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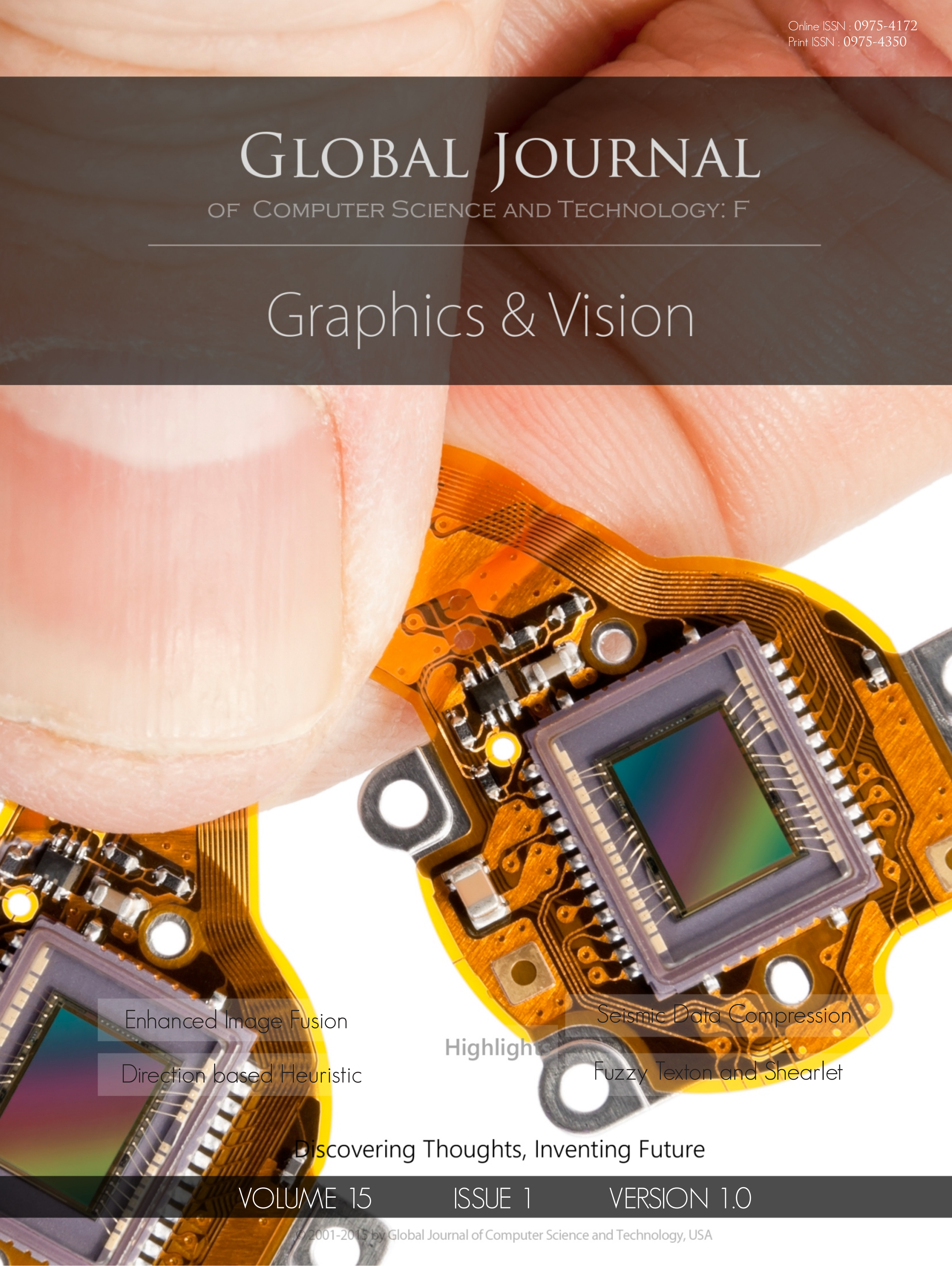

Highlights

Enhanced Image Fusion

Direction based Heuristic

Seismic Data Compression

Fuzzy Texton and Shearlet

Discovering Thoughts, Inventing Future

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Direction based Heuristic for Pathfinding in Video Games

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Abstract- Pathfinding has been one of major research areas in video games for many years. It is a key problem that most of the video games are confronted with. Search algorithms such as the A* algorithm and the Dijkstra's algorithm representing such regular grid, visibility graphs also have significant impact on the performance. This paper reviews the current widely used solutions for pathfinding and proposes a new method which is expected to generate a higher quality path using less time and memory than other existing solutions. The deployment of the methodologies and techniques is described in detail. The significance of the proposed method in future video games is addressed and the conclusion is given at the end.

