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## Graphics & Vision



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Noisy & Noise less Images

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Volume 17 Issue 3 Version 1.0



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VOLUME 17 ISSUE 3 (VER. 1.0)

OPEN ASSOCIATION OF RESEARCH SOCIETY

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GLOBAL JOURNAL OF COMPUTER SCIENCE AND TECHNOLOGY: F  
GRAPHICS & VISION  
Volume 17 Issue 3 Version 1.0 Year 2017  
Type: Double Blind Peer Reviewed International Research Journal  
Publisher: Global Journals Inc. (USA)  
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

# A Comparative Study of Image Retrieval Algorithms for Enhancing a Content-based Image Retrieval System

By Elsaeed E. AbdElrazek  
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**Abstract-** Content Based image retrieval (CBIR) is in retrieve digital images by the actual content in the image. The content are the features of the image such as color, shape, texture and other information about the image including some statistic measures of the image. In this paper Content Based Image Retrieval algorithms are discussed. The comparative study of these algorithms is done. This article covers various techniques for implementing Content Based Image Retrieval algorithms and Some Open Source examples of Content-based Image Retrieval Search Engines.

**Keywords:** *image retrieval algorithms, content-based image retrieval system, feature detection algorithms.*

**GJCST-F Classification:** *B.4.2, H.2.8, I.3.3*



ACOMPARATIVESTUDYOFIMAGERETRIEVALALGORITMSFORENHANCINGACONTENTBASEDIMAGERETRIEVALSYSTEM

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# A Comparative Study of Image Retrieval Algorithms for Enhancing a Content-based Image Retrieval System

Elsaeed E. AbdElrazek

**Abstract-** Content Based image retrieval (CBIR) is in retrieve digital images by the actual content in the image .The content are the features of the image such as color, shape, texture and other information about the image including some statistic measures of the image. In this paper Content Based Image Retrieval algorithms are discussed. The comparative study of these algorithms is done. This article covers various techniques for implementing Content Based Image Retrieval algorithms and Some Open Source examples of Content-based Image Retrieval Search Engines.

**Keywords:** image retrieval algorithms, content-based image retrieval system, feature detection algorithms.

**General Terms:** artificial Intelligent-image processing.

## I. INTRODUCTION

With the explosive growth of the Internet, Web Search technology marked by keywords has acquired a great success in the tremendous information retrieval. As the network develops into the Web2.0 era, people no longer satisfy with merely the text-search, also want to be able to find more images from the sample image. In the future, image search engine will become the main tool of the user to retrieve images in the network [1].

The image content is more complexity than the text content to search kinds of information; images can only be expressed through their own content features. Therefore, image retrieval to be implemented is much more difficult than text retrieval.

On the other hand, people have developed many convenient development toolkits, which are capable of establishing image feature database. That makes it possible that the image search technology becomes more and more mature. As the same time, the efficiency of retrieving image becomes better than that of the past [2].

With the growth of the Internet, and the availability of image capturing devices such as digital cameras and image scanners, image databases are becoming larger and more widespread, and there is a growing need for effective and efficient image retrieval systems. There are two approaches for image retrieval:

text-based and content-based. The text-based approach can be tracked back to 1970s [3]. In such systems, the images are manually annotated by text descriptors, which are then used by a database management system to perform image retrieval. There are two disadvantages with this approach, the first is that a considerable level of human effort is required for manual annotation. The second is the annotation inaccuracy due to the subjectivity of human perception. To overcome the above disadvantages in text-based retrieval system, content-based image retrieval (CBIR) was introduced in the early 1980s.

In CBIR, the image visual content is a matrix of pixel values which are summarized by low-level features such as color, texture, shapes. We describe a CBIR methodology for the retrieval of images, whereas for humans the content of an image refers to what is seen on the image, e.g. " a forest, a house, a lake ". One of the research issues in content-based image retrieval is to reduce this semantic gap between the image understanding of humans and the image understanding of the computer, Humans tend to use high-level features (concepts), such as keywords, text descriptors, to interpret images and measure their similarity. While the features are automatically extracted using computer vision techniques are mostly low-level features (color, texture, shape, spatial layout, etc.). In general, there is no direct link between the high-level concepts and the low-level features.

Digital image databases and image processing techniques have developed significantly over the last few years. Today, a growing number of digital image databases are available, and are providing usable and effective access to image collections. In order to access these resources, users need reliable tools to access images. The tool that enables users to find and locate images is an image search engine

Search engines that use Text-Based Image Retrieval (TBIR) are Google, Yahoo. TBIR is based on the assumption that the surrounding text describes the image. The technique relies on text surrounding the image such as filenames, captions and the "alt"-tag in HTML and paragraphs close to the image with possible relevant text. The other approach uses image annotation of the images and is often a manual task. Annotation of images lets the provider annotate the image with the text

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(metadata) that is considered relevant. Most text based image retrieval systems provide a text input interface that users can type keywords as a query. The query is then processed and matched against the image annotation, and a list of candidate images are returned to the users. The Drawbacks of TBIR as follows:

1. In TBIR, humans are required to personally describe every image in the database, so for a large image database the technique require too much effort and time for manual image annotation.
2. TBIR techniques based on the comparison of the exact string matching. If the query string is misspelled there are no results returned.
3. The manual text annotation is valid only for the language used for the Purpose of annotation. Other people that do not have a background in the used language(s) are not able to use the text-based retrieval systems
4. Description of the image content is subjective to human perception; different people may end up with different descriptions for the content of the image in hand. TBIR is non-standardized because different users use different keywords for annotation [4].
5. The queries are mainly conducted on the text information and consequently the performance heavily depends on the degree of matching between the images and their text description.
6. The use of synonyms would result in missed results that would otherwise be returned.

In order to overcome the drawbacks of text based image retrieval system outlined above, and to assist users in finding desired images from the expected tens of millions of images, the Content-based image retrieval (CBIR) techniques can be designed to meet this aim.

The current research will focus on Comparison of Image Retrieval Algorithms within Image search engines, to identify searchable image features, to compare them based on their features, and to analyze the possible impact of these features on retrieval for enhancing a content-based image retrieval system

Most search engines rely on weak algorithms such as Color Histogram and Texture, which affects search results and images that do not match the query image. So the current research is trying to review these algorithms as an attempt to integrate them to achieve the quality of the search results.

## II. THE RESEARCH PROBLEM CAN BE COUCHED IN THE FOLLOWING QUESTIONS

- What Main stages of Web Image Retrieval System?
- What are the current technologies for image recognition and retrieval on the web?
- What Image's low level feature algorithms?

- What are the most important Feature Detection Algorithms?

## III. OBJECTINE

This search introduces a Comparison of Image Retrieval Algorithms within image search engines on the World Wide Web based on image recognition techniques. The main objectives are summarized in the following aspects:

- Highlight image retrieval algorithms which collect images from the World Web according to its low level features (color, texture and shape).
- Forming a scalable and adaptive CBIR framework for World Wide Web (www) users and search engines platforms 2).
- Enable the user to search for the images which are similar to his/her query in the contents and returns a set of images that similar to the user's query.
- Improving the overall performance of feature extracting processing.
- To acquire reliable and accurate results to validate the approach.
- Improving the overall timing of user's query.

## IV. IMAGE RETRIVAL

Search for an image from a collection of images was commonly done through the description of the image. As the number of image collections and the size of each collection grow dramatically in recent years, there is also a growing needs for searching for images based on the information that can be extracted from the image themselves rather than their text description. Content Based image retrieval (CBIR) IS an approach for meeting this need .CBIR is in retrieve digital images by the actual content in the image The content are the features of the image such as color, shape, texture and other information about the image including some statistic measures of the image.

Image retrieval techniques integrate both low level Visual features addressing the more detailed perceptual aspects and high level semantic features underlying the more general conceptual aspects of visual data.

Image retrieval can be categorized into the following types:

- *Exact Matching Retrieves:* the items that are perfectly matched with the user request which seeks to discover essential commonality of features of two entities being matched
- *Low Level Similarity-Based Searching:* Low Level visual features such as color shape. Texture e.g. to represent image content directory
- Search –by-example is a common practice where by an image is supplied and the system returns images that have features similar to those of the

supplied image. The similarity of images is determined by the values or similarity measures that are specifically defined for each feature according to their physical meaning

- *High Level Semantic-Based Searching:* The notion of similarity is not based simple feature matching and usually from extended user interaction with the system. At a higher semantic level that is better attuned to matching information needs. Such indexing techniques produce descriptions using a fixed vocabulary or so-called high-level features also referred to as semantic concepts.

The image retrieval systems based on the most commonly used image features following:

- *The Color:* it does not find the images whose colors are exactly matched. But images with similar pixel color information. This approach has been proven to be very successful in retrieving images since concepts of the color-based similarity measure is simple. And the convention algorithms are very easy to implement. Besides, this feature can resist noise and rotation variants in images. However, this feature can only used to take the global characteristics into account rather than the local one in an image. Such as the color difference between neighboring objects in an image. it is often fails to retrieve the images that are taken from the same scene in which the query example is also taken from under different time or conditions [5]
- *The Shape:* Natural objects are primarily recognized by their shape. A number of features characteristic of object shape are computed for every object identified within each stored image. Generally, Shape representations can be divided into two categories, boundary – based and region-based. The former uses only the outer boundary of the shape while the latter uses the entire shape region [4]
- A shape-based image retrieval stein accepts as input an image provided by the user and outputs a set of (possibly ranked) images of the system's database, each of which should contain shapes similar to the query, There are two main types of possible queries: queries by example and quay by sketch. In shape-based retrieval no isolated objects are difficult to deal with because they need to be localized in the image before in order to be compared with the query. shape localization is a non-trivial problem, since it involves high level scene segmentation capabilities how to separate interesting objects from the background is still an open and difficult research problem in computer vision .the second problem is the necessity to deal with inexact matching between a stylized sketch and a real. Possibly detailed, shape contained in the

image, will be need to take into account possible differences between the two shapes when compared between of them [6]

- *The Texture:*texture is an important characteristic in many types of images. Despite its importance a formal definition of texture does not exist. When an image has wide variation of tonal primitives, the dominant property of that image is Texture. Texture is the spatial relationship exhibited by grey levels in a digital image. Textural measures are measures capture that spatial relationship among pixels, spatial measures, which refer to measures mostly derived from spatial statistics, have been used largely in geospatial applications for characterizing and quantifying spatial patterns and processes [7]

The method of texture analysis is divided into two approaches: statistical and structural. For biological section images, the statistical approach is appropriate because the image is normally not periodical like a crystal. In the statistical approach, there are various ways to measure the features of the texture. Tested the discriminating power of various tools: spatial gray –level dependence method (SGLDM), gray –level difference method (GLDM), gray-level nun length method(GLNLM), power spectrum method(PSM),Gray level co-occurrence matrix(GLCM),Intensity histogram features and GLCM features are extracted in our proposed method.

A useful approach to texture analysis is based on the intensity histogram of all or part of an image. Common histogram features include: moments, entropy dispersion, mean (an estimate of the average intensity level), variance (the second moment is a measure of the dispersion of the region intensity), mean square value or average energy, skewness (the third moment which gives an indication of the histograms symmetry) and kurtosis (cluster prominence).

One of the simplest ways to extract statistical features in an image is to use the first-order probability distribution of the amplitude of the quantized image may be defined as:

$$P(b) = P_R \{F_{(j,k)=r_b}\}$$

Where  $r_b$  denotes the quantized amplitude level for 0, b, L-1. The first order histogram estimate of  $p(b)$  is simply.

$$P(b) = \frac{N(b)}{M}$$

Where M represents the total number of pixels in a neighborhood window of specified size centered about (j, k), b is a gray level in an image, and N(b) is the number of pixel of amplitude  $r_b$  in the same window.

## V. CONTENT-BASED IMAGE RETRIVAL (CBIR)

CBIR is mainly based on the visual content of images such as color, Texture and shape information.

Several techniques have been proposed to extract content characteristics from visual data automatically for retrieval proposed. CBIR applications became a part of a practical life and used in several commercial, governmental archives, and academic institutes such as libraries. CBIR is alternative to the text-based image retrieval and becomes the current research area of image retrieval [8,9]. In CBIR systems, the image content is represented by a vector of image features instead of a set of keyword. The image is retrieved according to the degree of similarity between features of images.

