0 or 255 which is again noisy. To solve this problem, the mean of the selected window is found and the processing pixel is replaced by the mean value.

Case (ii): If the selected window contains salt or pepper noise as processing pixel (i.e. 255/0 pixel value) and neighboring pixel values contains some pixels that adds salt (i.e. 255 pixel value) and pepper noise to the image. Now eliminate the salt and pepper noise from the selected window. That is, elimination of 0's and 255's. The 1-D array of the matrix is [78 90 108 0 120 0 255 97 255 73 112 95 0 83 75 56 180 0 78 0 55 43 255 93 87]. After elimination of 0's and 255's the pixel values in the selected window will be [78 90 108 120 97 73 112 95 83 75 56 180 78 55 43 93 87]. Here the processing pixel is replaced by median value of the remaining pixels.

If the processing pixel (P_{ij}) value is not 0 or 255, then it is an uncorrupted pixel and it is processed by following case.

Case (iii): If the selected window contains a noise free pixel as a processing pixel, it does not require further processing. For example, 1-D array of the matrix is [43 67 70 55 75 108 112 143 164 85 97 45 80 95 100 45 87 43 190 87 90 79 85 81 66]. Here the processing pixel is 80 then it is noise free pixel. Since "80" is a noise free pixel it does not require further processing.

Repeat the steps until all the pixels in the entire image are processed.

V. Experimental Results

The proposed algorithm foe tested for 256x256 images. It is tested for various levels of noise values and also compared with Standard median filter (SMF).

Figure.2 shows the de-noising performance of the proposed algorithm. Table.1 show the PSNR values of the proposed method and based soft shrinkage and SWT method with different noise variance.

(a) (b) (c) (d)

Figure 2 : (a) Input image, (b) Noise added Image, (c) Median filtered Image and (d) Our proposed method

Noise density in %	PSNR in db			
	Median filter	PSMF	DBA	Our Proposed Method
10	31.60	26.42	39.78	39.91
20	31.38	26.42	37.29	37.31
30	31.04	26.42	35.42	35.63
40	30.64	26.42	34.09	34.42
50	30.63	26.42	34.08	34.44
60	29.59	26.42	32.06	32.54
70	28.86	26.42	31.14	31.57
80	28.21	26.42	30.14	30.54
90	27.55	26.42	29.49	29.51

Table 1 : PSNR value for the proposed method

VI. Conclusion

In this work, image denoising based on Stationary wavelet transform (SWT) and soft threshold method are discussed. Experimental results show that the proposed method restore the original image much better than standard non linear median-based filters and some of the recently proposed algorithms. The proposed filter requires less computation time compared to other methods. The visual quality results clearly shows the proposed filter preserve fine details such as lines and corners satisfactorily. This filter can be further improved to apply for the images corrupted with high density impulse noise up to 90% and random valued impulse noise.

References Références Referencias

1. Jayaraj, V and Ebenezer, D, "A New and Efficient Algorithm for the Removal of High Density Salt and Pepper Noise in Images and Videos", IEEE Second International Conference on Computer Modeling and Simulation, 2010, PP 409-413.
2. Yi Wan, "A novel quadratic type variational method for efficient salt-and-pepper noise removal", IEEE International Conference on Multimedia and Expo (ICME), 2010, pp 1055-1060.
3. Wang Jian, Qin Wu and Dong Xiao-gang, "A new adaptive weight algorithm for salt and pepper noise removal", IEEE International Conference on Consumer Electronics, Communications and Networks, 2011, pp 26-29.
4. Jia-Shiuan Tsai and Ching-Te Chiu, "Switching Bilateral Filter with a Texture/Noise Detector for Universal Noise Removal", IEEE Transaction on Image Processing, Vol. 19, pp 2307 – 2320
5. Esakkirajan, S.and Vennila, I, "Salt and pepper noise removal in video using adaptive decision based median filter" IEEE International Conference on Multimedia, Signal Processing and Communication Technologies, 2011, pp 87-90.
6. Sheebha, S.P. and Sriraman, L, "A Modified Algorithm for Removal of Salt and Pepper Noise in Color Images", IEEE Third International Conference on Intelligent Systems, Modelling and Simulation (ISMS), 2010, pp 356-361.
7. Rahman, M.M. and Ashfaqueuddin, S. "An enhanced decision based adaptive median filtering technique to remove Salt and Pepper noise in digital images", IEEE 14th International Conference on Computer and Information Technology, 2011, pp 428-433.
8. Rabbani, H, "Wavelet-based medical infrared image noise reduction using local model for signal and noise", IEEE Signal Processing Workshop, 2011, pp 549-552.
9. Sarath, S. and Palanisamy, P., "Detection and removal of Salt and Pepper noise in images by improved median filter", IEEE Recent Advances in Intelligent Computational Systems, 2011, pp 363-368.
10. Yih-Tyng Wu, Shau-Yin Tseng and Chao-Yi Cho, "An Impulse Noise Removal Algorithm by Considering Region-Wise Property for Color Image", IEEE 9th International Symposium on Parallel and Distributed Processing with Application, 2011, pp 36-40.

Global Journal of Computer Science and Technology
Graphics & Vision
Volume 12 Issue 12 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Performance Analysis of Modified Lifting Based DWT Architecture and FPGA Implementation for Speed and Power

By C.Chandrasekhar & Dr.S.Narayana Reddy
S.V.University, Tirupathi

Abstract - Demand for high speed and low power architecture for DWT computation have led to design of novel algorithms and architecture. In this paper we design, model and implement a hardware efficient, high speed and power efficient DWT architecture based on modified lifting scheme algorithm. The design is interfaced with SIPO and PISO to reduce the number of I/O lines on the FPGA. The design is implemented on Spartan III device and is compared with lifting scheme logic. The proposed design operates at frequency of 280 MHz and consumes power less than 42 mW. The pre-synthesis and post-synthesis results are verified and suitable test vectors are used in verifying the functionality of the design. The design is suitable for real time data processing.

Keywords : Lifting scheme, low power, high speed, FPGA implementation.

GJCST-F Classification: I.4.5

PERFORMANCE ANALYSIS OF MODIFIED LIFTING BASED DWT ARCHITECTURE AND FPGA IMPLEMENTATION FOR SPEED AND POWER

Strictly as per the compliance and regulations of:

Performance Analysis of Modified Lifting Based DWT Architecture and FPGA Implementation for Speed and Power

C.Chandrasekhar [α] & Dr.S.Narayana Reddy [σ]

Abstract - Demand for high speed and low power architecture for DWT computation have led to design of novel algorithms and architecture. In this paper we design, model and implement a hardware efficient, high speed and power efficient DWT architecture based on modified lifting scheme algorithm. The design is interfaced with SIPO and PISO to reduce the number of I/O lines on the FPGA. The design is implemented on Spartan III device and is compared with lifting scheme logic. The proposed design operates at frequency of 280 MHz and consumes power less than 42 mW. The pre-synthesis and post-synthesis results are verified and suitable test vectors are used in verifying the functionality of the design. The design is suitable for real time data processing.

Keywords : Lifting scheme, low power, high speed, FPGA implementation.