Keywords: *pathfinding*, A*, A* *optimization*, *computer game.*

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DIRECTIONBASEDHEURISTICFORPATHFINDINGINVIDEOGAMES

Strictly as per the compliance and regulations of:

Direction based Heuristic for Pathfinding in Video Games

Geethu Elizabeth Mathew [α] & Mrs. G. Malathy [σ]

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I. Introduction

Pathfinding is the plotting, by a computer application, to find the shortest path between two points. It starts from a start node and reaches the goal node by repeatedly searching for the same, for finding a path between these points. Finding the optimal path is a complicated scenario. There are significant difference between the terms path and shortest path. In graph theory, the problem of finding a path between two vertices in a graph such that the sum of the weights this path's edges is minimized is called a shortest path problem. Two primary problems of pathfinding are to find a path between two nodes in a graph and to find the optimal shortest path[4]. Pathfinding in the context of video games concerns the way in which an object finds a path around obstacles; the best explained context is real-time strategy games in which the player leads units around a play area containing obstacles, but the variations of this approaches are found in many of the games. path finding has grown in importance as games and their environments have become more complex. Many Artificial Intelligence based platforms and the tools are developed for providing solutions to pathfinding problem. Many of them uses basic pathfinding and provides ready made plugins for users to incorporate in their games. Real-time strategy games sometimes contain large areas of open terrain which is often relatively simple to navigate through, although it is common for more than one unit to travel simultaneously; this makes it necessary to employ different, and often more complex algorithms and methods to avoid traffic problems and bottlenecks at some points in terrain. In strategy games the map is normally divided into sub-worlds and there are practical methods of applying some algorithms in the smaller problems to apply it to larger sets.

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II. A* Algorithm

A* is a generic search algorithm that can be used to find solutions to many problems, pathfinding is just one of them. Many problem in the engineering are related to pathfinding problems. The lookahead effort in searching trees are found to provide improved results in pathfinding. The base of the A* algorithm arises from a view that the information from the problem domain can be incorporated in a formal mathematical manner to analyse the problem. The method shows that this approach will always try to find out a path by exploring minimum number of nodes to offer a minimum cost solution. A* is the most popular and widely used AI pathfinding algorithm proposed by Hart, Nilsson and Raphael in the year 1967. Due to its simplicity it guarantees, A* is almost always the search method of choice. This is because A* is guaranteed to find a shortest path on the graph. The problem with A* is that a shortest path on the graph is not equivalent to a shortest path in the continuous environment. Another issue related to A* is that, when the map size is significantly larger, A* algorithm cannot find a minimum path to goal state in limited amount of time. Also for large maps A* uses memory extensively. Even though many other methods are emerging, A* and its variations are widely used in pathfinding. A* uses this heuristic to improve on the behavior relative to Dijkstra's algorithm. When the heuristic evaluates to zero, A* is equivalent to Dijkstra's algorithm. As the heuristic estimate increases and gets closer to the true distance, A* continues to find optimal paths, but runs faster. When the value of the heuristic is exactly the true distance, A* examines the fewest of the nodes .However it is generally impractical to write a heuristic function that always computes the true distance. As the value of the heuristic increases, A* examines fewer nodes but no longer guarantees an optimal path. In many applications this is acceptable and even desirable, in order to keep the algorithm running quickly. In order to expand less number of nodes as possible while searching for an optimal path, A* constantly make informed decision as possible about

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which node to expand next. Otherwise it is a wasting effort to use that particular method. If the algorithm constantly avoids nodes on optimal path, then there is less chance that the algorithm will come up with a solution. Suppose, we have some evaluation function f(n) to be calculated for some node n. The nodes with f values are considered for exploring next. The node with the minimum f value is explored then we can define the A* search algorithm as follows[8].

Search Algorithm A*:

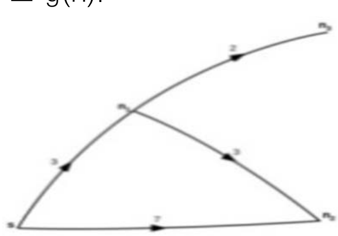
1. *Add the starting node to the open list.*
2. *Repeat the following steps:*
   a) *Look for the node which has the lowest f on the open list. Refer to this node as the current node.*
   b) *Switch it to the closed list.*
   c) *For each reachable node from the current node*
      i. *If it is on the closed list, ignore it.*
      ii. *If it isn't on the open list, add it to the open list. Make the current node the parent of this node. Record the f, g, and h value of this node.*
      iii. *If it is on the open list already, check to see if this is a better path. If so, change its parent to the current node, and recalculate the f and g value.*
   d) *Stop when*
      i. *Add the target node to the closed list.*
      ii. *Fail to find the target node, and the open list is empty.*
3. *Tracing backwards from the target node to the starting node. That is your path.*

Figure: Pseudocode of A* [3]

For any sub graph G and goal set T, let f(n) be the actual cost of an optimal path which go through n, from s to a preferred goal node of n. Determination of f(n) is the primary interest. In A* algorithm we see that, the function f(n) can be written as the sum of two functions:

$$f(n)=g(n)+h(n)$$

where g(n) is the actual cost from s to the node n, and h(n) is the actual cost from n to the preferred goal node of n. Let $\hat{g}(n)$ be the estimate of g(n). An excellant choice for $\hat{g}(n)$ is the minimum cost that has found so far. We observe $\hat{g}(n) \geq g(n)$.