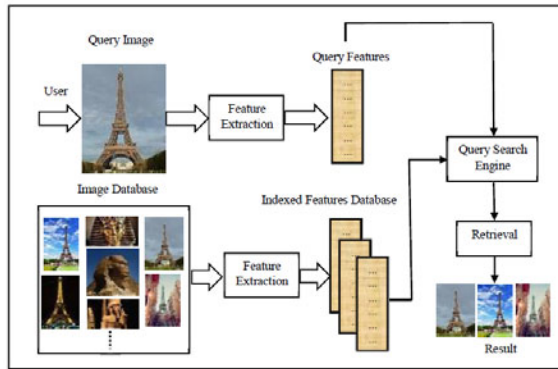


Figure 1: Content-based Image Retrieval System

The main components of CBIR system are as follows [10]:

1. Graphical User Interface which enable the user to select the query which can be in one of the following forms:
2. An image example: content based image retrieval systems allow the user to specify an image as an example and search for the images that are most similar to it, presented in decreasing order of similarity score.
3. Query/search engine: it is a collection of algorithms responsible for searching the database for images that is similar to the user's query.
4. Image Database: it is repository of images.
5. Feature extraction: it is the process of extracting the visual features (color, shape and texture) from the images.
6. Feature Database: it is repository for image features.

## VI. FEATURE DETECTION ALGORITHM

Feature detection algorithms consist of two basic categories [11]:

- a) Feature-based algorithms such as color histogram and shape or edge detector.
- b) Texture-based algorithms such as Scale Invariant Feature Transform (SIFT), Speed-Up Robust Feature (SURF) and Principal Component Analysis-SIFT (PCA-SIFT).

### a) Color Histogram as Feature-based Algorithm

These algorithms rely on extract a signature for every image based on its pixel values, and to define a rule for comparing images. However, only the color signature is used as a signature to retrieve images. Existing color based general-purpose image retrieval systems roughly fall into three categories depending on the signature extraction approach used: histogram, color layout, and region-based search. And histogram-based search methods are investigated in two different color spaces. A color space is defined as a model for representing color in terms of intensity values. Typically, a color space defines a one-to four-dimensional space. Three-dimensional color spaces such, RGB (Red, Green, and Blue) and HSV (Hue, Saturation and Value), are investigated [12].

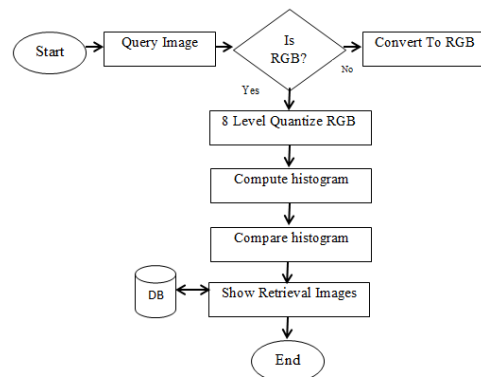


Figure 2: Show the flow chart of image retrieval using color histogram [3]

The drawback of a global histogram representation is that information about object location, shape, and texture is discarded. Color Histogram variants with rotation, scale, illumination variation and image noise with no sense of human perception. So, new algorithms are presented to overcome this limitation [4].

### b) Features from Accelerated Segment Test (FAST) Algorithm

The beginnings of feature detection can be tracked with the work of Harris and Stephen and the later called Harris Corner Detector which aims to introduce a novel method for the detection and extraction of feature-points or corners.

The Harris corner detector is a popular interest point detector due to its strong invariance to: rotation, scale and image noise by the auto-correlation function. Harris was successful in detecting robust features in any given image meeting basic requirements that satisfied the first two criterions above [13]. But since it was only detecting corners, his work suffered from a lack of connectivity of feature-points which represented a major limitation for obtaining major level descriptors (such as surfaces and objects) and limitation in speed.

The main contribution of FAST was summarized as: "A new algorithm which overcame some limitations of currently used corner detectors"[14].

With FAST, the detection of corners was prioritized over edges as they claimed that corners are one of the most intuitive types of features that show a strong two dimensional intensity change, and are therefore well distinguished from the neighboring points. Also, FAST modified the Harris detector so as to decrease the computational time[8].

c) *Scale Invariant Feature Transform (SIFT) Algorithm*

SIFT was developed by David Lowe in 2004. It presents a method for detecting distinctive invariant features from images that can be later used to perform reliable matching between different views of an object or scene. Two key concepts are used in this definition: distinctive invariant features and reliable matching [9]. SIFT is broken down into four major computational stages [11]:

- a. *Scale-space extreme detection:* The first stage of computation searches over all scales and image locations. It is implemented efficiently by using a difference-of-Gaussian function to identify potential interest points that are invariant to scale and orientation.
- b. *Key-point localization:* This stage attempts to eliminate more points from the list of key-points by finding those that have low contrast or are poorly localized on an edge.
- c. *Orientation assignment:* One or more orientations are assigned to each key-point location based on local image gradient directions. All future operations are performed on image data that has been transformed relative to the assigned orientation, scale, and location for each feature, thereby providing invariance to these transformations.
- d. *Key-point descriptor:* The local image gradients are measured at the selected scale in the region around each key-point. These are transformed into a representation that allows for significant levels of local shape distortion and change in illumination.

The main contribution of SIFT was summarized as: "A new texture algorithm which invariant feature transforms and overcome some limitations of currently used corner detectors". In SIFT algorithm, "there is no need to analysis the whole image" but you can use only interested key points to describe image. Unfortunately, the drawback of algorithm is that SIFT consider as the slowest texture-based algorithm, complex in computations and consume resources [15].

PCA is a standard technique for dimensionality reduction and has been applied to a broad class of computer vision problems, including feature selection, object recognition. While PCA suffers from a number of shortcomings, such as its implicit assumption of

Gaussian distributions and its restriction to orthogonal linear combinations, it remains popular due to its simplicity. The idea of applying PCA to image patches is not novel. Our contribution lies in rigorously demonstrating that PCA is well-suited to representing keypoint patches (once they have been transformed into a canonical scale, position and orientation), and that this representation significantly improves SIFT's matching performance. Research showed that PCA-SIFT was both significantly more accurate and much faster than the standard SIFT local descriptor. However, these results are somewhat surprising since the latter was carefully designed while PCA-SIFT is a somewhat obvious idea. We now take a closer look at the algorithm.

d) *Principal Component Analysis - Scale Invariant Feature Transform (PCA-SIFT Algorithm)*

Our algorithm for local descriptors (termed PCA-SIFT) accepts the same input as the standard SIFT descriptor: the sub-pixel location, scale, and dominant orientations of the key-point. We extract a 41x41 patch at the given scale, centered over the key-point, and rotated to align its dominant orientation. PCA-SIFT can be summarized in the following steps: pre-compute an eigenspace to express the gradient images of local patches; given a patch, compute its local image gradient; project the gradient image vector using the eigenspace to derive a compact feature vector. The feature vector is significantly smaller than the standard SIFT feature vector, and it can be used with the same matching algorithms. The Euclidean distance between two feature vectors is used to determine whether the two vectors correspond to the same key-point in different images [16].



(A1) PCA-SIFT	(A2) SIFT	(B1) SIFT	(B2) PCA-SIFT
9/10 correct	4/10 correct	6/10 correct	10/10 correct

Figure 2: A comparison between SIFT and PCA-SIFT (n=20) on some challenging real-world images taken from different viewpoints. (A) is a photo of a cluttered coffee table; (B) is a wall covered in Graffiti from the INRIA Graffiti dataset. The top ten matches are shown for each algorithm: solid white lines denote correct matches while dotted black lines show incorrect ones.

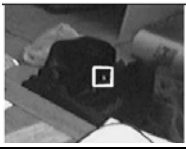
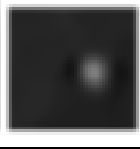


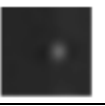



Query keypoint			
Rank	1	2	3
SIFT			
SIFT Distance	158	245	256
PCA-SIFT Distance	8087	8551	4438
PCA-SIFT			
SIFT Distance	256	399	158
PCA-SIFT Distance	4438	7011	8087

Figure 3: A closer look at matching results for a particular key point (zoomed in view of a region from Figure 2.3). The top three matches for this key point for SIFT and PCA-SIFT (n=20) are shown. The correct match is third on the list for the standard representation, while it is the top match for PCA-SIFT. The two algorithms use different feature spaces so a direct comparison of the distance values is not meaningful.

According to PCA-SIFT testing, fewer components requires less storage and will be resulting to a faster matching than SIFT, they choose the dimensionality of the feature space , n=20, which results to significant space benefits. But, PCA suffers from a number of shortcomings,

Such as its implicit assumption of Gaussian distributions, less accuracy, less reliable and its restriction to orthogonal linear combinations, it was proved to be less distinctive than SIFT.

The parameters which are used for the experimental evaluation of the results by the above stated algorithms are accuracy, precision and recall [17] where:

$$\text{Accuracy} = \frac{\text{Relevant images retrieved in top T returns}}{T}$$

$$\text{Precision} = \frac{\text{number of retrieved relevant images}}{\text{total number of retrieved images}}$$

$$\text{Recall} = \frac{\text{number of retrieved relevant images}}{\text{total number of relevant images in the database}}$$

T: total number of all relevant images in the database

## VII. A COMPARISON OF IMAGE RETRIEVAL ALGORITHMS

The following table provides the comparison of various Image Retrieval algorithms:

Table 1: The comparison of various Image Retrieval algorithms

No.	Algorithms	Developer	Algorithm Steps	Dataset Used	Performance Results
1	Scale Invariant Feature Transform- (SIFT)	David Lowe	-Constructing a scale space -Laplace of Gaussian approximation -Finding Keypoints -Eliminate edges and low contrast regions -Assign an orientation to the keypoints -keypoint descriptor extraction -Keypoint Matching	Google Image API	Precision ranges from 80% to 85%
2	Principle Component Analysis- Scale Invariant Feature Transform (PCA-SIFT)	Y Ke and R. Sukthanka r	Input: location of keypoint ,scale, orientation -Select a representative set of pictures and detect all keypoints in these pictures -for each point: Extract an image patch around it with size 41 x 41 pixels , calculate horizontal and vertical gradients, resulting in a vector of size 93x93x2=3042 -put all these vectors into a kx3042 matrix A where k is the number of keypoints detected -calculate the covariance matrix of A	Google Image API	Precision ranges up to 90%
3	Speeded Up Robust Features- (SURF)	HERBER T BAY et. all	SURF like SIFT in the major of stages, but different in two computational stages a) Orientation Assignment. b) Descriptor Components.	Google Image API	Precision ranges up to 90%

## VIII. SOME OPEN SOURCE OF CONTENT- BASED IMAGE RETRIEVAL SEARCH ENGINES

### a) AltaVista Photo Finder Search Engine

Features Similarity is based on visual characteristics such as dominant colors only. No details are given about the exact features. First, the user type keywords to search for images tagged with these words. If a retrieved image is shown with a link "similar", the link gives images that are visually similar to the selected image. Similarity is based on visual characteristics such as dominant colors. The user cannot set the relative weights of these features, but judging from the results, color is the predominant feature.

### b) Anaktisi Photo Finder Search Engine

In this website a new set of feature descriptors is presented in a retrieval system. These descriptors have not been designed with particular attention to their size and storage requirements. These descriptors incorporate color information into one histogram while keeping their sizes between 23000 and 740000 bytes per image.

High retrieval scores in content-based image retrieval systems can be attained by adopting relevance feedback mechanisms. These mechanisms require the user to grade the quality of the query results by marking the retrieved images as being either relevant or not. Then, the search engine uses this grading information in subsequent queries to better satisfy users' needs. It is noted that while relevance feedback mechanisms were first introduced in the information retrieval field, they currently receive considerable attention in the CBIR field.

The vast majority of relevance feedback techniques proposed in the literature is based on modifying the values of the search parameters so that they better represent the concept the user has in mind. But, the semantic gap between the user query and the result isn't maintained yet.

There is no ranking algorithm for more usability and reliability Figure 2.7 shows the result of bus query image of Anaktisi Photo Finder search engine.



Figure 4: Screenshot about Results of Bus Query Image of Anaktisi Photo Finder Search Engine

c) *Akiwi Photo Finder Search Engine*

In this web-site a new set of feature descriptors is presented in a retrieval System. These descriptors have been designed with particular attention to their size and storage requirements, keeping them as small as possible without compromising their discriminating ability. These descriptors incorporate color and texture information into one histogram while keeping their sizes between 22 and 70 kilobytes per image. There are no High retrieval techniques and the semantic gap between human perception and the machine perception is very high. Figure 2.8 shows the result for logo of University Damietta query image of Akiwi Photo Finder search engine.