I. Introduction

Discrete wavelet transforms (DWT) decomposes image into multiple subbands of low and high frequency components. Encoding of subband components leads to compression of image. DWT along with encoding technique represents image information with less number of bits achieving image compression. Image compression finds application in every discipline such as entertainment, medical, defense, commercial and industrial domains. The core of image compression unit is DWT. Other image processing techniques such as image enhancement, image restoration and image filtering also requires DWT and Inverse DWT for transformations. DWT-IDWT is one of the prominent transformation techniques that are widely used in signal processing and communication applications. DWT-IDWT computes or transforms signal into multiple resolution sub bands [1][2][3][4][5]. DWT is computationally very intensive and consumes power due to large number of mathematical operations. Latency and throughput are other major limitations of DWT as there are multiple levels of hierarchy [6][7][8]. DWT has traditionally been implemented by convolution. Digit serial or parallel representation of input data further decides the architecture complexity. Such an implementation demands a large number of computations and a large storage that are not desirable for either high-speed or low-power applications. Recently, a lifting-based scheme that often requires far fewer computations has been proposed for the DWT. The main feature of the lifting based DWT scheme is to break up the high pass and low pass filters into a sequence of upper and lower triangular matrices and convert the filter implementation into banded matrix multiplications. Since DWT requires intensive computations, several architectural solutions using special purpose parallel processor have been proposed, in order to meet the real time requirement in many applications. The solutions include *parallel filter architecture, SIMD linear array architecture*, *SIMD multigrid architecture, 2-D block based architecture*, and the AWARE's *wavelet transform processor* (WTP) [9][10][11]. Several versions of lifting scheme architecture have been compared and reported in literature. In terms of hardware complexity, the folded architecture in [12] is the simplest and the DSP-based architecture in [13] is the most complex. All other architectures have comparable hardware complexity and primarily differ in the number of registers and multiplexor circuitry. The control complexity of the architecture in [14] is very simple. In contrast, the number of switches, multiplexors and control signals used in the architectures of [15] is quite large. The control complexity of the remaining architectures is moderate. In terms of timing performance, the architectures in [14, 12, 16–18] are all pipelined, with the architectures in [17] having the highest throughput (1/*Tm*). The architecture in [19] has fewer cycles since it is RPA based, but its clock period is higher. The architecture in [17] has the lowest computation delay.

In this paper, we propose, design, model, implement and compare the performances of three different DWT architectures. Section II briefly discusses the Lifting Scheme DWT algorithm for image processing, Section III discusses modified lifting base DWT and Section IV presents the FPGA implementation and compares the results of modified lifting algorithm. Conclusion is presented in Section VI.

II. Dwt

The influx of sophisticated technologies in the field of image processing is affiliated with that of

Author α : HOD, Dept.of ECE SVCET, CHITTOOR.
E-mail : Umashekar_2000@yahoo.com
Author σ : Prof & Head in Dept.of ECE, S.V.University, Tirupathi.
E-mail : snreddysvu@yahoo.com

digitization in the computers arena. Image Compression plays an important role of all the Image Processing techniques. The compression techniques are of two types: Lossless and Lossy. The most common image format that uses a lossy compression scheme is JPEG (Joint Photographic Experts Group) format. JPEG 2000 structure is wavelet based compression methodology that provides a number of benefits over the Discrete Cosine Transformation (DCT) compression method, which was used in JPEG format. Wavelet compression converts the image into a series of wavelets that can be stored more efficiently than pixel blocks. The Wavelet compression is accomplished through the use of JPEG 2000 encoder as shown in the figure 1.

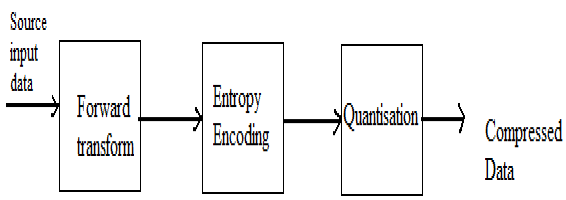


Figure 1 : JPEG 2000 Block Diagram

The problem statement in the present section deals

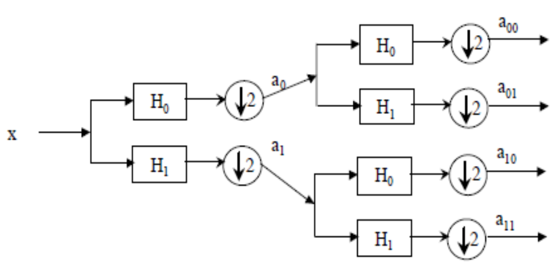


Figure 2 : Two-level DWT decomposition [6]

With the design of the modified two-level DWT architecture for decomposition. The Discrete Wavelet Transform (DWT), which is based on sub-band coding is found top yield a fast computation of Wavelet Transform. It is easy to implement and reduces the computation time and resources required. In DWT, a time-scale representation of the digital signal is obtained using digital filtering techniques [6]. The signal to be analyzed is passed through filters with different cut-off frequencies at different scales as shown in figure 2.

Lifting Scheme:

The Lifting Scheme is a well known method for constructing bi-orthogonal wavelets. The main difference with the classical construction is that it does not rely on the Fourier transform. The lifting scheme is an efficient implementation of a wavelet transform algorithm. It was primarily developed as a method to improve wavelet transform, and then it was extended to a generic method to create so-called second-generation wavelets. Second-generation wavelets are much more flexible and powerful than the first generation wavelets. The lifting scheme is an implementation of the filtering operations at each level [6]. The figure 3 represents the classical and lifting based implementations of DWT.

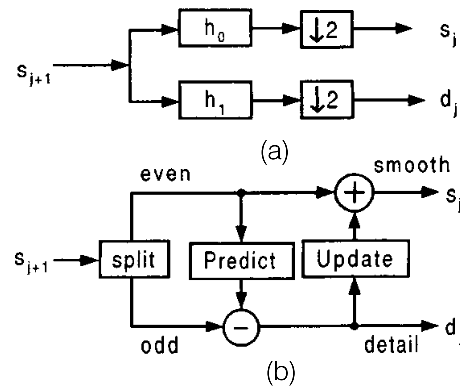


Figure 3 : a) Classical Implementation, b) Lifting scheme based DWT [6]

Lifting Scheme consists of three steps: SPLIT, PREDICT and UPDATE, as shown in the figure 3 (b).

- SPLIT: In this step, the data is divided into ODD and EVEN elements.
- PREDICT: The PREDICT step uses a function that approximates the data set. The differences between the approximation and the actual data, replace the odd elements of the data set. The even elements are left unchanged and become the input for the next step in the transform. The PREDICT step, where the odd value is "predicted" from the even value is described by the equation [6].

$$\mathrm{Odd}_{j+1,\,i} = \mathrm{odd}_{j,\,i} - P\,(\mathrm{even}_{j,\,i})$$

- UPDATE: The UPDATE step replaces the even elements with an average. These results in a smoother input for the next step of the wavelet transform. The odd elements also represent an approximation of the original data set, which allows filters to be constructed. The UPDATE phase follows the PREDICT phase. The original values of the odd elements have been overwritten by the difference between the odd element and its even "predictor". So in calculating an average the UPDATE phase must operate on the differences that are stored in the odd elements [6]:

$$\mathrm{Even}_{j+1,\,i} = \mathrm{even}_{j,\,i} + \boldsymbol{U}\ (\mathrm{odd}_{j+1,\,i})$$

The equations for the lifting based implementation of the bi-orthogonal wavelet are:

$$\text{Predict P1: } d_i^{1} = \alpha\,(x_{2i} + x_{2i+2}) + x_{2i+1}$$
$$\text{Update U1: } a_i^{1} = \beta\,(d_i^{1} + d_{i-1}^{1}) + x_{2i}$$
$$\text{Predict P2: } d_i^{2} = \gamma\,(a_{i1} + a_{i+1}) + x_{2i+1}$$
$$\text{Update U2: } a_i^{2} = \delta\,(d_i^{2} + d_{i-1}^{2}) + a_i^{1}$$

Scale G1: $a_i = \zeta\, a_i^2$
Scale G1: $d_i = d_i^2/\zeta$

The figure 4 shows the lifting scheme architecture to realise the equations shown above.