Consider the subgraph shown in Fig. It consists of a start node s and three other nodes n1, n2 and n3. The arcs are shown with arrowheads and costs. Starting from s, we get successors n1, n2. The estimates $\hat{g}(n)$ and $\hat{g}(n2)$ are 3 and 7 respectively. Suppose A* expands n1 next with successors n2,n3. At this stage $\hat{g}(n3)=3+2=5$, and $\hat{g}(n2)$ is lowered to $3+3=6$. The value of $\hat{g}(n1)$ remains equal to 3. Next we must have an estimate $\hat{h}(n)$ of h(n). Here we rely on information from the problem domain. Many minimum cost path problems through a paragraph has some information to estimate $\hat{h}$. In a city example where our paths are roads, we can use airline distance as the heuristic function. If h is any lower bound, then we can say that algorithm is admissible [8].There are variations of A* to optimize algorithm so that less memory is used.

The traditional A* algorithm has shortages as follows:

1. It is slow in searching speed is slow and is poor applicability in the large scale path search environment. For example to get the optimal diagonal path in the 100*100 grid environment needs for searching 513 nodes at least.
2. Due to the limitations of the traditional A* algorithm, the algorithm always lead to fall into failing situation in the unknown and complex grid environment.
3. The traditional A* doesn't support path search operation between multi nodes at the same time which means generating different path from multi-starts to multi-target needs to retry.

a) Heuristics

Heuristics is a method used for experience based problem solving, which may or may not end up with an optimal solution. Algorithm's behavior based on the heuristic and cost functions can be very useful in a game. The trade off between speed and accuracy can be exploited to make your game faster. One way to construct an exact heuristic is to precompute the length of the shortest path between every pair of points. This is not feasible for most game maps. However, there are ways to ap proximate this heuristic:

- Fit a coarse grid on top of the fine grid. Precompute the shortest path between any pair of coarse grid locations.
- Precompute the shortest path between any pair of waypoints. This is a generalization of the coarse grid approach.

In a special circumstance, the heuristic can be exact without precomputing anything. If there is a map with no obstacles and no slow terrain, then the shortest path from the starting point to the goal should be a straight line.On a grid, there are well-known heuristic functions to use

- On a square grid that allows 4 directions of movement, use Manhattan distance

- On a square grid that allows 8 directions of movement, use Diagonal distance
- On a square grid that allows any direction of movement, might or might not want Euclidean distance.
- On a hexagon grid that allows 6 directions of movement, uses the Manhattan distance adapted to hexagonal grids.

b) Manhattan Distance

The standard heuristic for a square grid is the Manhattan distance. Look at cost function and find the minimum cost D for moving from one space to an adjacent space. In the simple case, we can set D to be 1.The heuristic on a square grid where you can move in 4 directions should be D times the Manhattan distance:

Function heuristic(node)

dx=abs(node.x-goal.x)

dy=abs(node.y-goal.y)

return d*(dx+dy)

Set D to the lowest cost between adjacent squares. In the absence of obstacles, and on terrain that has the minimum movement cost D, moving one step closer to the goal should increase g by D and decrease h by D. When we find f (which is set to g + h) will stay the same; thats a sign that the heuristic and cost function scales match.

c) Grids

A grid map uses a uniform subdivision of the world into small regular shapes some- times called tiles. Common grids in use are square, triangular, and hexagonal. Grids are simple and easy to understand. If were using grids for pathfinding, units are not constrained to grids, and movement costs are uniform, We may want to straighten the paths by moving in a straight line from one node to a node far ahead when there are no obstacles between the two. If units can move anywhere within a grid space, or if the tiles are large, think about whether edges or vertices would be better choice for our application. A unit usually enters a tile at one of the edges (often in the middle) and exits tile at another edge. With pathfinding on tiles, the unit moves to the center of the tile, but with pathfinding on edges, the unit will move directly from one edge to the other. Obstacles in a grid system typically have their corners at vertices. The shortest path around an obstacle will be to go around the corners. With pathfinding on vertices, the unit moves from corner to corner. This produces the least wasted movement, but paths need to be adjusted to account for the size of the unit. This is referred as Vertex movement.

III. Proposed Work

After performing the literature survey, it is clear that a lot more improvements and optimisations are possible in the field of pathfinding in video games. So in our paper, we are intended to work on the pathfinding and the path planning in games using the Artificial Intelligence principles. The proposed work is aimed at combining different approaches for pathfinding to effectively find out paths in video game environments using less resources by utilizing Artificial Intelligence Concepts.

In our paper, we put forward an Efficient Pathfinding Algorithm for video games by

- Optimizing search techniques.
- Effective terrain mapping.
- Improving Heuristics.