Figure 5: Screenshot about Results for logo of University Damietta Query Image of Akiwi Photo Finder search engine

d) *Google Search Engine*

In this web-site, there is no description about what exactly feature extraction algorithm used. But during analysis and testing of Google search (as shown in figure 2.9), we observe that the result of rose query image returns the exactly image and other images not related to the query.

We considered that returned images by color feature. For semantic technique, Google used ontology tagging for retrieval process. Consequently, ranking method is page rank method as alternative of relevance feedback to optimize usability.

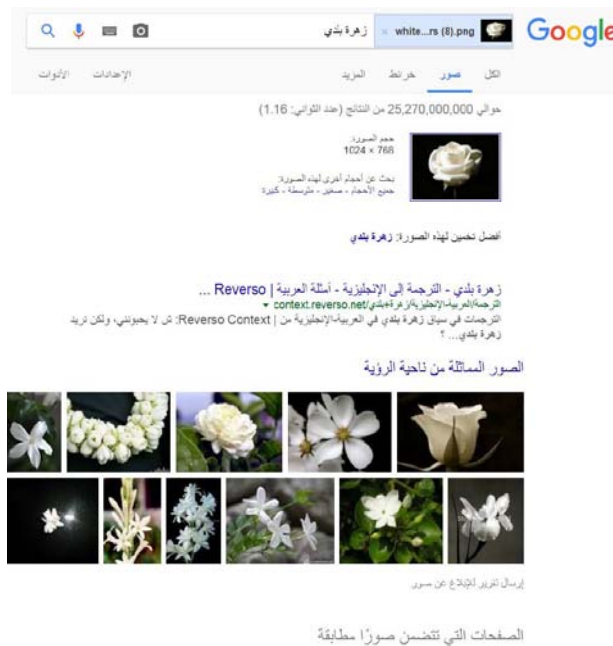


Figure 6: Screenshot about Results of Rose Query Image of Google Search Engine

IX. CONCLUSION AND FUTURE SCOPE

In this paper, compared to content-based image retrieval algorithms used in the most famous image search engines, the set of algorithms used and their results are discussed in detail. From the results of

the different methods discussed, it can be concluded that to improve algorithm retrieval performance must integrate these algorithms to increase the values of standard evaluation criteria such as accuracy, proportion of convergence or accuracy to obtain the higher values of the standard evaluation parameters used to evaluate a large algorithm to demand better results for retrieval performance.

The horizon is still wide for future studies to work on increasing the accuracy and speed of searching the web. Following points show open issues that need to be addressed:

- Increase the accuracy of search results by combining of Image Retrieval Algorithms
- Increase the accuracy of the search results in the retrieval of images
- Increase the speed (Response time) in image retrieval
- The development of search engines with high accuracy in retrieving information based on the integration of several algorithms of image retrieval.

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# Alpha Trimmed Mean based JPEG Compression for an Objective Image Quality Enhancement of Noisy and Noise Less Images

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**Abstract-** We can see that over the past few years, the number of people using the internet and the amount of information transmitted over the internet has grown to such a wide range. One of the best ways to reduce the image size is via image compression. In the compression of the still image, JPEG is better when it comes to bandwidth conservation. In this paper, we discussed an innovative JPEG compression algorithm with alpha-trimmed means based clustering. The proposed algorithm is expected to produce better results regarding MSE, PSNR and the number of bits transmitted when compared to the standard algorithms. The proposed JPEG algorithm enhances the speed and reduces the number of encoded bits, thereby reducing the amount of memory required. The reassembled image after decompression is as similar as the input image.

**Keywords:** *image compression, clustering, PSNR, MSE, AD, SC.*

**GJCST-F Classification:** *B.4.2, I.4.1*



ALPHATRIMMEDMEANBASEDJPEGCOMPRESSIONFORANOBJECTIVEIMAGEQUALITYENHANCEMENTOFNOISYANDNOISELESSIMAGES

*Strictly as per the compliance and regulations of:*



RESEARCH | DIVERSITY | ETHICS

# Alpha Trimmed Mean based JPEG Compression for an Objective Image Quality Enhancement of Noisy and Noise Less Images

Vanitha Kakollu <sup>α</sup> G. Narasimha <sup>σ</sup> & P. Chandrasekhar Reddy <sup>ρ</sup>

**Abstract-** We can see that over the past few years, the number of people using the internet and the amount of information transmitted over the internet has grown to such a wide range. One of the best ways to reduce the image size is via image compression. In the compression of the still image, JPEG is better when it comes to bandwidth conservation. In this paper, we discussed an innovative JPEG compression algorithm with alpha-trimmed means based clustering. The proposed algorithm is expected to produce better results regarding MSE, PSNR and the number of bits transmitted when compared to the standard algorithms. The proposed JPEG algorithm enhances the speed and reduces the number of encoded bits, thereby reducing the amount of memory required. The reassembled image after decompression is as similar as the input image.

**Keywords:** image compression, clustering, PSNR, MSE, AD, SC.

## I. INTRODUCTION

The encoder generates a set of symbols when a two-dimensional image  $f(x, y)$  is given as an input. Then transmit this through a channel and the encoded image is now sent to the decoder. The decoder generates a reconstructed image  $f'(x, y)$ . The output  $f'(x, y)$  is an accurate imitation of  $f(x, y)$  in lossless compression. Else it means that there is some misconception present in the re-enacted image [1].

The JPEG (Joint Photographic Experts Group), the committee that shaped the JPEG standard, is an identifiable lossy compression proposal. Not just using less memory, but also the data in the regenerated image in a JPEG compression appears very much identical. Though the quality is reduced with JPEG compression, the image will look nearly as similar as the original image.

The JPEG Algorithm wipes out high-frequency components that the human eye can't identify.

### a) JPEG Algorithm

When compared to straight better, it involves the following steps.

1. The acquired image can be divided it into 8-pixel by 8-pixel blocks. If the image size is not precisely multiplied by 8, then add zeros in empty pixels around the edges.

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2. For each 8-by-8 block, get image data such that you have values to represent the color at each pixel.
3. 8-by-8 blocks can be obtained from the Discrete Cosine Transform (DCT).
4. To make some values as zero from the DCT matrix, the DCT of each 8X8 block should be multiplied by a normalized mask.
5. Normalization abandons most of the high-frequency components. Next, the assortment of significant 2-D normalized DCT Coefficients by traversing in a ZIGZAG fashion and categorizing them in a 1-D array. In the 1-D array, the two types of DCT coefficients the first one is termed as direct current (DC) element, while other coefficients are called alternating current (AC) elements. Variable length Huffman coding is used to code AC components.
6. The reverse operation of compression is decompression. First calculate the normalized DCT values by decoding the compressed bit stream by Huffman code. Then organize all the DCT values in the 2-D array in a ZIGZAG fashion. We can obtain the decoded DCT values by multiplying them with normalized coefficients. Now an IDCT is executed on the denormalized DCT array. The decoding process engenders ensuing image block will not be identical to respective original image block used during encoding[1].

If in 8x8 blocks include a lot of dissimilarity in pixel values then the number of constructive DCT coefficients will grow to be more. Otherwise only first few DCT coefficients will be more noteworthy while others are zeros. On the application of filters, as a result the image gets smoothened the distinction of the pixel values of a block abridged [1].

## II. INTENDED INNOVATIVE JPEG COMPRESSION ALGORITHMS

If in 8x8 blocks include lot of distinction in pixel values then the number of constructive DCT coefficients will grow to be more. Otherwise only first few DCT coefficients will be more noteworthy while others are zeros. On the application of filters the image gets smoothened as a result the distinction of the pixel values of a block abridged.

There are two different ways to implement the JPEG Algorithm.

- 1) Earlier than segregating the image into 8X8 blocks the images tainted with Poisson, Speckle, Salt & Pepper noise and Gaussian noise is convoluted with Alpha trimmed Mean filter.
- 2) Before the application of normalized matrix, the image is convoluted with the Alpha trimmed Mean filter.

This paper examines the comparison between the proposed approaches with the standard JPEG compression. The planned methods illustrate enhanced

results compared to the JPEG in terms encoded bits. This paper implements the proposed algorithms by using MATLAB tools and the images are extracted from SIPI image database.

*Algorithm1:* Alpha trimmed Mean Based JPEG algorithm on noisy images.

*Step1:* Read the image.

*Step 2:* Apply speckle/Poisson/ Gaussian/ Salt & Pepper Noise.

*Step 3:* Apply Alpha trimmed Mean.

*Step 4:* Standard Jpeg Compression [8, 9].

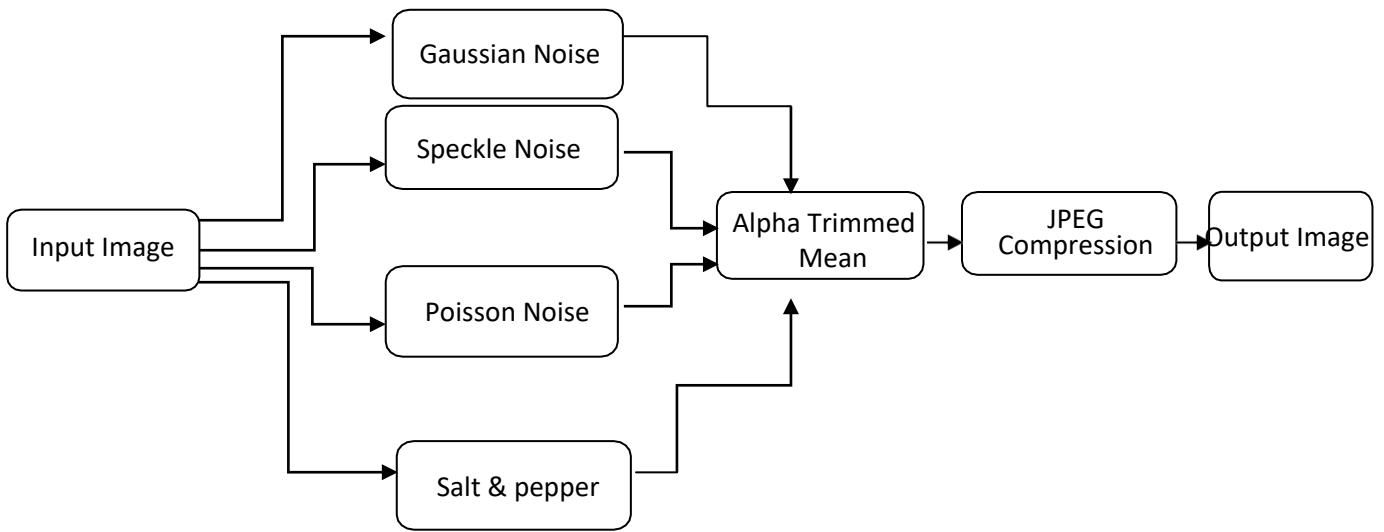


Fig.1: Structure of Planned JPEG algorithms on images corrupted with various types of noise.

*Algorithm 2:* Alpha trimmed Mean based JPEG Algorithm on regular images.

*Step1:* Read the image.

*Step 2:* Apply the smoothing operator Alpha trimmed Mean.

*Step 3:* Standard Jpeg Compression [7, 8, 9].

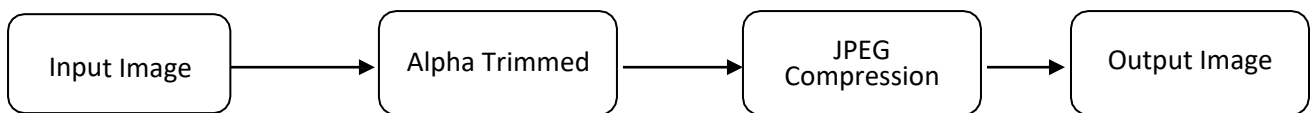


Fig. 2: Structure of Planned JPEG algorithms on images corrupted with various types of noise.

### III. IMPLEMENTATION OF PLANNED JPEG ALGORITHMS

In this paper Alpha trimmed mean based JPEG compression is executed on images of different sizes. Contemplation of results entrusts that the lately expected compression techniques are enormously a prominent alternate since they are proved to be better

regarding image quality metrics like PSNR, MSE, AD, SC, Compression ratio.

N1 is the extent of information hauling units required to imply uncompressed dataset and N2 is the number of entities in the encoded dataset. The units for N1 and N2 are same.

$$CR = N1/N2$$

The reconstructed image is identical to the original image with lossless compression algorithms as they not only swab out redundancy but also eradicates the redundancy present in the data they even guard all the information that is present in the input image.