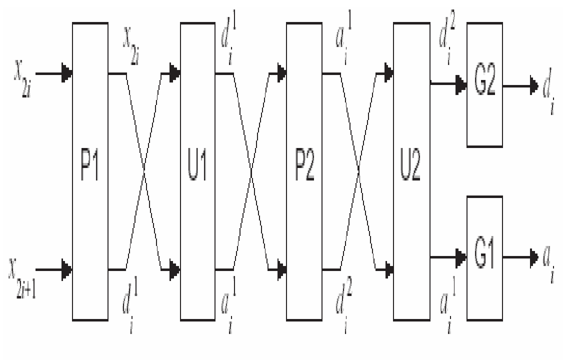


Figure 4 : Lifting Scheme Architecture

The input data x is first split into even and odd samples and each of the samples are taken through predict and update stages as per the architecture shown above. As the data moves from first stage to the last stage, data switching occurs at the input and output of every stage. Every stage consists of multipliers and adders. For the given set of Predict and Update stages, assuming the value of **i = 0,** the equation can be finalized.

III. Modified Lifting Scheme

By re-arranging all the values and the constant co-efficient, the final equation can be derived.

$$ai= (\underline{3 * \gamma.\beta.\delta.\zeta + \delta.\zeta + \beta.\zeta}) [\alpha (x_0 + x_2) + x_1 + \alpha (x_0 + x_{-2}) + x_{-1}] + \underline{\zeta.\delta.\beta.\gamma} [\alpha(x_2 + x_4) + x_3 + \alpha(x_{-2} + x_{-4}) + x_{-3}] + \underline{\zeta.\delta.\gamma} (x_0 + x_2 + x_0 + x_{-2}) + \zeta * x_0$$

$$di= 1/\zeta\ [(\underline{2 * \gamma.\beta +1})\{ \alpha (x_0 + x_2) + x_1\} + \underline{\gamma.\beta} \{ \alpha (x_0 + x_{-2}) + x_{-1} + \alpha(x_2 + x_4) + x_3\} +\underline{\gamma}(x_0 + x_2)].$$

Being a dedicated DWT core for JPEG 2000, the filter coefficients are fixed. The filter coefficients are: α = 1.586134342, β = 0.05298011854, γ = 0.8829110762, δ =0.4435068522, ζ = 1.149604398. By substituting the above values in the modified equation, the coefficient values obtained then are also decimals, by multiplying them with constants they form integers as: 1 * 32 = 57, 2 * 256 = 6, 3 * 64 = 30, 4 * 32 = 35, 5 * 256 = 12, 6 * 32 = 26, 7 * 32 = 50.

Thus the above integers are the values of the underlined coefficients in above equations. From the equations it is observed that there are common lifting coefficients to compute ai and di coefficients and there are input terms. The architecture realised by the above equations considering the constant coefficients is shown in the figure 5.

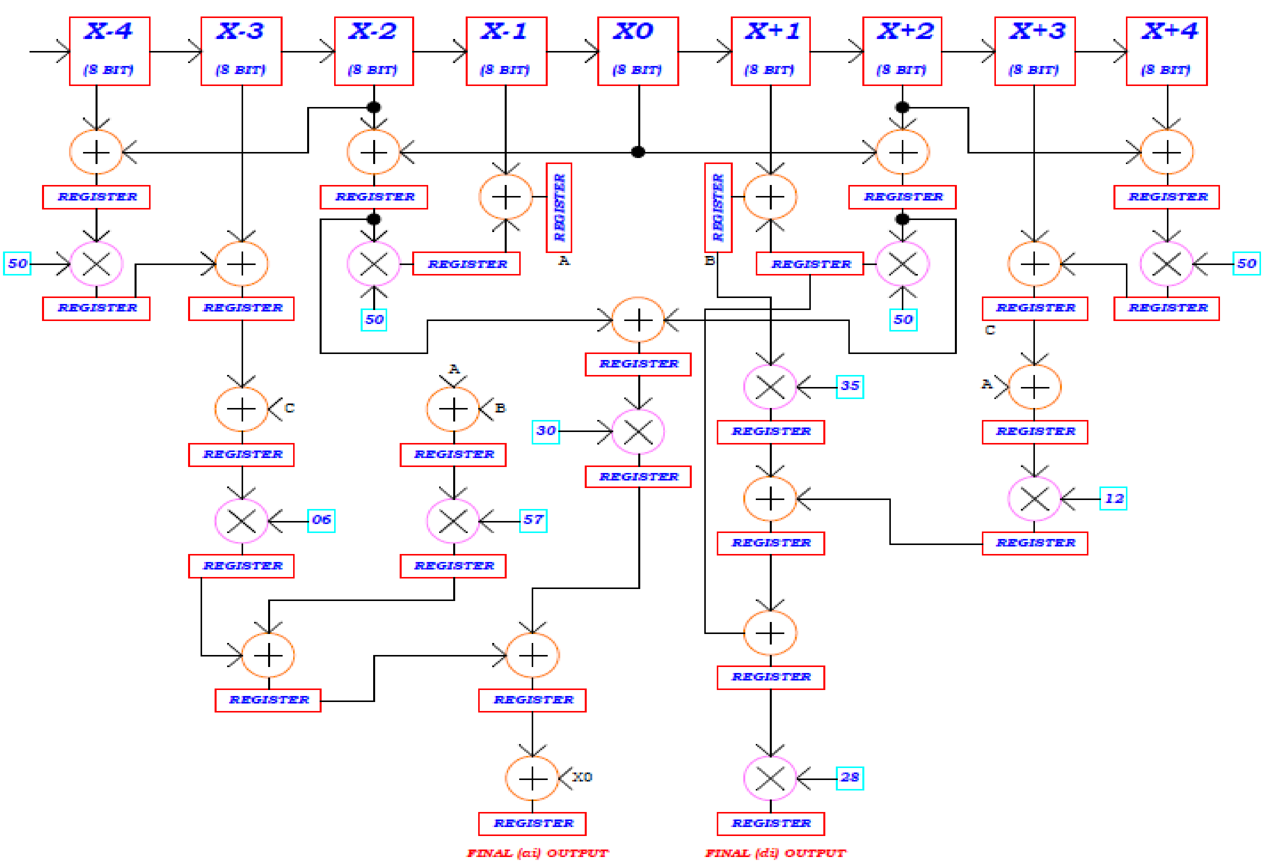


Figure 5 : Modified Lifting Scheme Architecture for DWT

Global Journal of Computer Science and Technology (F) Volume XII Issue XII Version I Year 2012

The FPGA implementation of the modified lifting based DWT is designed based on the following:

- The input data X should be of 8 bit signed data.
- Output should be of 16 bit signed representation (including a_i and d_i).
- The lifting coefficients should be of 8 bit signed representation.
- The architecture should work on the streaming input sequence (Serial input).
- The intermediate outputs should be stored in a memory.
- The input data flows into the architecture through one input line and the output should be read out through one output line.

Thus by considering the above design specifications the architecture shown in the figure 5 is designed as per the requirements.