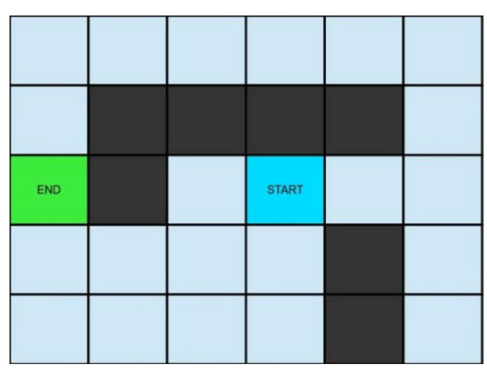
We here use the direction based approach for pathfinding. New approach is applied in a grid based environment. As most of the game worlds are divided into grids for simplicity, this method has scope in all of them. This method can also be extended to all types of grid based worlds.

To find the shortest paths between two points in a map, is an important topic in mathematics and algorithm research. In the present gaming industry, pathfinding has its own requirements:

1. We do not really care too much whether a path is optimal in a mathematical sense, so long as it is virtually short enough.
2. We do not want to devote too much resource for pathfinding in the gaming environment which which is usually resource constrained.

a) Direction Based Heuristics

In order to apply some sort of optimisation in pathfinding algorithms, the first thing needed is an efficient approach for pathfinding. The method I use here is applied on grid based maps. It uses the direction to the goal state as the heuristic function



A grid map example

In the above figure there is a starting and an ending point. The Heuristic Information needed is the

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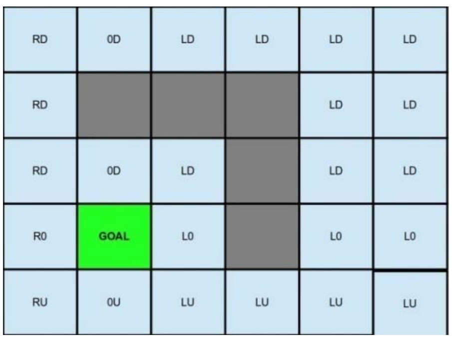
relative position of a particular node to the end node. We start with the Start node. In order to calculate the information regarding the relative position of the goal node, In our approach, we use four letters (For explanation purpose). They are L, R, U, D which represents Left, Right, Up and Down respectively. Every node will have a Heuristic information which gives a clear idea about the relative position of that node with the goal node. In the above figure, the Heuristic Key can be recorded as L0 (Where 'L' represents left and '0' indicates that end state is in the same horizontal level as that of the start state.) The following figure gives more clear idea about direction based Heuristics



Grid showing direction based heuristics of all cell

As in the above figure, there are 8 Heuristic Keys applied in a pathfinding environment which are explained using table

Direction Key	Interpretation and direction of exploration
L0	Left
LU	Left – Up
0U	Up
RU	Right – Up
R0	Right
RD	Right – Down
0D	Down
LD	Left – Down

Direction Keys used for determining the direction of exploration

These information is used to determine which are the next nodes to be explored in order to reach the goal faster. For example, when the Heuristic key of a node is LU it has children in the top and in the left side. We then check whether those cells are free or not. A cell is said to be free if it is not previously explored or its not a non traversable cell. If there are no free children for a particular node, then we change the direction key by making L as R, R as L, U as D, D as U and '0' is kept as such. In usual practice with lightly obstructed map, this is not required in general. We continue to explore new children obtained through the changed Heuristic key. The method continues as such till it reaches the goal state. The above explained method is just a framework of the method. As it is very simple and straight, many optimizations are possible for the above mentioned method. In this work, We aim to implement the above direction concept so as to reduce the memory overheads and hence execution time.

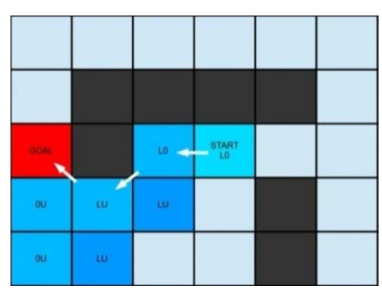
b) Comparison with Other Algorithms in A Small Grid

The new method is compared with other basic grid based pathfinding algorithms and results are analyzed. Here this analysis is made for some fixed grid environments. Preliminary analysis is conducted only to analyse the number of nodes explored in the Direction based Heuristics method and in other methods for a small graph.

This algorithm is compared with other algorithms such as breath first search,, A* algorithm. Comparison results are shown below. Even though A* solves a given problem based on heuristics a necessary condition has to be satisfied. Basic comparison with the A* algorithm indicates that, this approach converges to the direction of goal as in the A* algorithm. Comparison with the other two algorithms also shows that the new approach converges to the direction of the goal state, even faster than Breadth First Search. These have to be proved mathematically.

c) Converging Behavoiur of Direction Hueristics

The method based on Direction Heuristic converges towards the goal state faster than Breadth First Search in tested environments. This makes it more usable. It also explores less number of nodes to reach final state. This is a good expected behaviour for a pathfinding algorithm. The proposed method explores less number of neighbors and hence the number of nodes processed each time is reduced. By using perfect data structures we can make it more appealing. So that the optimization for this particular work mainly concentrate on a data struture which can process nodes faster and which converges to the goal nodes so easily.