Higher compression is achieved in lossy compression algorithms as the output image and the input image will not be similar. We can either use subjective fidelity criteria or objective fidelity criteria for comparing the original and reprocessed image. An example for objective fidelity criteria is Root mean square (RMS) error.

Measurement of the image quality is an imperative implication in image processing. In many of the image processing applications, estimation is a compulsion for the excellence of the image. The judgment of the quality of an image by the human is not sufficient. Therefore some more metrics like PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error) are needed. PSNR is one of the specialized image quality metric. The differences between the restructured image and the input image will be small when the PSNR value is high.

This paper spot the comparison between the proposed Alpha trimmed Mean based approaches with the standard JPEG compression. The premeditated approaches exemplify improved results contrasted to the JPEG. Out of these proposed JPEG compressions the Alpha Trimmed Mean filter on images corrupted with on Poisson noise in *algorithm1*, Alpha trimmed Mean on images encodes the images with a fewer number of bits, as a result the images will be transmitted with high speed. The decisive insinuation in image processing is the amount of image quality. Evaluation and assessing are obligatory for image quality in many image processing implementations. The refinement of human to boost the image quality is not adequate. So we necessitate some additional image quality metrics like Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR).

The number of encoded bits required to characterize the compressed image is minimized with the Alpha trimmed Mean. The corrupted images with Poisson noise in the proposed algorithm resulted a high compression ratio compared to the standard JPEG compression technique.

#### IV. RESULTS

This paper presents the evaluation between the proposed Alpha trimmed mean based JPEG approaches with the standard JPEG compression. The wished-for approaches typify improved results compared to the JPEG. This paper makes use of MATLAB tools to access the proposed algorithm and the images are from SIPI image database.

Table 1: Alpha Trimmed mean JPEG Compression on Images corrupted with Gaussian noise of size 256X 256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	38915	35567	40756	48505
Saved bits	485373	488721	483532	475483
RMS Error	1.99	2.14	2.16	2.95
Compression ratio	13.47	14.74	12.86	10.8
PSNR	42.19	41.55	41.48	38.76
MSE	3.96	4.58	4.66	8.71

Table 2: Alpha Trimmed mean JPEG Compression on Images corrupted with Gaussian noise of size 512x512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	160880	185945	151629	171235
Saved bits	1936272	1911207	1945523	1925917
RMS Error	1.98	2.15	1.92	1.97
Compression ratio	13.03	11.27	13.83	12.24
PSNR	48.27	47.54	48.52	48.30
MSE	3.91	4.61	3.68	3.88

Table 3: Alpha Trimmed mean JPEG Compression on Images corrupted with Salt & Pepper noise of size 256x256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	33233	32096	37968	52879
Saved bits	491055	492192	486320	471409
RMS Error	1.62	2.21	1.96	2.66
Compression ratio	15.77	16.33	13.80	9.91
PSNR	43.95	41.28	42.30	39.67
MSE	2.64	4.88	3.86	7.07

Table 4: Alpha Trimmed mean JPEG Compression on Images corrupted with Salt & Pepper noise of size 512x512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	138715	173238	130268	152700
Saved bits	1958437	1923914	1966884	1944452
RMS Error	1.60	1.88	1.54	1.58
Compression ratio	15.11	12.10	16.09	13.73
PSNR	50.12	48.71	50.42	50.22
MSE	2.55	3.52	2.37	2.49

**Table 5:** Alpha Trimmed mean JPEG Compression on Images corrupted with *Poisson noise* of size 256 X 256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	31807	28385	34746	46210
Saved bits	492481	495903	489542	478078
RMS Error	1.56	1.86	1.86	2.49
Compression ratio	16.48	18.47	15.08	11.34
PSNR	44.28	42.76	42.78	40.22
MSE	2.44	3.47	3.46	6.22

**Table 6:** Alpha Trimmed mean JPEG Compression on Images corrupted with *Poisson noise* of size 512 X512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	134461	170584	124837	151040
Saved bits	196261	1926568	1972315	1946112
RMS Error	1.55	1.78	1.46	1.54
Compression ratio	15.59	12.29	16.79	13.88
PSNR	50.37	49.17	50.87	50.45
MSE	2.41	3.17	2.14	2.37

**Table 7:** Alpha Trimmed mean JPEG Compression on Images corrupted with *Speckle noise* of size 256X256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	32309	27980	34650	46407
Saved bits	492249	496308	489638	477881
RMS Error	1.56	1.82	1.92	2.46
Compression ratio	16.36	18.73	15.13	11.29
PSNR	44.33	42.96	42.50	40.35
MSE	2.42	3.31	3.69	6.04

**Table 8:** Alpha Trimmed mean JPEG Compression on Images corrupted with *Speckle noise* of size 512X512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	134490	170840	124478	150890
Saved bits	1962662	1926312	1972674	1946262
RMS Error	1.53	1.82	1.46	1.54
Compression ratio	15.59	12.27	16.84	13.89
PSNR	50.52	49.00	50.90	50.44
MSE	2.33	3.30	2.13	2.37

**Table 9:** JPEG Compression on Images corrupted with *Gaussian noise* of size 256X256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	131762	128052	130105	112493
Saved bits	392526	396236	394183	411795
RMS Error	8.30	8.21	8.14	7.18
Compression ratio	3.97	4.09	4.02	4.66
PSNR	29.79	29.88	29.95	31.04
MSE	68.84	67.39	66.25	51.56

**Table 10:** JPEG Compression on Images corrupted with *Speckle noise* of size 256X256.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	534501	571916	523400	543731
Saved bits	1562651	1525236	1573752	1553421
RMS Error	8.24	8.22	8.28	8.29
Compression ratio	3.92	3.66	4.00	3.85
PSNR	35.86	35.89	35.82	35.82
MSE	67.97	67.49	68.57	68.64

**Table 11:** JPEG Compression on Images corrupted with *Speckle noise* of size 512X512.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	85872	107713	110033	107065
Saved bits	438416	416575	414255	417223
RMS Error	7.07	7.81	7.65	6.96
Compression ratio	6.10	4.86	4.76	4.89
PSNR	31.18	30.32	30.49	31.31
MSE	49.99	60.93	58.54	48.46

**Table 12:** JPEG Compression on Images corrupted with *Speckle noise* of size 512X512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	352151	422756	344034	354298
Saved bits	1745001	1674396	1753118	1742854
RMS Error	6.79	6.99	7.06	6.65
Compression ratio	5.95	4.96	6.09	5.91
PSNR	37.55	37.30	37.21	37.72
MSE	46.07	48.81	49.86	44.27

**Table 13:** JPEG Compression on Images corrupted with *Poisson noise* of size 256X256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	81211	86149	91099	93492
Saved bits	443077	438139	433189	430796
RMS Error	6.71	6.92	6.94	5.68
Compression ratio	6.45	6.08	5.75	5.60
PSNR	31.63	31.36	31.34	33.08
MSE	45.08	47.92	48.19	32.26

**Table 14:** JPEG Compression on Images corrupted with *Poisson noise* of size 512X512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	333965	408287	320709	347564
Saved bits	1763187	1688865	1776443	1749588
RMS Error	6.41	6.81	6.61	6.52
Compression ratio	6.27	5.13	6.53	6.03
PSNR	38.05	37.52	37.78	37.89
MSE	41.11	46.39	43.73	42.57

**Table 15:** JPEG Compression on Images corrupted with *Salt & Pepper* size 256X256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	100843	97834	102094	118128
Saved bits	423445	426454	422194	406160
RMS Error	6.65	5.95	5.98	5.85
Compression ratio	5.19	5.35	5.13	4.43
PSNR	31.7	32.68	32.64	32.82
MSE	44.27	35.35	35.71	34.22

**Table 16:** JPEG Compression on Images corrupted with *Salt & Pepper* size 512X512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	412269	485030	396350	433858
Saved bits	1682883	1612122	1700802	1663294
RMS Error	6.34	6.96	6.38	6.73
Compression ratio	5.06	4.32	5.29	4.83
PSNR	38.14	37.34	38.09	37.63
MSE	40.19	48.42	40.69	45.28

**Table 17:** Alpha trimmed Mean JPEG Compression on Images of size 256X256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	29370	22971	30094	45560
Saved bits	494918	501317	494194	478728
RMS Error	1.35	1.68	1.48	2.17
Compression ratio	17.85	22.8	17.42	11.5
PSNR	45.58	43.68	44.78	41.44
MSE	1.81	2.81	2.18	4.71

Table 18: Alpha trimmed Mean JPEG Compression on Images of size 512X512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	126602	168049	115194	147353
Saved bits	1970550	1929103	1981958	1949799
RMS Error	1.35	1.74	1.29	1.43
Compression ratio	16.56	12.47	18.2	14.23
PSNR	51.57	49.37	51.97	51.05
MSE	1.83	3.03	1.67	2.06

Table 19: JPEG Compression on Images of size 256X256.

Images	5.1.09	5.1.11	5.1.12	5.1.13
No of Bits Required	60840	40534	50289	65622
Saved bits	463448	483754	473999	458666
RMS Error	4.25	2.26	3.04	3.6
Compression ratio	8.61	12.93	10.42	7.98
PSNR	35.59	41.10	38.50	37.5
MSE	18.10	5.09	9.26	12.94

Table 20: JPEG Compression on Images of size 512X512.

Images	5.2.08	5.2.10	7.1.03	7.1.05
No of Bits Required	246431	363397	243255	298239
Saved bits	1850721	1733755	1853897	1798913
RMS Error	3.48	5.39	3.8	4.7
Compression ratio	8.51	5.771	8.62	7.03
PSNR	43.35	39.55	42.58	40.74
MSE	12.11	29.09	14.46	22.11

## V. CONCLUSION

In this paper, Alpha trimmed mean based JPEG compression algorithm is proposed. This algorithm is evaluated with standard JPEG algorithm. The proposed algorithm uses less encoded bits for compression of images and hence the loading and storing of the image took less time. Also, the mean square error (MSE) of the proposed approach is low compared to the regular JPEG. Due to the peak signal noise ratio (PSNR) perfect classification correctness is augmented with the estimated approach. The projected compression ratio can be realized with good quality image with necessary planned algorithm compared to JPEG compression technique. The requirement of encoded bits to represent the compressed image is less compared to JPEG compression. Also the image corrupted with various types of noises like Gaussian, Poisson, Speckle, Salt & Pepper noise are compressed efficiently with alpha trimmed JPEG compression. This proposed alpha trimmed JPEG compression algorithm eliminates the noise and encodes the image with fewer number of bits compared JPEG compression technique.

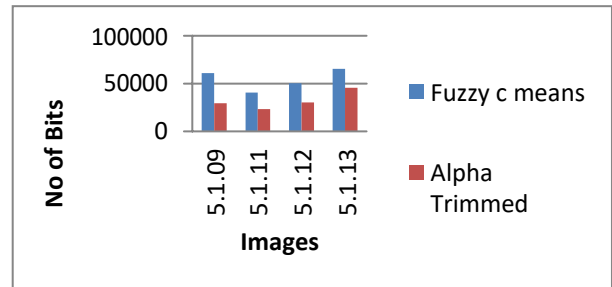


Fig. 1: Comparison between JPEG and Alpha trimmed mean in terms of No of bits transmitted for images of size 256x256

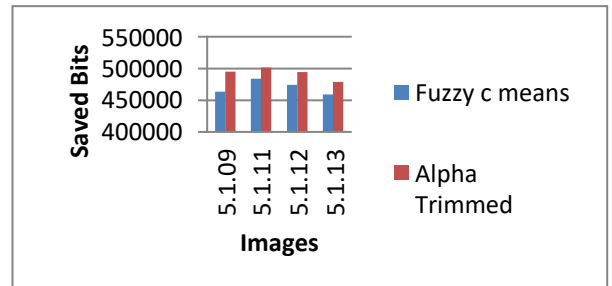


Fig. 2: Comparison between JPEG and Alpha trimmed mean in terms of Saved bits transmitted for images of size 256x256

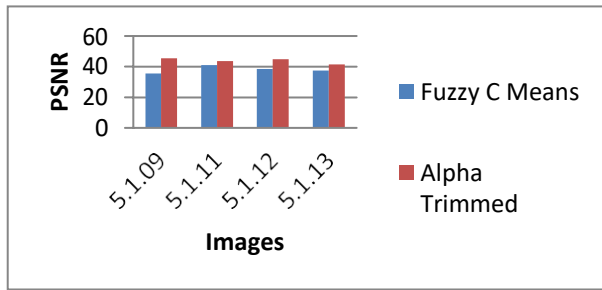


Fig. 3: Comparison between JPEG and Alpha trimmed mean in terms of PSNR transmitted for images of size 256x256