- ➢ The blocks from X -4 to X +4 resemble the input 9 samples designed in form of SIPO, each of 8-bit signed representation (serial in parallel out).
- ➢ Here the input stream is given through the single input line to 9 SIPOs. The outputs of those are taken in parallel to perform the addition and multiplication operations.
- ➢ The addition and multiplication operations are of 8 bit signed operators.
- ➢ The intermediate results of these addition and multiplication operations are stored in registers than preferring memory, as the data can be stored in registers with ease and in random, but in memory the storage (write operation in particular) should be done in orderly fashion.
- ➢ These intermediate registers are of PIPO structure and of 8 bit signed representation.
- ➢ Though final outputs ai and di are single bit, those are stored in the registers of PISO structure as the output should be taken for 8 bits.

The inputs can be 8-bit signed at any point of time. But the outputs should not be a signed number and can be more than 8-bits as every time the adders create an extra bit and the multipliers create more than one bit of data. That might be the major cause for the failure of the hardware; the architecture might not work properly. In order to minimize the error, suitable modifications are carried out.

Modifications to minimize the Errors:

The few possible modifications that can be done for the calculations which can minimize the errors are:

1. An adder performs the addition of two 8-bit numbers and gives the result as a 9-bit number. Instead of a 9-bit number the LSB is discarded. As the Least Significant Bit is discarded the value of the number might not change drastically and the output still is an 8-bit data which is used for further operations.
2. The multiplier performs multiplication of one 8-bit number and the other is coefficient numbers. For each multiplication the hardware will be different so the final architecture requires a lot of multipliers which are of different width and again gives different output values.
3. The lifting co-efficient which should be of 8-bit signed number goes in decimal numbers like **0.458** so that the computation will become very difficult. For multiplying this number multiplier takes more time to compute and the final output would be a decimal as **57.35.**

The lifting coefficient is multiplied with an integer as **57** so that representing it might be much easier. These coefficients should be multiplied such that the final values should be obtained as 8-bit signed number and it should not have any decimal value as **57.000.** This can be achieved by taking only the positive values and discarding all other decimal point values (e.g.XY.xy). Thus the values of all the lifting coefficients have integer without any decimal values so that the calculations can be much easier. From the architectural calculations, the values of ai and di are **65** and **39** respectively, and match with theoretical calculations.

By comparing those values we can come to know that:

1. The architecturally calculated values are of 8-bit singed representation while theoretically calculated are unsigned.
2. The architectural values do not have any decimal values.
3. The architectural values do not exceed more than 8-bit.
4. The intermediate calculations will be always 8-bit and signed instead of 9 or more bits.
5. The outputs of the adder in architectural calculations are 8-bit by discarding the LSB than having 9-bits which will be continued to increase for next level of addition.

Estimation of Power, Area and Delay of Sub-Blocks of Architecture:

The main sub-blocks of the modified lifting scheme architecture are:

- ✓ Adders
- ✓ Multipliers (Constant Coefficient-IP Cores)
- ✓ Registers

The table 1 represent the estimation of Power, Delay and Area of these sub blocks.

Table 1 : Estimation of Power, Delay and Area of sub blocks

Sl No	Sub Block	Power (W)	Area(no of slices,utilization of slice%)	Delay(nS)
1)	Adder	0.142	5(1%)	3.369
2)	Multiplier(50)	0.007	9 (1%)	1.999
3)	Multiplier(30)	0.037	7(1%)	0.881
4)	Multiplier(12)	0.037	6(1%)	0.881
5)	Multiplier(35)	0.037	13(1%)	0.881
6)	Multiplier(57)	0.037	11(1%)	0.881
7)	Multiplier(6)	0.037	6(0%)	0.881
8)	Multiplier(26)	0.037	7(1%)	0.881
9)	PISO	0.011	5(1%)	1.216
10)	SIPO	0.037	36(1%)	0.915
11)	PIPO	0.037	1(0%)	0.916

The table 1 represents the estimation of Power, Delay and Area of the Sub-blocks. Here every block is of 8 bit signed representation from +127 to -128. As observed from the table there are one type of adder, multipliers of 7 types of constant coefficient type to reduce the complexity of multiplication the IP cores in XILINX are used. Of all the sub-blocks the Adder has the highest delay and the highest utilisation of the resources. Thus by instantiating these sub-blocks the area utilised by the DWT architecture is 12% and the delay is 3.313ns. From the table 1 the delays of individual blocks are known. Almost all work at different clock frequencies, as the delay mentioned in the table is the minimum period of the design clock. But the whole or the top level design should work at one clock frequency, thus the concept of synchronising the clocks arise. The clock frequency of top level architecture should synchronise with the sub modules, in general the problem of Synchronisation is addressed by any of these below:

- Increase system clock period (usually not feasible).
- Decrease tcomb (use no combinational logic).
- Decrease tsu (use fast flip-flops)
- Increase synchroniser clock period.

The figure 6 represents the clock synchroniser.

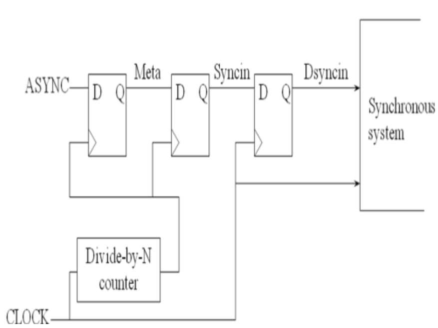


Figure 6 : Clock Synchroniser

In applying the same for the implementation of the present top-level design architecture, the DCM is used. The Divide-by-N counter block in the figure 7 can be replicated by using DCM. The figure 2.8 represents how to configure the DCM.

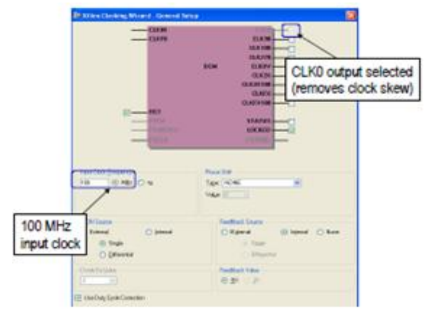


Figure 7 : Configuring DCM [2]

Thus by configuring the DCM in the frequency mode the tool generates the instantiation template and thus that instantiation template is used in the design to make the design run on same clock. The operating frequency of the present design runs at 280MHz.

Observations:

- The equation of the lifting scheme for two-level DWT is simplified based on the basic equations mentioned.
- The simplified equation is made into an architecture such that both the ai and di is implemented using the same architecture.
- The mathematical and the architectural computation of the equation are computed and compared, and observed that the architectural computations are the modified version of the mathematical, where the discarding of the LSBs result to scaling down of the original values.
- The power, area and the delay of the sub-blocks are observed and noticed that the Adder takes the maximum delay i.e. 3.39ns and maximum utilisation of resources i.e. 13%, and registers SIPO and PIPO takes the least delay and least utilisation of resources i.e. 1%

IV. HDL Modeling and FPGA Implementation

The top level module or block of the DWT architecture is shown in the figure 8. The figure explains the input and output ports. The input ports are **clk, en, piso_load, rst and ser_in** and the output ports are **ai** and **di**. The input 9 samples each of 8 bit signed data is entered into the design through the **ser_in** input. The **rst** signal is used to reset the design when the signal is high. When the **en** signal is high, loading of the input data in all the 9- 8 bit registers for 280 clock cycles is done. The **piso_load** signal is used to take the output at **ai** and **di,** and this signal is kept high for 8 clock cycles as the 8 bit is to be taken out through the single line. The HDL models of the sub-block can be understood from the internal hardware of the RTL schematic shown in the figure 9. The figure 9 represents the schematic of the DWT architecture where all the sub blocks can be viewed. Thus the sub blocks are modelled in such a way that the multipliers used are the IP cores from the XILINX library, and the adder that is designed for 8 bit signed addition is instantiated wherever necessary. The simulation of the top level module is shown in the figure 10 where the intermediate signals gives the performance of the sub blocks in the total simulation.