(a) Path obtained by direction heuristics

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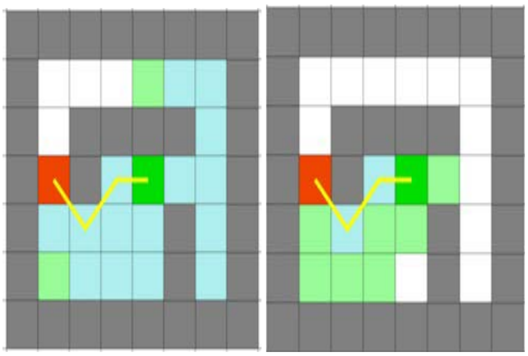
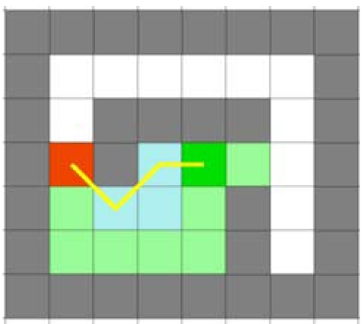


(b) Path obtained by breathfirst search and depth first serach



(c) Path obtained by A Star algorithm

The converging behaviour and thus the improvement of the work in obtaining a path in less time need to be theoretically proved. The converging behaviour of the algorithm of the algorithm can be explained as

- Compared to A* and other algorithms like Breadth First Search, the direction Heuristic approach explores less node each time. This is because of the fact that only those nodes in the direction of the goal node is considered in for expansion.
- Each time this approaches avoids a certain direction, in many of the cases the same direction is chosen. This implies that the portions in the graph which are not relevant is not searched

d) Applying The Concept of Direction Based Heuristics On A Star Algorithm

Developed in the context of learning based heuristics our method speeds up search by expanding and evaluating only necessary nodes in the map. Further, this method eliminates redundant nodes from the graph which reduces additional memory over-heads. Using this heuristic function, we are able to identify a large set of cells which can be skipped. We have implemented the direction oriented Heuristic function normally in a simple grid based environment. The aim is to study the behaviour of the algorithm. Following are the scenarios taken under consideration:

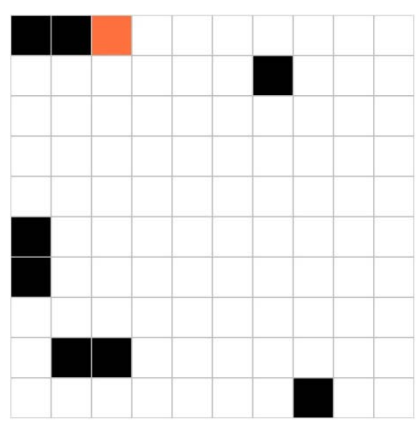
- A square grid of typical size is used. The algorithm works on every kind of grid based maps. But for the ease of calculation of results and observing the performance, square worlds are considered.
- The territory type used is spacious maps and lightly obstructed maps. The method is based on finding out the cells to be expanded out of many neighboring cells. So this is perfectly applicable in the above mentioned types. Also it can be applied on mazes. But for experimental purpose I used maps with less obstacle density.

Every edge has given same weight as we are considering diagonal direction also. This is a mandatory step in the implementation. Expanding diagonal nodes improves the realistic movement which is very essential in game playing. There are a total of eight neighbors for a node under consideration. Sup- pose we are considering a particular node which can be denoted by (x,y) in a grid based environment. Then we can consider the neighboring nodes as a set:

$$\{(x\text{-}1,y\text{-}1),(x,y\text{-}1),(x+1,y\text{-}1),\\ (x1,y),(x+1,y),\\ (x\text{-}1,y+1),(x,y+1),(x+1,y+1)\}$$

Our particular aim is to eliminate some nodes from the above eight neighbors to optimize the result. Popular algorithms like the A star algorithm and Breadth First Search algorithm expands every node so that all nodes are to be processed.