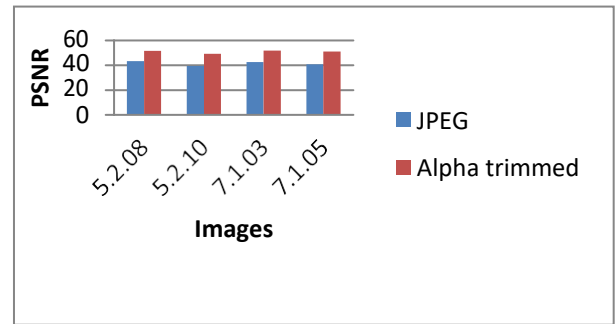


Fig. 7: Comparison between JPEG and Alpha trimmed mean in terms of PSNR transmitted for images of size 256x2

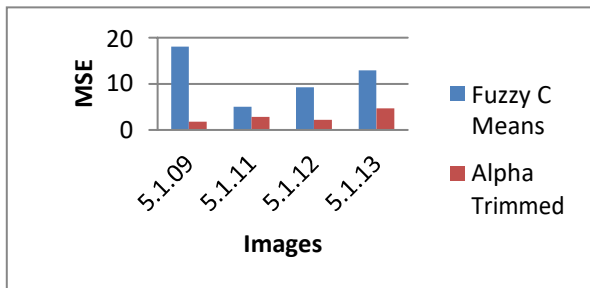


Fig. 4: Comparison between JPEG and Alpha trimmed mean in terms of MSE transmitted for images of size 256x256

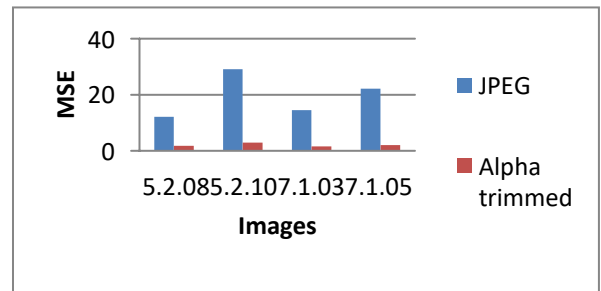


Fig. 8: Comparison between JPEG and Alpha trimmed mean in terms of MSE transmitted for images of size 256x256

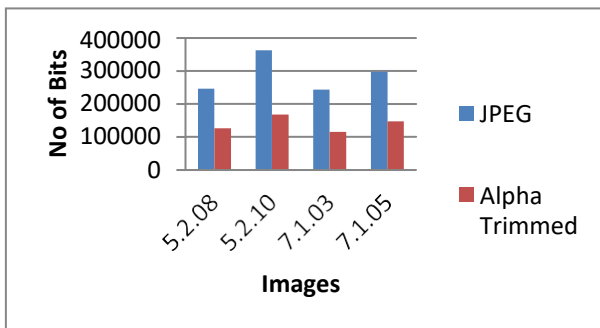


Fig. 5: Comparison between JPEG and Alpha trimmed mean in terms of No of bits transmitted for images of size 256x256

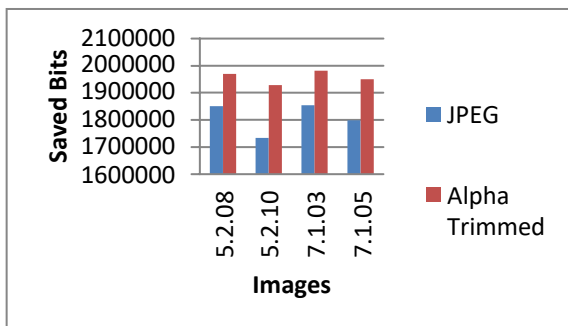


Fig. 6: Comparison between JPEG and Alpha trimmed mean in terms of Saved bits transmitted for images of size 256x256

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GLOBAL JOURNAL OF COMPUTER SCIENCE AND TECHNOLOGY: F  
GRAPHICS & VISION  
Volume 17 Issue 3 Version 1.0 Year 2017  
Type: Double Blind Peer Reviewed International Research Journal  
Publisher: Global Journals Inc. (USA)  
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

## Face Recognition using Morphological Analysis of Images

By Saiba Nazah & Md. Monjurul Islam

*Chittagong University*

**Abstract-** Face recognition from still and motion image has been an active and emerging research area in the field of image processing, pattern recognition and so on in the recent years . The challenges associated with discriminant face recognition can be attributed to the following factors such as pose, facial expression, occlusion, image orientation, image condition, presence or absence of structural component and many more. In this paper, we have tried to emphasize on the morphological analysis of images based on the behavior of the intensity value. Firstly images with various situations of a person are selected as training images. Based on the min, max and average characteristics of images, the training model has been built. Morphological analysis like binary image processing, erosion and dilation play the important role to identify the facial portion of an image from the whole one. Finally face recognition has been made for input images based on their intensity value measurement. The training images collected from various database such as YALE, ORL, and UMIST and others. The algorithm performed well and showed 80 percent accuracy on face prediction

**Keywords:** *face recognition, intensity value, morphological analysis, binary image.*

**GJCST-F Classification:** *B.4.2, I.3.3*



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Saiba Nazah<sup>α</sup> & Md. Monjurul Islam<sup>σ</sup>

**Abstract-** Face recognition from still and motion image has been an active and emerging research area in the field of image processing, pattern recognition and so on in the recent years. The challenges associated with discriminant face recognition can be attributed to the following factors such as pose, facial expression, occlusion, image orientation, image condition, presence or absence of structural component and many more. In this paper, we have tried to emphasize on the morphological analysis of images based on the behavior of the intensity value. Firstly images with various situations of a person are selected as training images. Based on the min, max and average characteristics of images, the training model has been built. Morphological analysis like binary image processing, erosion and dilation play the important role to identify the facial portion of an image from the whole one. Finally face recognition has been made for input images based on their intensity value measurement. The training images collected from various database such as YALE, ORL, and UMIST and others. The algorithm performed well and showed 80 percent accuracy on face prediction

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## I. INTRODUCTION AND BACKGROUND STUDY

Face recognition research started in the late 1970s and has become one of the most active and exciting research areas in computer vision and pattern recognition since 1990s. Many algorithms have been developed for face recognition in the last years. Among the crucial issues of face recognition technology, the low-dimensional feature represent action with enhanced discriminatory power is of paramount importance in face recognition systems [1].

Many dimension reduction methods are proposed in the past research, such as linear discriminant analysis (LDA) [2], principal component analysis (PCA) [3], and independent component analysis [4], and so on. But for face recognition problem, owing to the nonlinear and complex distribution of face images under a perceivable variation in viewpoint, illumination or facial expression, the linear techniques, such as PCA or LDA, cannot provide reliable and robust solutions to those face recognition problems with complex face variations [1]. In this paper, we have applied a method to propose morphological analysis for face recognition.

## II. PROPOSED METHODOLOGY

The main objective of our work is to develop a technique that recognizes face using morphological analysis. The step by step procedure has been discussed below:

- *Step 1:* Choose a set of training image from any directory under various situations to get required image whose information is required for training purposes.
- *Step 2:* Find the binary images from the original images.
- *Step 3:* Morphological operations on the training set of images are done to calculate the average intensity value. We also calculate the minimum and maximum value from the set values of the training images. The information is stored for further processing of the face recognition.
- *Step 4:* Select an input image which completely or slightly differs from the training images.
- *Step 5:* Face recognition of the input image is done. Newly calculated average intensity value is compared with database images. The mostly matched image is used to identify the name of the person.

The overall procedure of proposed image recognition technique is illustrated in Fig. 1. The component of the algorithms like binary image processing, erosion and dilation are described in the sub section A.1 and A.2.

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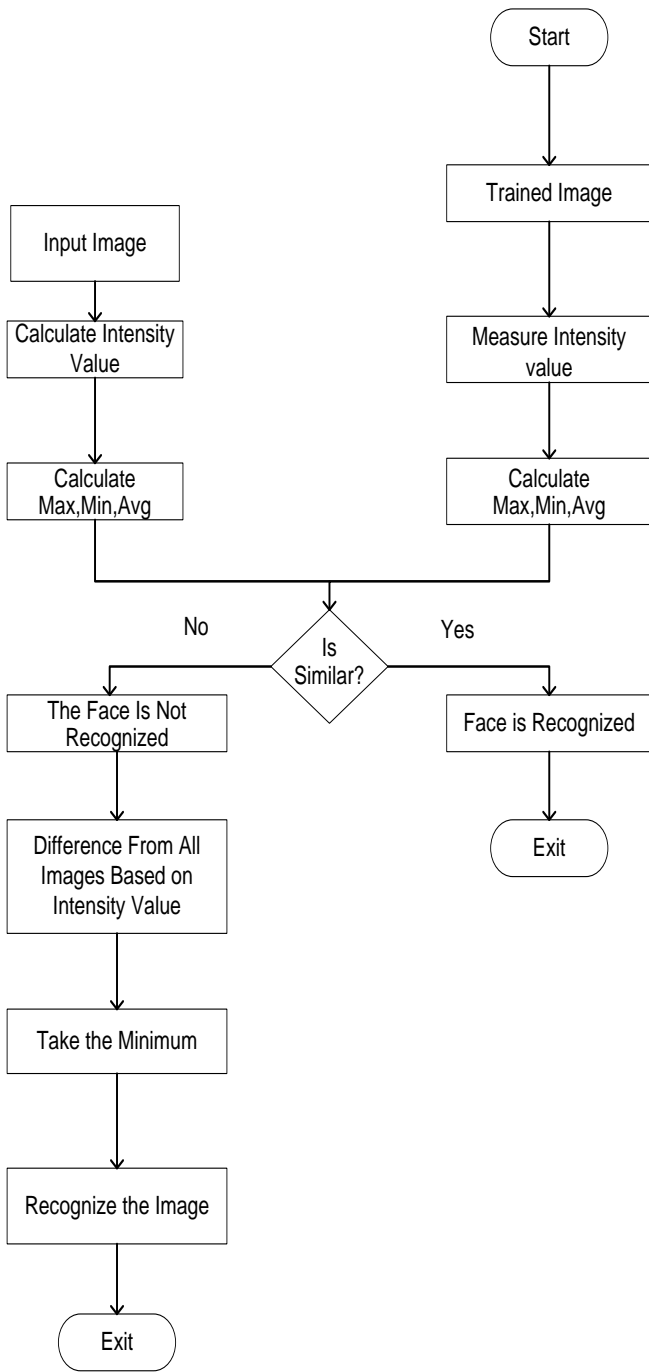


Fig. 1: Flow chart of the face recognition procedure

a) Morphological Analysis

i. Binary Image Processing

A binary image is a digital image that has only two possible values for each pixel. Typically the two colors used for a binary image are black and white though any two colors can be used. The color used for the object(s) in the image is the foreground color while the rest of the image is the background color. In case of binary operation we approach by this procedure:

- Step 1: Take an input as a binary image and convert it into two dimensional images such as 640\*480, 480 \*320 and so on. Then intensity value like 0 and 1 will be found.
- Step 2: Add all these pixels value by this way 0+1+1+1+1+0+1+1+.....and finally found the total pixel value for the face region.
- Step 3: Since we get all input from database thus the size of the all pixel are comparatively same. Now we divide the binary image pixel value with the total pixel value to get a value which ranged from 0 to 1.

b) Structuring Element

The basic idea in binary morphology is to probe an image with a simple, pre-defined shape, drawing conclusions on how this shape fits or misses the shapes in the image. This simple "probe" is called structuring element, and is itself a binary image (i.e., a subset of the space or grid).

Dilation is an operation that "grows" or "thickens" objects in a binary image. The specific manner and extent if this thickening is controlled by a shape referred to as structuring element. Fig 2.6 shows how dilation works. Fig.2.6a shows a simple binary image containing a rectangular object. Fig 2.6(b) is a structuring element, a three pixel long vertical line in this case. Computationally, structuring elements typically are represented by a matrix of 0s and 1s; sometimes it is convenient to show only the 1s, as illustrated in the figure. In addition, the origin of the structuring element must be clearly identified. Figure 2.6(b) shows the origin of the structuring element using a box outline. Dilation process translates the origin of the structuring element throughout the domain of the image and checks to see where it overlaps with 1-valued pixels. The output image in fig 2.6(c) is 1 at each location of the origin such that the structuring element overlaps at least one 1-valued pixel in the input image.