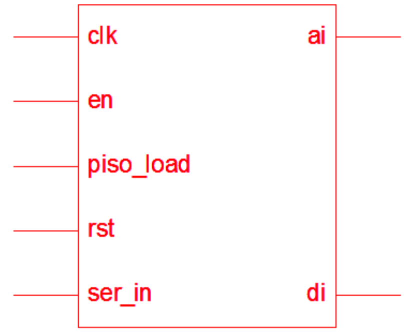


Figure 8 : Top-level DWT architecture

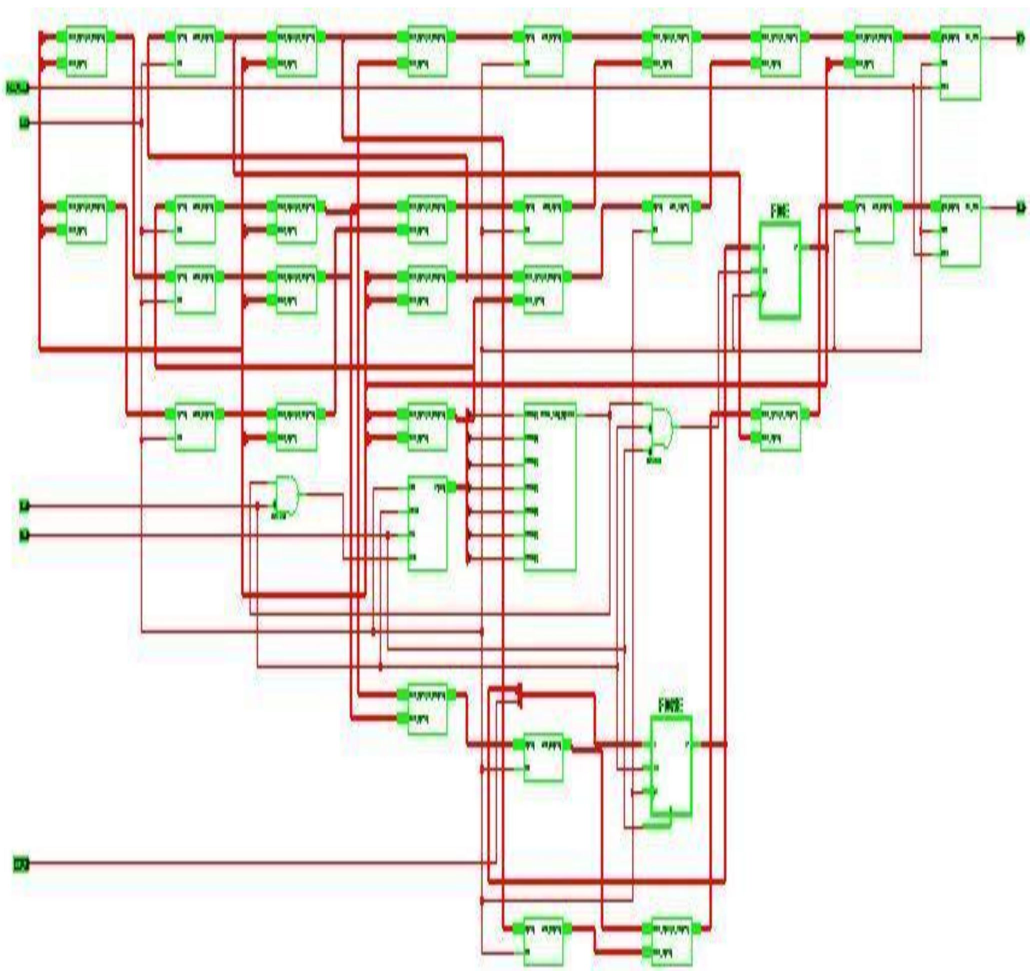


Figure 9 : RTL schematic of DWT showing sub-block

The figure **explains the integration of the sub blocks** in the main top level architecture. Initially the sub blocks are designed by considering the DWT equation, the multiplier used in the design is a **constant coefficient multiplier** as it is faster than any other for the application required. For the present design, the constant coefficient multipliers are taken as a **IP core** from the XILINX library for different coefficients. The **adder** is 8-bit signed operator designed or modelled in the HDL and instantiated where it is necessary. The registers that are used in the design covers all the types SIPO, PIPO, PISO. SIPO at the initial stage while giving the inputs, PIPO while performing the operations intermediately, and the PISO at the output stage to take the outputs serially i.e. one bit for 8 clocks, as the required is two outputs of 8 bits taking serially. From the figure 9, the top level ports are shown; the serial input data is given in a random way. This is loaded inthe registers (SIPO), when enable signal is high, after 72 clock cycles the enable is made low, and for four clock cycles the operation is performed and the output is taken when the piso_load signal is high for 8 clock cycles as the output is taken for 8 bit. Thus the same procedure follows for 8 (load)+ 4 (operation) + 8 (output) = 22 clocks. To program a single device using iMPACT, all needed is a bitstream file. To program several devices in a daisy chain configuration, or to program devices using a PROM, iMPACT is used to create a PROM file. iMPACT accepts any number of bitstream and creates one or more PROM files containing one or more daisy chain configurations.