Here Simple direction based Heuristics is applied for the implementation. We used the same datastructures as used by the A* algorithm and Breadth First Search algorithm to study the behaviour of the algorithm. From the above implementation, we could see that the proposed approach always finds solution without fail. A* algorithm can find out a solution pretty faster and the drawback is it eats up lot of memory. So an efficient optimization applied as this would greatly enhance the approach



An example for game world simulated in browser

IV. Evaluation

Evaluating of the proposed system is perhaps the most important part of a our work. For precisely

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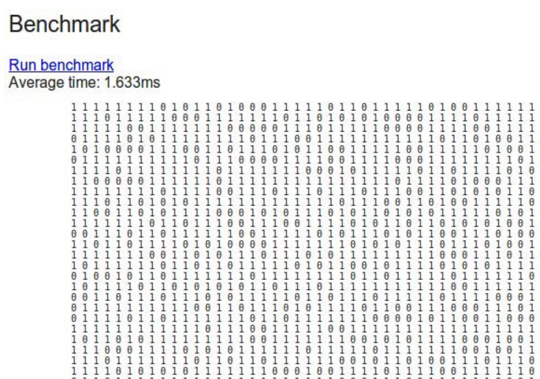
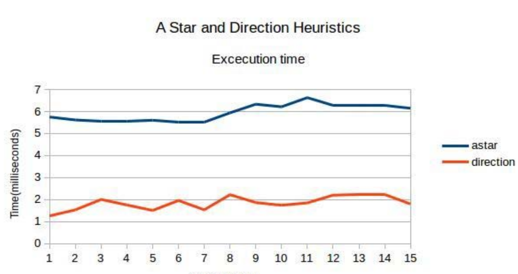
evaluating the results a common benchmark should be considered where all the algorithms under consideration can be executed. As we know A* algorithm is the most popular algorithm for pathfinding. Based on the time of excecution, Comparisons are made between a* algorithm and direction heuristic approach Every game world is represented as grids in the evaluation. For world representation a multi dimensional array is used. For getting the stable results in every platform, world representations in all such cases should be same. In most of the game worlds are represented using arrays. By using the same representation, results obtained are standard results which can be applied universally. A screen shot for running benchmark for the performance evaluation is given where it uses a 150 × 150 grid. The experiment is done in browser.



Map is represented using a 2D array for obtaining standard results.

First, both the algorithms are run several times and values are taken for execution time. The time thus calculated in milliseconds is plotted. An important observation is that the time taken by the proposed method is always less than that of A*. Both the algorithms, A* and Direction Heuristic approach are run thousand times and the average of the execution time is calculated for a grid of same size and obstacle density but randomly distributed obstacles. This result is given as the first instance. Fifteen such instances are calculated and result is plotted. By doing this we will get a result which is stable. Here also we have better performance for proposed algorithm



Comparision between A* and direction

Heuristics for 15 randon worlds of same size

V. Conclusion

In our work, we have introduced a new Heuristic method for speeding up Pathfinding on uniform cost maps which are represented using grids. The new approach selectively expands certain nodes from grid map so that minimum number of nodes are explored. The most important highlight of this work is identification of the nodes to be explored and proper usage of efficient data structure. we prove that unnecessary nodes are not expanded in this approach, or Direction Heuristics would try to minimize the number of nodes to be explored and yet come up with a solution in less time.

One of the important observation is that applying the new logic will not affect the solution. the solution is guaranteed by the new heuristic. it is simple yet highly efficient ,it reduces the amount of the memory needed by wisely choosing the nodes to be explored. It does not require any pre-processing and therefore it is a very fast method. Due to its simplicity it can easily be combined with other pathfinding methods, speedup methods and path smoothing methods to get a solution faster and there is scope for research in all these combinations. Direction based heuristic approach is highly competitive to other works from literature especially when dealing with large maps. When compared to the most popular A* algorithm and its optimized variation which is using priority queue for implementing data structures, Direction Based Heuristics is found to show improve ments.

The process speed up the path finding process by implementing an efficient data structure to handle the nodes for the evaluatation. This reflects in improvement in time when compared to traditional list based linear data structures. By efficiently deciding the number of nodes that are to be explored, new approach needs to process less number of nodes than other. This results in a memory efficient solution, Memory efficiency obtained by using Direction Heuristics is a key highlight when compared to A* algorithm which uses more memory. An interesting direction for further work is to extend Direction Based Heuristic approach to other type of grids like hexagonal and triangular grids. This can be easily achieved by employing proper direction keys for obtaining goal information pretty faster. Utility libraries and the pathfinding plug-ins can be developed by employing this idea so that it is avaliable as a package for the pathfinding. Much remains to be done in the field of Artificial Intelligence and pathfinding. Most of the research is oriented towards other areas like robotics and very few has been done towards their application in tile based games. We hope that our work would certainly benefit the game industry.

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Automatic Classification and Segmentation of Tumors from Skull Stripped Images using PNN & SFCM

By Adapala Praveen Kumar & J Krishna Chaithanya
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Abstract - Automatic classification of brain tumor is area of concern from last few decades for better perceptive analysis in accurate manner. In this paper an automatic brain tumor classification approach namely probabilistic neural network are proposed with image and data processing techniques. The conventional algorithms which are reported in the literature are not automatic in nature and mainly their processing is based on human inspection. Then after some time a new classification approaches came into existence by overcoming the disadvantages of conventional algorithms namely Operator assisted classification methods which proves impractical for huge data amounts and simultaneously it is non-reproducible. The MR brain tumor images contains the noise like content which is mainly caused by the operator performance while processing and this noise results in highly inaccurate classification analysis. For better accuracy in classification of tumor image artificial intelligent techniques like fuzzy logic and neural networks usage are encouraged these days.