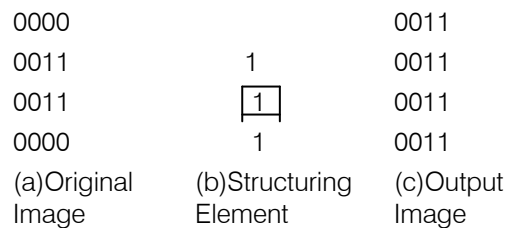


Fig. 2: Sample Dilation Process

This image was produced by two dilation passes using a disk shaped structuring element. Dilation is one of the two basic operators in the area of mathematical morphology, the other being erosion. It is typically applied to binary images, but there are versions that work on grayscale images. The basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels (i.e. white

pixels, typically). Thus areas of foreground pixels grow in size while holes within those regions become smaller.

### III. EXPERIMENTAL ANALYSIS

The experiment has been done on 400 images for training purposes. For the clarity of the algorithm, we included 20 images of US Ex-president Obama and Clinton. The algorithm is tested with 40 images and performed significantly well than the existing state of the art.



Fig. 3: Sample training dataset with normalized intensity value

The algorithm performed well in terms of space and time. Particularly most complex processing is absence there which makes this algorithm computationally less expensive. The snapshot of the training model with their normalized average intensity is shown in the Figure 3.



Fig. 4: Sample input and output of the proposed methodology

The detection procedure of an image is shown in Figure 4. It has been shown the image of Barak Obama. The average intensity value which is obtained here found very close to the training images intensity value. This makes the assumption that the image is the Ex-president Obama. The comparative analysis of our new improved face recognition method with other face recognition method is given in Table 1.

Table 1: Comparison with some features to the existing algorithms

Characteristics	Existing models	New Improved model
Required space for processing the trained image	More	Comparatively less
Time Required for processing the trained image	More	Comparatively less
Accuracy	Low	High

### IV. EXPERIMENTAL ANALYSIS

In this paper, For our experiment we built the model by using approximately 400 training images which reflected on the accuracy of the algorithms. It should be tested for various methods and then can be select the best one. Here all sets of pictures contains in one database. For further improvement we can experiment with multiple databases. Kernel Optimization criteria can be used for future improvement.

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GLOBAL JOURNAL OF COMPUTER SCIENCE AND TECHNOLOGY: F  
GRAPHICS & VISION  
Volume 17 Issue 3 Version 1.0 Year 2017  
Type: Double Blind Peer Reviewed International Research Journal  
Publisher: Global Journals Inc. (USA)  
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

# Dual Transition Region Extraction based Colour Image Segmentation: Application to Fish Image Segmentation

By Piyadarsan Parida & Nilamani Bhoi

*Veer Surendra Sai University*

**Abstract-** Image segmentation using transition region has been quiet effective in recent years due to its simplicity. Previous approaches using transition region only concentrate in segmentation of gray scale images. Colour image segmentation using transition region approach is a challenging task due to the increase in complexity involving various colour components. Here we have proposed a hybrid transition region approach for colour image segmentation. Two existing transition region based approaches: (i) Gabor based transition region approach and (ii) local variance based transition region approach are used to develop the proposed method. Initially, the R, G, B colour components are separated from the original image. Gabor based transition region approach is applied to segment the texture features from the image. The result of previous method is used as input to local variance based transition region approach for final object extraction from image. The proposed method works effectively on variety of images containing both single and multiple objects. The method is applied for fish image segmentation. Experimental results revel that the proposed method outperforms many existing approaches.

*GJCST-F Classification: B.4.2, H.2.8*



*Strictly as per the compliance and regulations of:*



# Dual Transition Region Extraction based Colour Image Segmentation: Application to Fish Image Segmentation

Piyadarsan Parida<sup>α</sup> & Nilamani Bhoi<sup>σ</sup>

**Abstract-** Image segmentation using transition region has been quiet effective in recent years due to its simplicity. Previous approaches using transition region only concentrate in segmentation of gray scale images. Colour image segmentation using transition region approach is a challenging task due to the increase in complexity involving various colour components. Here we have proposed a hybrid transition region approach for colour image segmentation. Two existing transition region based approaches: (i) Gabor based transition region approach and (ii) local variance based transition region approach are used to develop the proposed method. Initially, the R, G, B colour components are separated from the original image. Gabor based transition region approach is applied to segment the texture features from the image. The result of previous method is used as input to local variance based transition region approach for final object extraction from image. The proposed method works effectively on variety of images containing both single and multiple objects. The method is applied for fish image segmentation. Experimental results reveal that the proposed method outperforms many existing approaches.

## I. INTRODUCTION

Image segmentation is a basic pre-processing step for all computer vision and image understanding application. A number of image segmentation algorithms exist in literature where both gray scale image and colour images are segmented. Segmentation can be of two types: (i) Separating the objects from background, (ii) Dividing the image into number of constituent regions. Colour is an important visual perception. Gray scale image segmentation is a bit simple process as the image is processed in a simple plane where the intensity range 0 to 255. But colour image segmentation is a complex process due to the involvement of different colour planes. The RGB colour image constitutes of three different colour planes. The complexity increases as the processing has to be performed into these three different planes. Various approaches has been developed for colour image segmentation that divide the images into constituent regions. Few approaches has been developed for separating objects from background. Transition region approaches[1–8] are recent hybrid techniques which are

applied to gray scale images due to their simplicity. Existing transition region approaches (for gray scale images) work well for segmenting images containing single object. Parida et al.[6] developed a gray scale approach for multi object segmentation. The method uses local variance features with global thresholding for segmentation. It is suitable for images with non-overlapping gray levels. To eradicate the former drawback they have proposed a new approach using 2-D Gabor filters[7]. This approach is suitable for gray images with overlapping gray intensities between object and background. But the former approach provide better results in case of simple foreground. So, we have proposed a new hybrid approach that takes care of both overlapping and non-overlapping gray levels.

The rest of the paper is organized as follows: Section 2 describes the proposed approach. Section 3 gives a brief idea about the various performance measures used to quantify the proposed along with other methods. The reason behind using dual transition region is discussed in Section 4. The results and their corresponding discussion is given in Section 5. Application of the proposed method in segmentation of underwater fish image is given in Section 6. The paper is concluded in Section 7.

## II. PROPOSED METHOD

The proposed method uses two different transition region extraction for the segmentation process. The proposed method starts with separating the R, G and B colour components from the original RGB colour image. Each colour component is subjected to 2-D Gabor filtered based transition region extraction process followed by morphological operations to generate the object masks. Further the colour components are combined to generate the colour object region. In the process of first step of segmentation process, it may happen some background regions are left out at the edge regions of the segmented object portion. To get rid of these, further the segmented object portion is subjected to local variance based transition region extraction using l a b colour model. In this process, the segmented object colour object is converted to L a b. The individual L, a and b components are further processed using local variance

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and morphological operation to generate the object mask. The object region of object mask of corresponding colour components are separated and

combined to regenerate the colour object region. The architecture of proposed method is shown in Fig.1.

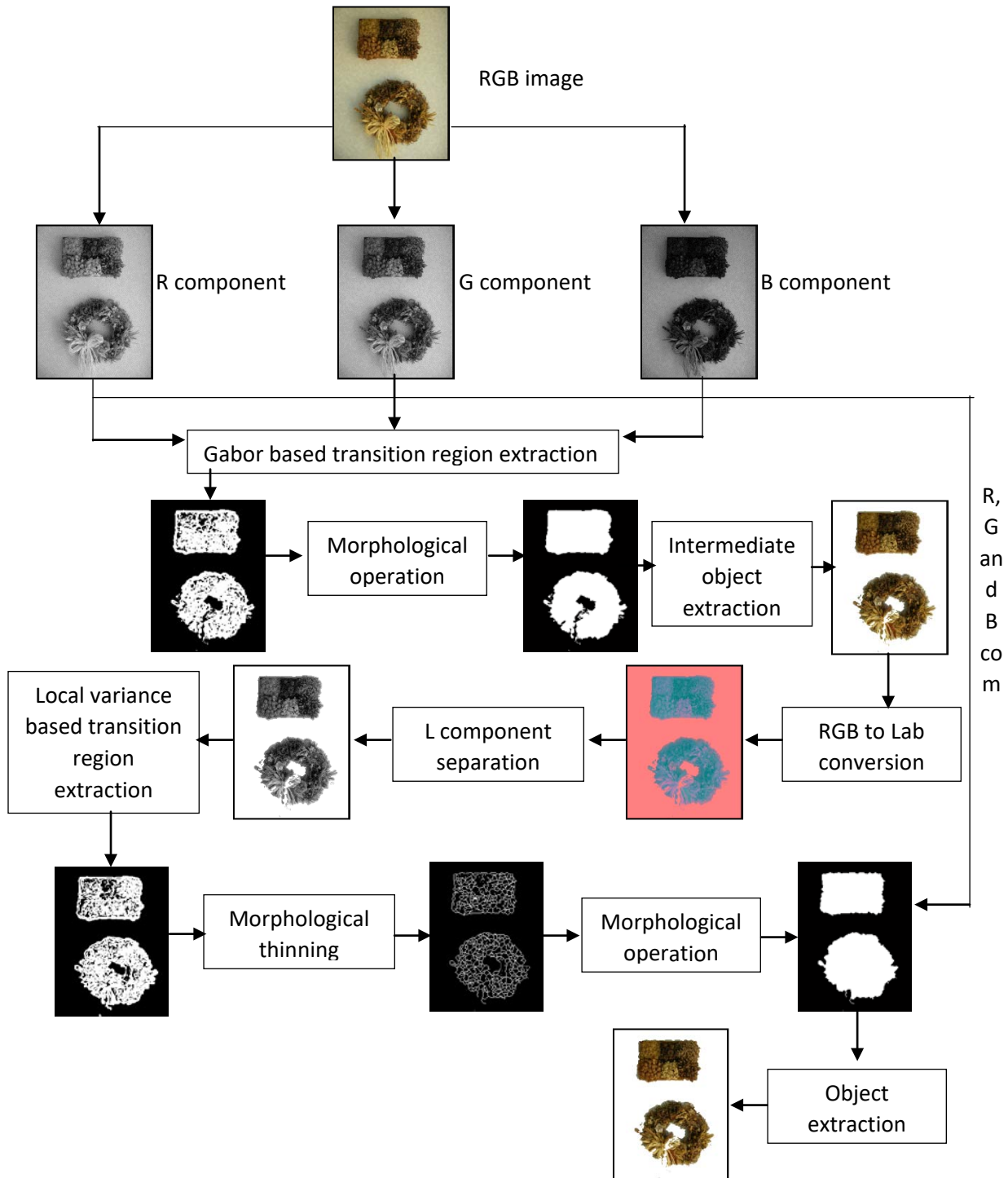


Fig.1: Architecture of the proposed method

a) Extraction of Gabor based transition region

Initially the colour components R, G and B are separated from the RGB colour image. Each colour component is separately processed using 2-D Gabor filter based transition region extraction method [7]. Here

the Gabor features of individual colour components are extracted. Further, the common features are selected via an intersection operation. The intersected features are then thresholded to extract the transition region. The standard deviation of the feature is considered as

threshold. The transition region extracted is having a value of 1 at transition portions whereas the remaining portions has a value 0 (binary image).

b) *Morphological operation for object region extraction*

The transition region extracted from the former region undergo a series of morphological operation for object region extraction from transition region. At first, morphological region filling operation is applied to the transition regions obtained from the former step. In this operation, the transition regions are filled with holes having a value of 1 using 4-connectivity rule. This results in the inner portions of the transition regions to take a value 1 (white) leaving all other portions to be 0 (black). At the end of this step, we obtain a binary image where the object regions are labelled as 1 where as the remaining regions are labelled as 0. In this process, it may happen that some unwanted background portions (background texture appearing as false transition region) are also labelled as 1. To get rid of these, it further undergoes morphological shrinking operation to shrink the false object portion without holes as points. Further, these points are separated.

c) *Intermediate object extraction*

The object regions extracted from former step are binary regions where objects are represented as 1 and background as 0. The objects regions are replaced with their corresponding R, G and B values to get an intermediate colour object. This process results in a colour object extraction with background as white.

d) *Conversion of intermediate objects to Lab and separation of intensity component*

The intermediate RGB objects extracted sometimes retain partial background near the object edges which is not desired. The RGB colour system simply separates the R, G and B components separately without considering the intensity (or luminance). But, the L-a-b system separates the intensity/luminance components from the colour. This effectively identifies the partial background regions associated with the object edges. So, the intermediate RGB objects are converted to L-a-b space and the L-component which represents the intensity is separated out for further processing.

e) *Second transition region extraction using local variance*

From the former step, we achieve an intensity image which retain some background portion near the object edges. This can be well identified using local variance. The process of local variance based transition region is discussed in [6]. The window size and parameters are chosen as per [6]. The local variance feature image is thresholded using a threshold which is basically the intensity mean of the local variance features. After thresholding, the resultant image is a

binary image representing transition regions as 1 leaving the rest as 0.

f) *Morphological thinning and region filling for extraction of object regions*

The transition region extracted from the former step are of several pixels width. To extract the edge image of single pixel width, morphological thinning operation is performed. The thinning operation results in object contours. The object contours are further filled with holes using morphological region filling operation. This results in binary image with object regions having a value 1 and background to 0.

g) *Extraction of objects from the object regions*

The object regions extracted from the former step has a value 1. The original R, G and B components are replaced in place of 1 value to extract the object colour pixel values. The background is replaced with a value 255 to make the background as white. Finally, in this operation the objects are separated from the background.