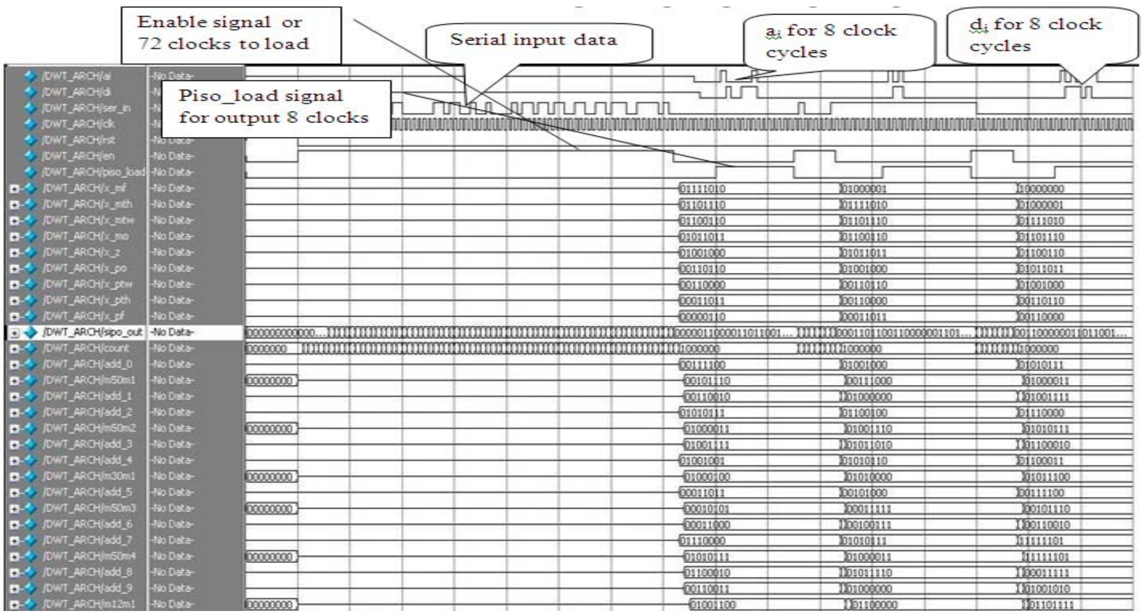


Figure 10 : Simulation results for the DWT architecture

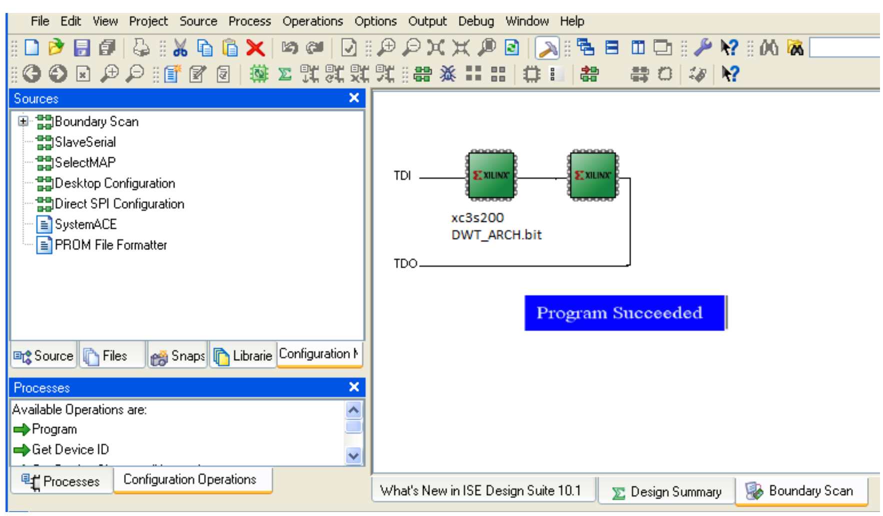


Figure 11 : Program downloaded into FPGA

Comparison of Post and Pre- Synthesis results:

The Post-synthesis result is that obtained after the place and route process has done. Here the delays of the LUTs and also the interconnection delay are added. But the Pre-Synthesis is nothing but the behavioral simulation. The comparison between the Post and Pre Synthesis results is shown in the figure 12 and 13.