Keywards: probabilistic neural network (PNN), principle component analysis, SFCM, brain tumor.

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AUTOMATICCLASSIFICATIONANDSEGMENTATIONOFTUMORSFROMSKULLSTRIPPEDIMAGESUSINGPNNSFCM

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Adapala Praveen Kumar[α] & J Krishna Chaithanya[σ]

Abstract- Automatic classification of brain tumor is area of concern from last few decades for better perceptive analysis in accurate manner. In this paper an automatic brain tumor classification approach namely probabilistic neural network are proposed with image and data processing techniques. The conventional algorithms which are reported in the literature are not automatic in nature and mainly their processing is based on human inspection. Then after some time a new classification approaches came into existence by overcoming the disadvantages of conventional algorithms namely Operator assisted classification methods which proves impractical for huge data amounts and simultaneously it is non-reproducible. The MR brain tumor images contains the noise like content which is mainly caused by the operator performance while processing and this noise results in highly inaccurate classification analysis. For better accuracy in classification of tumor image artificial intelligent techniques like fuzzy logic and neural networks usage are encouraged these days. A new automatic classification and segmentation approach namely probabilistic neural network is presented in this paper and the required decision making is performed in two steps (i) Feature extraction from the tumor images by principle component analysis approach and (ii) probabilistic neural network (PNN). (iii) Segmentation of the abnormal region with spatial fuzzy c- means clustering (SFCM).

The evaluation of PNN classifier performance is evaluated by training performance and classification accuracies. The proposed PNN classifier gives the fast, reliable and accurate classification of the brain tumor for better analysis and the proposed PNN is considered path breaking tool in brain tumor classification.

Keywords: probabilistic neural network (PNN), principle component analysis, SFCM, brain tumor.

I. Introduction

Research on brain and its related tumors are area of concern from last few decades in the medical image processing and data processing techniques. In literature so many different classification algorithms are reported for differentiating the area of tumor region from the respective brain region. Although so many innovative classification techniques are implemented for accurately analyze the situation of patient but due to high complexity and noise related issues this conventional techniques are not considered as promising tool for classification of tumor because this conventional algorithms are not designed meet the practical scenario requirements and produces inaccuracy results.

The drawbacks and disadvantages of conventional classification algorithms gives path to the new way to research on brain tumor and researchers starts to make research on artificial independent techniques like fuzzy logic and neural networks which are considered as promising technologies in many application oriented domains. Automatic image classification of brain tumor is motivated by these artificial independent algorithms in medical image processing domain. As the research relates to human life so the classification results should give less error rate and high accuracy for better analysis and that's why computer assistance is demanded these days for automatic classification.

Advantages of the proposed method stress not only on the classification but also concentrates to extract the abnormal image region using clustering based segmentation algorithm.

Double reading of tumor images can give better accuracy but this could also increase the cost so to tackle the expensiveness of double reading a better software is needed and is in great interest now a days. The main difference between the conventional and artificial intelligent techniques is conventional techniques resolve the issue of handling the large number of patients in accurate manner.

In the proposed work a new automatic approach is presented for classification of brain MR images automatically by make use of some extensive like pixel intensity from the tumor brain image and some anatomical features. The automatic and most reliable methods for detection of tumor is an area of interest and in great need for analyzing the patient scenario by respective physician and these automatic techniques are in great demand mainly because of drawbacks of conventional approaches.

The proposed PNN approach is not yet used to its full extent in the classification of data from the respective brain images which gives the data related to brain tumor and if the Proposed PNN is utilized manually then problems related to handling high amount of data of different patients at intensive care units can be

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handled very efficiently and simultaneously reduces the time consumption significantly. The PNN approach can be efficiently used for both clustering, recognition and classification for better accuracy and it gives scope to introduce the neural networks systems in order to solve the medical problems.

II. Tumor Image Compression by Principle Component Analysis

Many researchers considered principle component analysis is most promising tool for feature extraction and the main purpose of principle component analysis is reduce the size of large data in terms of dimensionality. The MR brain recognition system is designed to recognize the test image according to the memory. The respective memory which is used to recognize the test