### III. PERFORMANCE MEASURES

The performance of the proposed method along with the existing methods are measured via three mathematical measures: misclassification error (ME) [9,10], false positive rate (FPR) [11] and false negative rate (FNR) [12,13]. The pixels of foreground (object) falsely classified as background or vice versa is quantified by misclassification error. The ME is defined as

$$ME = 1 - \frac{|B_o \cap B_T| + |F_o \cap F_T|}{|B_o| + |F_o|} \quad (1)$$

where,  $B_o$  and  $F_o$  corresponds to background and foreground pixels in ground truth image. The term  $B_T$  and  $F_T$  corresponds the background and foreground pixels respectively in the segmented image and the operator  $||$  represent the cardinality of set operation. The value of ME varies between 0 and 1. The value 0 represents errorless segmentation whereas 1 corresponds to full erroneous segmentation. The lower the value (i.e., close to value 0) represents better segmentation. The FPR and FNR defines the ME measure more precisely.

The FPR is the number of background pixels classified as foreground pixels to the total number of background pixels. The FNR corresponds to the number of foreground pixels classified into background pixels to the total foreground pixels. The FPR and FNR can be defined as



$$FPR = \frac{|B_o \cap F_T|}{|B_o|} \quad (2)$$

$$FNR = \frac{|F_o \cap B_T|}{|F_o|} \quad (3)$$

Like ME, the values of FPR and FNR also varies from 0 to 1. High values of FPR and FNR leads to serious over segmentation and under segmentation respectively. In over segmentation a portion of background region appears with the actual foreground in the segmented image whereas, in case of under segmentation some portion of object portion is missed in the resultant segmented image [14].

To evaluate the similarity of the segmentation result with the ground truth Jaccard index is used. The Jaccard index [15] is defined as

$$JI = \frac{|GT \cap SR|}{|GT \cup SR|} \quad (4)$$

where,  $GT$  and  $SR$  correspond to ground truth and segmentation result respectively. The  $JI$  value varies between 0 and 1. Higher value (i.e., close to 1) denote better segmentation result or maximum resemblance with the ground truth (required segmentation result).

Segmentation accuracy (SA) [16] is a global measure which denote the ratio of total well classified pixels in the segmentation result which is given as

$$SA = \frac{\text{Number of correctly segmented pixels}}{\text{Total number of pixels}} \quad (5)$$

The value of SA remain in the range from 0 to 1. High SA value indicate better segmentation accuracy. Based on the above five performance measures the proposed method is quantitatively compared with various segmentation methods.

#### IV. REASON FOR DUAL TRANSITION REGION

An obvious question would be why dual transition region when we are achieving the result even in using single transition region. This can be better clarified using this example. For Clock image, the output of first stage is shown in Fig.2 (b) which has still some background portions near the object edges. But in second stage those regions are discarded to a great extent which can be depicted from Fig. 2(c). The effect can be well marked from the segmentation masks of first and second stages in Fig. 2(e) and Fig. 2(f) respectively. Based on visual representations the quantitative measures improve to a great extent which is reflected from Table 1. The experimentation is performed on two other images such as the Aeroplane and Wall decoration image which is shown in Fig.3 and Fig.4. Their corresponding performance measures are given in Table 1.

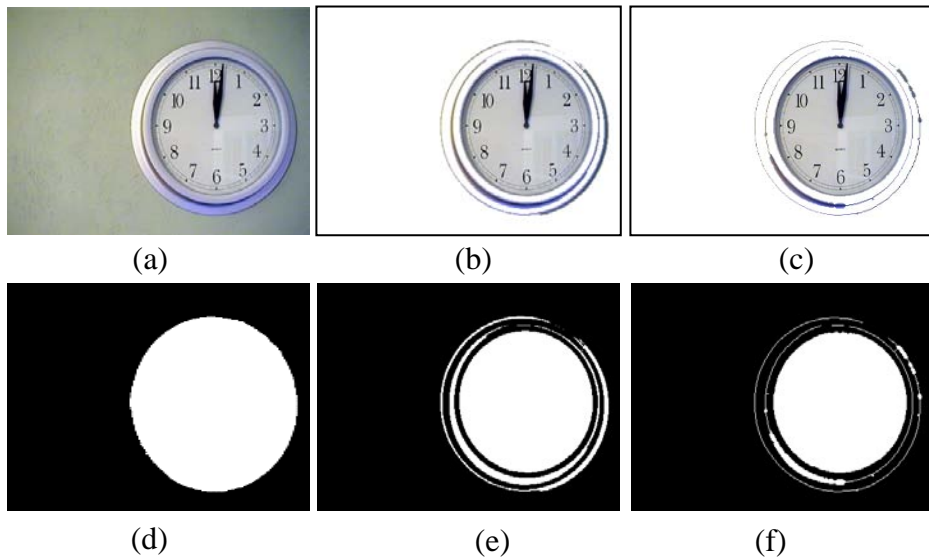


Fig. 2: Segmentation results and mask of Clock image: (a) Original image, (b) Segmentation result of first stage, (c) Segmentation result of second stage, (d) Ground truth, (e) Mask of first stage, (f) Mask of second stage.

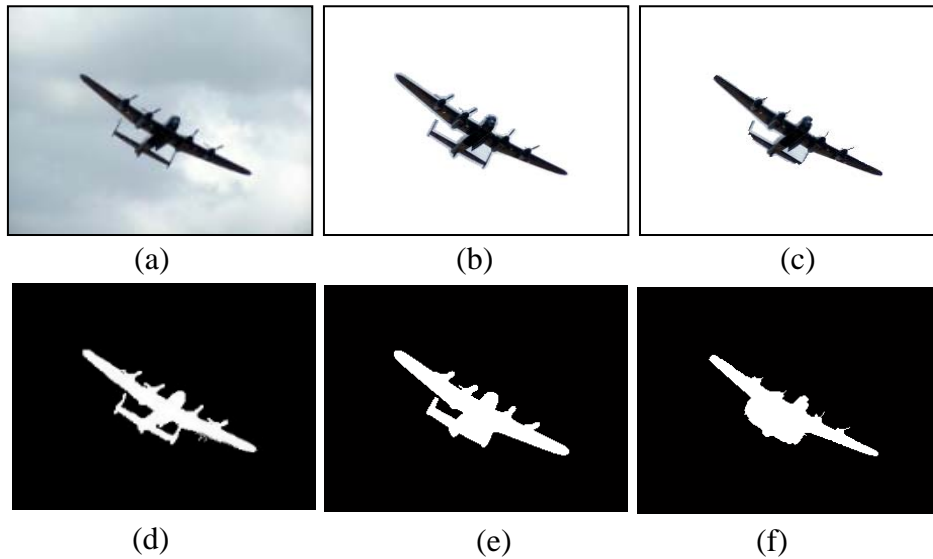


Fig. 3: Segmentation results and mask of Aeroplane image: (a) Original image, (b) Segmentation result of first stage, (c) Segmentation result of second stage, (d) Ground truth, (e) Mask of first stage, (d) Mask of second stage.

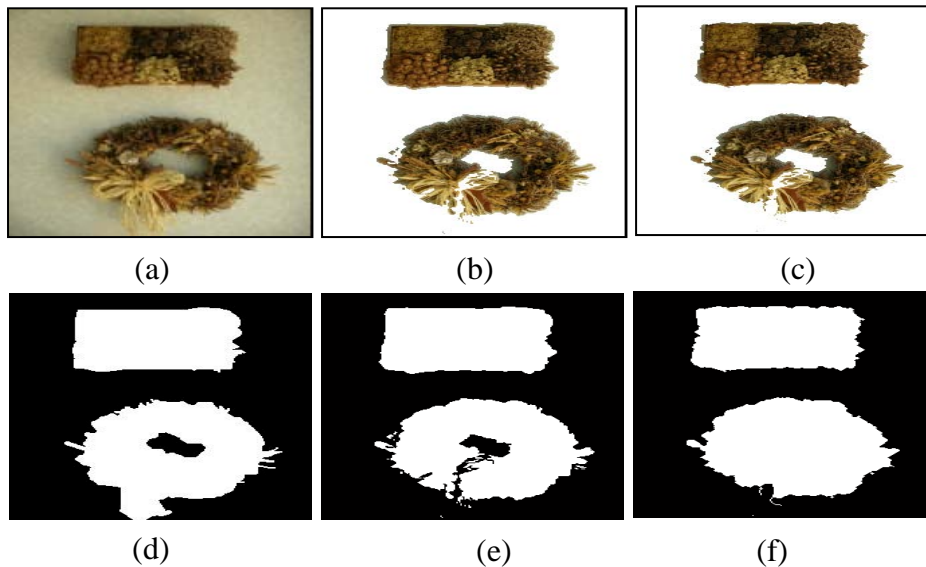


Fig. 4: Segmentation results and mask of Wall decoration image: (a) Original image, (b) Segmentation result of first stage, (c) Segmentation result of second stage, (d) Ground truth, (e) Mask of first stage, (d) Mask of second stage.

Table 1: Performance measures (ME, FPR, FNR) of Clock, Aeroplane and Wall decoration images

Sl. No.	Image	Stage	ME	FPR	FNR
1	Clock	First	0.3307	0.0000	0.9997
		Second	0.1034	0.0033	0.3064
2	Aeroplane	First	0.0572	0	0.9997
		Second	0.0179	0.0110	0.1331
3	Wall decoration	First	0.3558	0.0013	0.9996
		Second	0.0517	0.0380	0.0765

## V. RESULT AND DISCUSSION

The entire experimentation process is carried out on a PC having Core-i3, 1.9GHz processor and 8G RAM. The simulation is done in MATLAB 7.0 environment. The images as well as their corresponding ground truths are considered from Wisemann dataset

[17] and MSRMC dataset [18]. All images considered for experimentation are RGB color images. The proposed method is tested with several color image segmentation approaches such as CV model [19], Active contour model (ACWE) [20], Color image segmentation using genetic algorithm (CISGA) [21] and segmenting salient object from images and videos (SSOIV) [22].