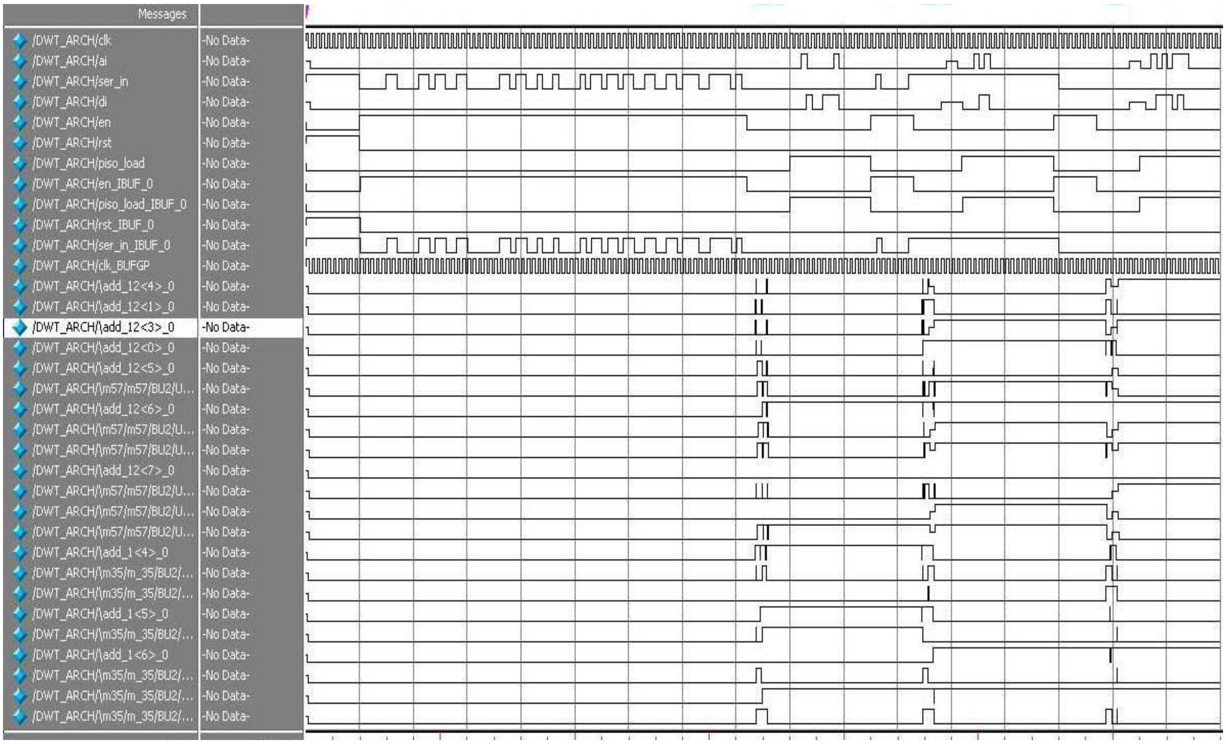


Figure 12 : Post-Synthesis simulation

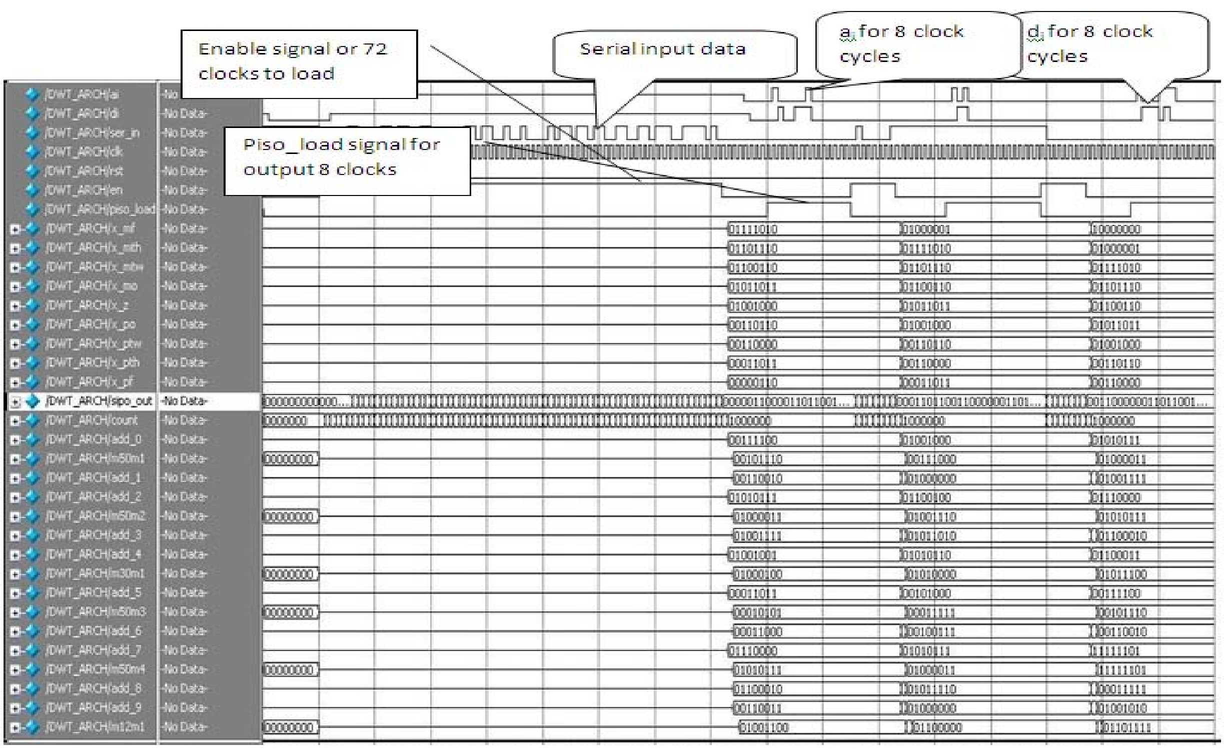


Figure 13 : Pre-Synthesis Simulation

Logic Utilization

Number of Slice Flip Flops: 247 out of 1,536

Number of 4 input LUTs: 295 out of 1,536

Logic Distribution

Number of occupied Slices: 245 out of 768

Number of Slices containing only related logic: 245 out of 245

Number of Slices containing unrelated logic: 0 out of 245

Total Number of 4 input LUTs: 314 out of 1,536

Number used as logic: 295

Number used as a route-thru: 19
Number of bonded IOBs: 6 out of 140
Number of GCLKs: 1 out of 4
Number of GCLKIOBs: 1 out of 4

Place and Route

Placement and routing is performed by the PAR program. *Place and route* is the most important and time consuming step of the implementation. It defines how device resources are located and interconnected inside an FPGA. Placement is even more important than routing, because bad placement would make good routing impossible. In order to provide possibility for FPGA designers to tweak placement, PAR has a "starting cost table" option. PAR accounts for timing constraints set up by the FPGA designer. If at least one constraint can't be met, PAR returns an error. The output of the PAR program is also stored in the NCD format. The device utilization summary of the architecture is given below.

Device Utilization Summary

- Number of GCLKs: 1 out of 4 25%
- Number of External GCLKIOBs: 1 out of 4 25%
- Number of LOCed GCLKIOBs : 0 out of 1 0%
- Number of External IOBs: 6 out of 140 4%
- Number of LOCed IOBs: 0 out of 6 0%
- Number of SLICEs: 245 out of 768 31%

Table 2 : Performance comparison of DWT architecture

Parameters	DWT [9]	Lifting DWT [18][19]	Modified Lifting DWT
No of Slices	432 out of 1536	358 out of 1536	247 out of 1536
No of gates	37K	27K	15K
Clock Speed	72 MHZ	156 MHz	268 MHz
Power dissipation	81 mW	67 mW	42 mW

V. Conclusion

In this work a modified lifting based DWT architecture is proposed, designed, modeled and verified. The design is modeled using HDL and is implemented on FPGA. The interfaces requried for data processing are also designed and is used to synchronize the data transfer operation. The HDL models and simulation of the sub blocks have been done to model the top-level design architecture. The test-bench to verify the functionality and performance of the sub modules and the top level architecture have been done. Implemented the design on FPGA and verified and debugged through the Chip-Scope. The Pre and Post Synthesis have been done and compared. The design can be further optimized for video signal processing.

References Références Referencias

1. N. Jayant and P. Noll, *Digital Coding of Waveforms: Principles and Applications to Speech and Video*. Englewood Cliffs, NJ: Prentice-Hall, 1984.
2. C. Diou, L. Torres, and M. Robert, “A wavelet core for video processing,” presented at the IEEE Int. Conf. Image Process., Sept. 2000.
3. N. Jayant, J. Johnston, and R. Safranek, “Signal compression based on models of human perception,” *Proc. IEEE*, vol. 81, pp. 1385–1422, Oct. 1993.
4. B. Zovko-Cihlar, S. Grgic, and D. Modric, “Coding techniques in multimedia communications,” in *Proc. 2nd Int. Workshop Image and Signal Processing, IWISP'95*, Budapest, Hungary, 1995, pp. 24–32.
5. *Digital Compression and Coding of Continuous Tone Still Images*, ISO/IEC IS 10918, 1991.
6. I. Daubechies, *Ten Lectures on Wavelets*. Philadelphia, PA: SIAM, 1992.
7. S. Mallat, “A theory of multiresolutio n signal decomposition: The wavelet representation,” *IEEE Trans. Pattern Anal. Machine Intell.*, vol. 11, pp. 674–693, July 1989.
8. M. Nagabushanam, Cyril Prasanna Raj P, S. Ramachandran, Design and Implementation of Parallel and Pipelined Distributive Arithmetic Based Discrete Wavelet Transform IP Core, European Journal of Scientific Research ISSN 1450-216X Vol.35 No.3 (2009), pp.378-392.
9. M. Vishwanath, R. Owens, and M. J. Irwin, “VLSI architectures for the discrete wavelet transform,” *IEEE Trans. Circuits Syst. II*, vol. 42, pp. 305–316, May 1995.
10. J. S. Fridman and E. S. Manolakos, “Discrete wavelet transform: Data dependence analysis and synthesis of distributed memory and control array architectures,” *IEEE Trans. Signal Processing*, vol. 45, pp. 1291–1308, May 1997.
11. T. Acharya, “A high speed systolic architecture for discrete wavelet transforms,” in *Proc. IEEE Global Telecommun. Conf.*, vol. 2, 1997, pp. 669–673.
12. C.J Lian, K.F. Chen, H.H. Chen, and L.G. Chen, “Lifting Based Discrete Wavelet Transform Architecture for JPEG2000,” in *IEEE International Symposium on Circuits and Systems*, Sydney, Australia, 2001, pp. 445–448.
13. M. Martina, G. Masera, G. Piccinini, and M. Zamboni, “Novel JPEG 2000 Compliant DWT and IWT VLSI Implementations,” *Journal of VLSI Signal Processing*, vol. 34, 2003, pp. 137– 153.
14. C.C. Liu,Y.H. Shiau, and J.M. Jou, “Design and Implementation of a Progressive Image Coding

Chip Based on the Lifted Wavelet Transform," in *Proc. of the 11th VLSI Design/CAD Symposium*, Taiwan, 2000.

15. H. Liao, M.K. Mandal, and B.F. Cockburn, "Efficient Architectures for 1-D and 2-D Lifting-BasedWavelet Transform," *IEEE Transactions on Signal Processing*, vol. 52, no. 5, 2004, pp. 1315–1326.
16. W.H. Chang, Y.S. Lee,W.S. Peng, and C.Y. Lee, "A Line-Based, Memory Efficient and Programmable Architecture for 2D DWT Using Lifting Scheme," in *IEEE International Symposium on Circuits and Systems*, Sydney, Australia, 2001, pp. 330–333.
17. C.T. Huang, P.C. Tseng, and L.G. Chen, "Flipping Structure: An Efficient VLSI Architecture for Lifting-Based Discrete Wavelet Transform," in *IEEE Transactions on Signal Processing*, 2004, pp. 1080–1089.
18. K. Andra, C. Chakrabarti, and T. Acharya, "A VLSI Architecture for Lifting-Based Forward and InverseWavelet Transform," *IEEE Trans. of Signal Processing*, vol. 50, no. 4, 2002, pp. 966–977.
19. H. Liao, M.K. Mandal, and B.F. Cockburn, "Novel Architectures for Lifting-Based Discrete Wavelet Transform," in *Electronics Letters*, vol. 38, no. 18, 2002, pp. 1010–1012.