Table 2: Performance measures (ME, FPR, FNR) of different methods for various types of images

Sl. No.	Image	Method	ME	FPR	FNR	Jl	SA
1	Boat	CV	0.3304	0.2513	0.5146	0.3062	0.6696
		ACWE	0.2621	0.1536	0.5153	0.3568	0.7379
		SSOIV	0.1586	0.0261	0.4674	0.5021	0.8414
		CISGA	0.2040	0.1089	0.4261	0.4575	0.7960
		Proposed method	<b>0.1002</b>	<b>0.0245</b>	<b>0.2765</b>	<b>0.6844</b>	<b>0.8998</b>
2	Bird	CV	0.3885	0.4111	<b>0.0051</b>	0.1243	0.6115
		ACWE	0.1520	0.1559	0.0860	0.2503	0.8480
		SSOIV	<b>0.0233</b>	<b>0.0146</b>	0.1710	0.6638	<b>0.9767</b>
		CISGA	0.0338	0.0191	0.2842	0.5402	0.9272
		Proposed method	0.0315	0.0324	0.0150	<b>0.6344</b>	0.9685
3	Aeroplane	CV	0.1232	0.1255	0.0862	0.2980	0.8768
		ACWE	<b>0.0104</b>	0.0003	0.1776	<b>0.8184</b>	<b>0.9896</b>
		SSOIV	0.0112	<b>0.0001</b>	0.1941	0.8050	0.9888
		CISGA	0.0393	0.0227	0.3125	0.5003	0.9222
		Proposed method	0.0145	0.0145	<b>0.0142</b>	0.7957	0.9855
4	Wall decoration	CV	0.0997	0.1098	0.0813	0.7664	0.9003
		ACWE	0.0860	0.0261	0.1947	0.7688	0.9140
		SSOIV	0.0968	0.0233	0.2299	0.7389	0.9032
		CISGA	0.2214	<b>0.0000</b>	0.6231	0.3769	0.7786
		Proposed method	<b>0.0495</b>	0.0377	<b>0.0709</b>	<b>0.8697</b>	<b>0.9505</b>
5	Clock	CV	0.4022	0.4865	0.2317	0.3872	0.5978
		ACWE	0.2666	0.2443	0.3117	0.4605	0.7334
		SSOIV	0.2784	0.0001	0.8416	0.8416	0.7216
		CISGA	0.3144	<b>0.0000</b>	0.9512	0.0487	0.6856
		Proposed method	<b>0.0825</b>	0.0095	<b>0.2302</b>	<b>0.7552</b>	<b>0.9175</b>

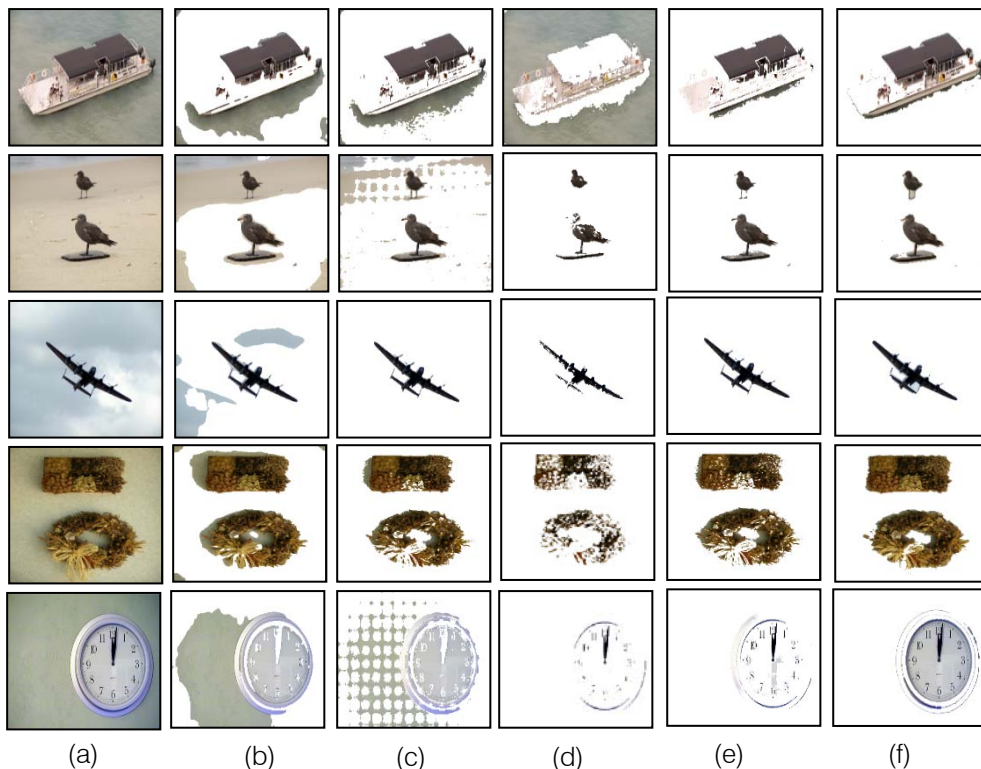


Fig. 5: Segmentation results of different methods applied on the Boat, Bird, Aeroplane, Wall decoration, Clock image: (a) Original image, (b) CV, (c) ACWE, (d) SSOIV, (e) CISGA, (f) Proposed method



The performance of the proposed method using 5 quantitative measures such as ME, FPR, FNR, JI and SA. The quantitative results of the proposed method along with others are given in Table 2. The best values of ME, FPR, FNR, JI and SA of every image is marked as bold in Table 2. The qualitative segmentation results of original images and other methods along with the proposed method is shown in Fig.5. For better comparison of the segmentation quality the ground truths of different images are compared with the segmentation mask of other methods along with the proposed method are given in Fig.6.

To begin our analysis, for the Boat image which comprises of both textured foreground and background the proposed method outperforms well quantitatively for all measures. The proposed method removes the background completely though it misses some foreground portion. This can be well visualized from comparing the segmentation mask with the ground truth in Fig.6. For Bird image, the method SSOIV achieves best ME and FPR where as the method CV attains lowest FNR. But it can be verified from Table2 that the proposed method achieves the ME value nearly equal to that of SSOIV. Segmentation result from Fig.5 indicate that although SSOIV attains best ME, FPR and SA values but it misses some inner object portions. The proposed method achieves better visual segmentation output in terms that it doesn't lose any object portion.

The proposed method attains the best JI indicating that the result of the proposed method is more similar to that of the ground truth. The Aeroplane image is a simple foreground and background image. For Aeroplane image, the method ACWE provides best ME, JI and SA where as the method SSOIV provide best FPR. The proposed method provide best FNR indicating that the result of the proposed method is not at all under-segmented. This can be well visualized from the segmentation mask in Fig.6. The wall décor image is having simple foreground with textured background. The proposed method best ME, FPR, JI and SA indicating low under-segmentation. The best FPR is provided by CISGA indicating that the proposed method result has a little background portion. Similarly, for Clock image the proposed method attains best ME, FNR, JI and SA where as the method CISGA attains lowest FPR. But visual results from Fig.5 indicate that majority portion of foreground regions are missed in case of CISGA.

To show the effectiveness of the proposed method, the average performance measures of all methods were calculated and given in Table 3. The best values are for each measure are marked in bold. From Table 3 it can be observed that the proposed method attains best values of all performance measures except for the average FPR. The method SSOIV attains best FPR value for all images.

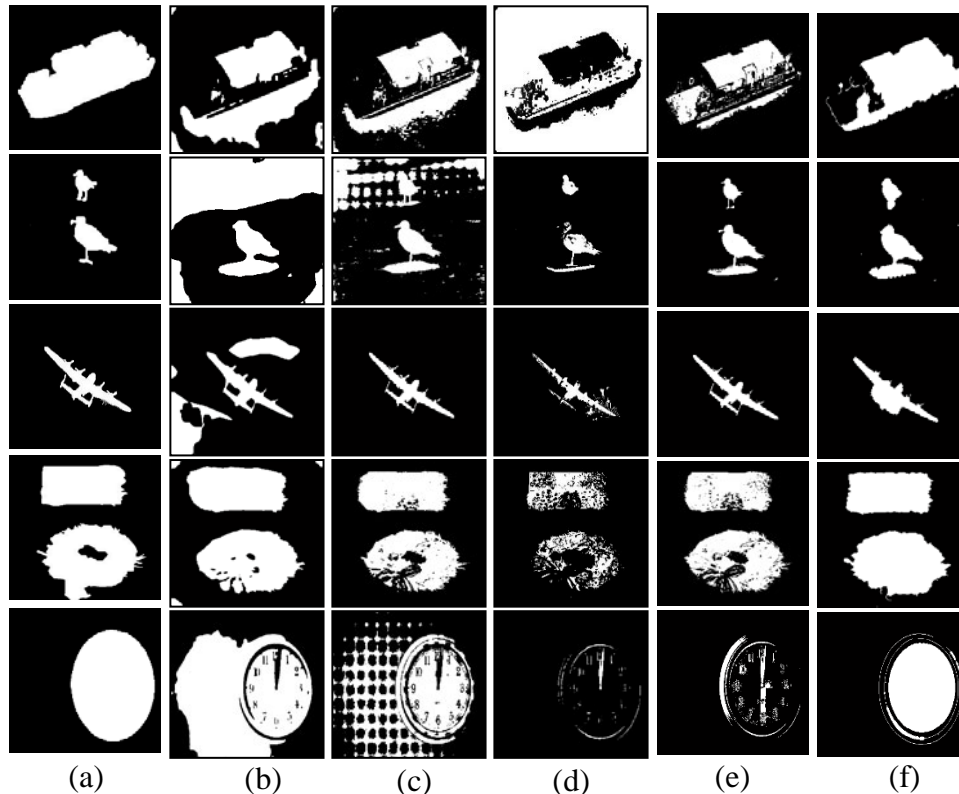


Fig. 6: Segmentation masks of different methods applied on the Boat, Bird, Aeroplane, Wall decoration, Clock image: (a) Original image, (b) CV, (c) ACWE, (d) SSOIV, (e) CISGA, (f) Proposed method

Table 3: Average performance of different methods for various performance measures

Method	Average ME	Average FPR	Average FNR	Average JI	Average SA
CV	0.2688	0.2768	0.1838	0.3764	0.7312
ACWE	0.1554	0.1160	0.2571	0.5310	0.8446
SSOIV	0.1137	<b>0.0128</b>	0.3808	0.7103	0.8863
CISGA	0.1626	0.0301	0.5194	0.3847	0.8219
Proposed method	<b>0.0556</b>	0.0237	<b>0.1214</b>	<b>0.7479</b>	<b>0.9444</b>

## VI. APPLICATION TO FISH IMAGE SEGMENTATION

The method is applied for under water fish image segmentation. Due to the unavailability of ground truth images we are not calculating their performance measures. The images are taken from fish recognition dataset [23] and [24]. Some synthetic images are also chosen along with the dataset image to show the effectiveness for multiple fish object segmentation which are shown in Fig.7.

Here we have considered the fish images from a standard fish image dataset [23], which were taken by underwater bots given in Fig.7(a)-(b). Their corresponding segmentation result using our proposed method is given in Fig. (g)- (h). For testing the proposed method in multi object segmentation, we have chosen some synthetic images containing multiple fishes in Fig.7 (e)-(f). The proposed method provides good segmentation output even in the varying intensity of foreground to background.

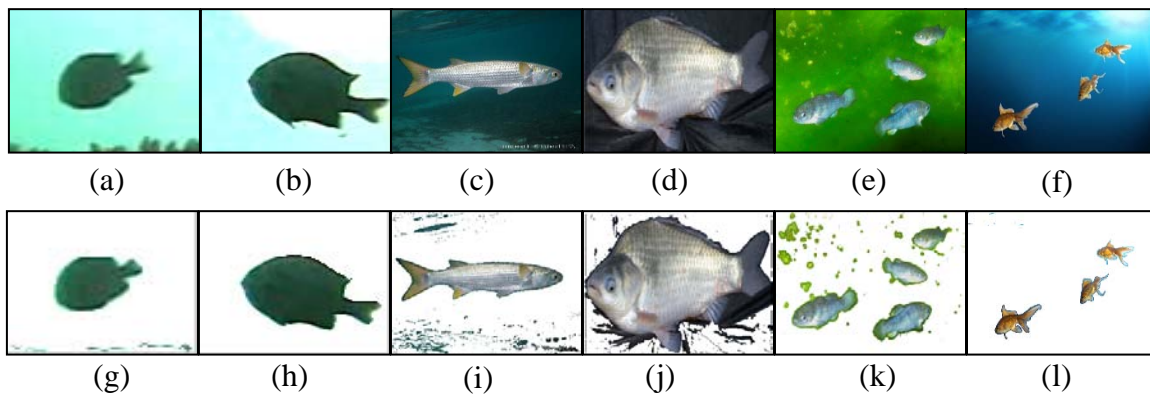


Fig. 7: Proposed method result applied to fish image segmentation: (a)-(b) Original underwater fish image from [23], (c) Synthetic image1, (d) Fish image from [24], (e)-(f) Synthetic images with multiple fishes, (g)-(h) Segmentation result of (a)-(b), (i) Segmentation result of (c), (j) Result of (d), (k)-(l) Result of (e)-(f).

## VII. CONCLUSION

In this article, we present a new hybrid transition region based approach for colour image segmentation. This is a new approach for colour image segmentation using transition region. The proposed approach uses dual transition region extraction methodology for image segmentation for colour images. The proposed method achieves better performance in comparison to the existing methods both qualitatively and quantitatively without loss of foreground and less emergence of background. The proposed method when applied to real time underwater fish images also performs fish segmentation effectively.

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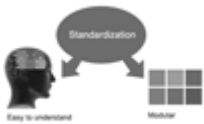




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“

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4. Manuscript's Category,
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- 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.
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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:

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- 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.
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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.
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### Approach

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- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
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- Recommendations for detailed papers will offer supplementary suggestions.

### Approach:

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<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring





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ISSN 9754350