Global Journals Inc. (US) Guidelines Handbook 2012

www.GlobalJournals.org

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN COMPUTING (FARSC)

- 'FARSC' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'FARSC" can be added to name in the following manner. eg. **Dr. John E. Hall, Ph.D., FARSC or William Walldroff Ph. D., M.S., FARSC**
- Being FARSC is a respectful honor. It authenticates your research activities. After becoming FARSC, you can use 'FARSC' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 60% Discount will be provided to FARSC members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- FARSC will be given a renowned, secure, free professional email address with 100 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, Spam Assassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- FARSC member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 15% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
- Eg. If we had taken 420 USD from author, we can send 63 USD to your account.
- FARSC member can apply for free approval, grading and certification of some of their Educational and Institutional Degrees from Global Journals Inc. (US) and Open Association of Research, Society U.S.A.
- After you are FARSC. You can send us scanned copy of all of your documents. We will verify, grade and certify them within a month. It will be based on your academic records, quality of research papers published by you, and 50 more criteria. This is beneficial for your job interviews as recruiting organization need not just rely on you for authenticity and your unknown qualities, you would have authentic ranks of all of your documents. Our scale is unique worldwide.
- FARSC member can proceed to get benefits of free research podcasting in Global Research Radio with their research documents, slides and online movies.
- After your publication anywhere in the world, you can upload you research paper with your recorded voice or you can use our professional RJs to record your paper their voice. We can also stream your conference videos and display your slides online.
- FARSC will be eligible for free application of Standardization of their Researches by Open Scientific Standards. Standardization is next step and level after publishing in a journal. A team of research and professional will work with you to take your research to its next level, which is worldwide open standardization.

- FARSC is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), FARSC can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 80% of its earning by Global Journals Inc. (US) will be transferred to FARSC member's bank account after certain threshold balance. There is no time limit for collection. FARSC member can decide its price and we can help in decision.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN COMPUTING (MARSC)

- 'MARSC' title will be awarded to the person after approval of Editor-in-Chief and Editorial Board. The title 'MARSC" can be added to name in the following manner. eg. Dr. John E. Hall, Ph.D., MARSC or William Walldroff Ph. D., M.S., MARSC
- Being MARSC is a respectful honor. It authenticates your research activities. After becoming MARSC, you can use 'MARSC' title as you use your degree in suffix of your name. This will definitely will enhance and add up your name. You can use it on your Career Counseling Materials/CV/Resume/Visiting Card/Name Plate etc.
- 40% Discount will be provided to MARSC members for publishing research papers in Global Journals Inc., if our Editorial Board and Peer Reviewers accept the paper. For the life time, if you are author/co-author of any paper bill sent to you will automatically be discounted one by 60%
- MARSC will be given a renowned, secure, free professional email address with 30 GB of space eg.johnhall@globaljournals.org. You will be facilitated with Webmail, Spam Assassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.
- MARSC member is eligible to become paid peer reviewer at Global Journals Inc. to earn up to 10% of realized author charges taken from author of respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account or to your PayPal account.
- MARSC member can apply for free approval, grading and certification of some of their Educational and Institutional Degrees from Global Journals Inc. (US) and Open Association of Research, Society U.S.A.
- MARSC is eligible to earn from their researches: While publishing his paper with Global Journals Inc. (US), MARSC can decide whether he/she would like to publish his/her research in closed manner. When readers will buy that individual research paper for reading, 40% of its earning by Global Journals Inc. (US) will be transferred to MARSC member's bank account after certain threshold balance. There is no time limit for collection. MARSC member can decide its price and we can help in decision.

ANNUAL MEMBER

- Annual Member will be authorized to receive e-Journal GJCST for one year (subscription for one year).
- The member will be allotted free 1 GB Web-space along with subDomain to contribute and participate in our activities.
- A professional email address will be allotted free 500 MB email space.

PAPER PUBLICATION

- The members can publish paper once. The paper will be sent to two-peer reviewer. The paper will be published after the acceptance of peer reviewers and Editorial Board.

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not convenient, and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

MANUSCRIPT STYLE INSTRUCTION **(Must be strictly followed)**

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, “Abstract” word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. **Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. **Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page

- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.

- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

A

Achieved · 4, 13, 23, 24, 25, 28, 52, 55, 59, 68
Algorithm · 17, 21, 23, 25, 27, 39, 40, 41, 43, 45, 46, 50, 52, 55, 56, 57, 58, 59, 60, 61, 62, 64, 65
Analysis · 33, 39, 46, 64
Andreopoulos · 27, 31, 32, 33
Anisotropic · 39, 40, 41, 42, 43, 44, 45, 46
Anisotropic · 39
Appropriate · 21, 28, 41
Architecture · 5, 64, 67, 68, 74, 75
Arithmetic · 15, 16, 17, 19, 20, 21
Artifacts · 9
Averaging · 39

B

Behavioral · 46
Benelux · 35

C

Cascaded · 58
Coefficients · 30, 49
Compensated · 11, 13, 15, 23, 24, 25, 27, 31, 32, 34
Compression · 9, 34, 35, 36, 65, 73
Correlation · 49, 51
Corrupted · 39
Cylinder · 3

D

Debugged · 73
Decomposition · 11, 13, 17, 19, 24, 27, 31, 35, 40, 54, 65, 73
Denoising · 39, 40, 46
Dimensional · 9, 10, 11, 24, 28, 32, 33, 35, 36, 40
Discarding · 68, 69
Discrete · 9, 24, 49, 65, 73, 74, 75

E

Extracted · 24, 49, 51, 52, 60

F

Fractional · 20, 21, 25
Further · 9, 16, 59, 60, 62, 64, 68, 73

G

Geometric · 3, 52

H

Hierarchically · 13
Horizontal · 2, 11, 13, 49

I

Implementation · 35, 64, 66, 73, 74
Interactive · 1, 5
Interfaces · 1

M

Modified · 62, 64, 67, 73
Monitoring · 1

O

Overwritten · 66

P

Piecewise · 28
Predisposal · 5
Preserving · 39, 45

Q

Quality · 9, 10, 11, 13, 30
Quantization · 13, 15, 23, 25, 32, 33, 36

R

Radioactive · 1, 5
Radwaste · 1
Resolution · 9, 10, 11, 13, 17, 22, 24, 27, 28, 35, 49, 50, 51, 64

S

Scalability · 9, 11, 13
Schematic · 4, 70
Smoothing · 42, 43
Square · 51, 55
Stationary · 55, 58, 62
Structure · 75
Symposium · 30, 31, 32, 34, 63, 74, 75
Synthesis · 71, 72, 73

T

Temporal · 9, 11, 13, 14, 23, 35
Transformation · 9, 65

U

Underlined · 67
Unexpected · 57

V

Variables · 4, 5
Varying · 33, 42
Visual · 9, 32, 33, 34, 35, 36
Volumetric · 10, 15, 17, 35, 36

W

Watermarking · 49
Wavelet · 9, 17, 24, 30, 31, 34, 35, 36, 40, 46, 49, 55, 58, 62, 65, 73, 74, 75
William · 33

save our planet

Global Journal of Computer Science and Technology

Visit us on the Web at www.GlobalJournals.org | www.ComputerResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9754350