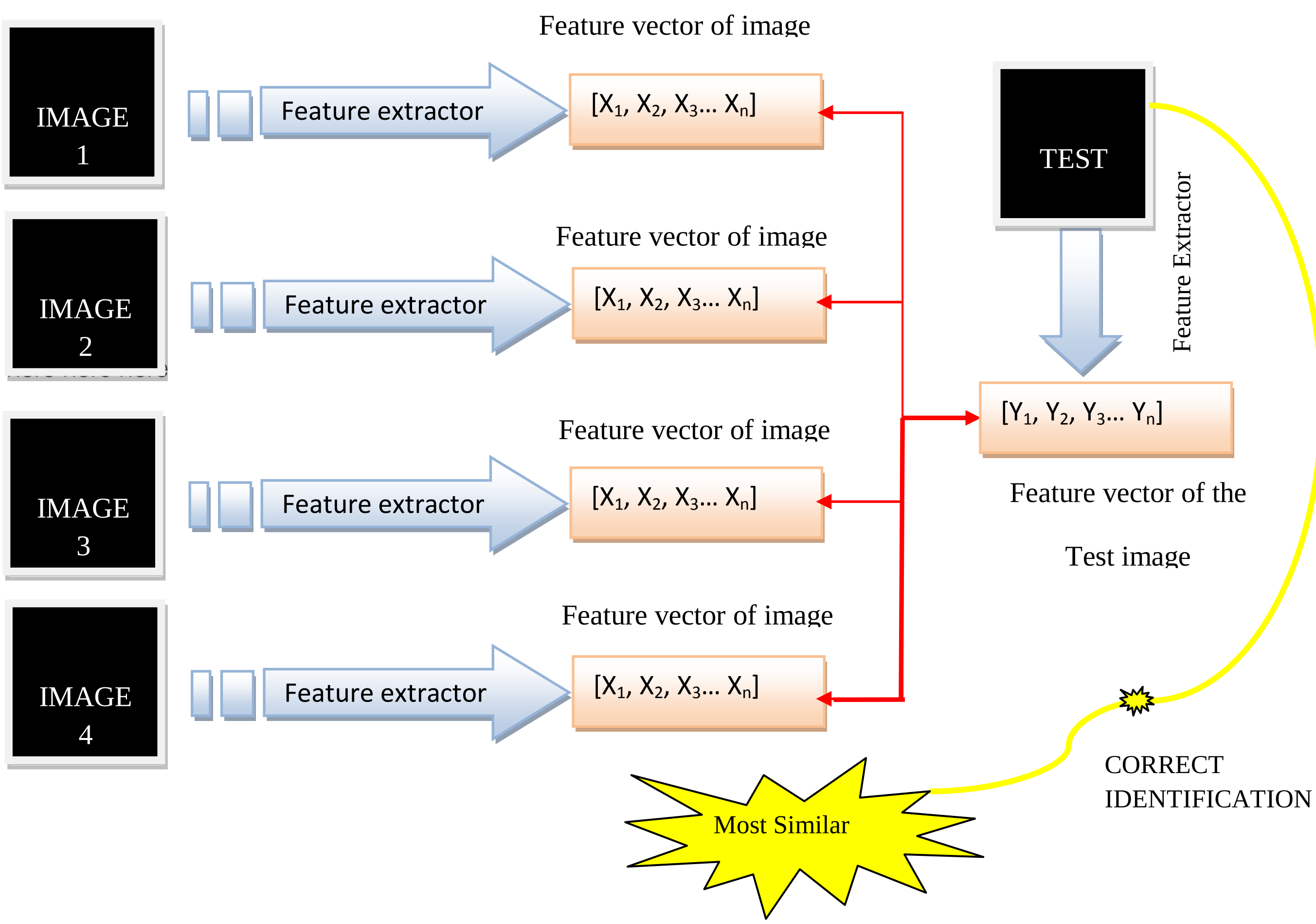

Figure 1 : Schematic diagram MR image recognizer

image according to the memory. The respective memory which is used to recognize the test image is simulated by a training set. The main intention of MR training recognizer is to recognize the most similar vector from the available training set. The most important phase is to extract the feature vectors from the each image from the available training set. Let Ω_1 be a training image of image 1 which has a pixel resolution of $M \times N$ where M represents the number of rows and N represents the number of columns. The conversion of respective image into pixel vector ϕ_1 is essential to extract necessary features of Ω_1 by using the PCA analysis technique and the dimensionality of the vector ϕ_1 will be $M \times N$. In the proposed work the PCA approach is used as reducing the dimensionality reduction technique further it transforms the vector ϕ_1 to a vector ω_1 which has the dimensionality d where d<< $M \times N$. For each training image Ω_1 these feature vectors ω_1 are calculated and stored. In the testing phase feature vector of the test image is computed and checks the similarity between the feature vectors using the Euclidian distance approach. The identity of the most similar is treated as recognizer output.

III. Probabilistic Neural Networks

The probabilistic neural networks are also termed as artificial independent algorithm which is developed by Donald Specht and most researchers termed the PNN as ideal solution to the pattern classification related problems and the specific classification is termed as Bayesian classifiers. PNN is simple in structure and its training speed is many times faster than the respective BP network and it is robust to noise too. The most important advantage of PNN is its training is easy and the respective weights are not trained but assigned. The structure of PNN is s follows

a) Input layer

The input vector, denoted as p, is presented as the black vertical bar in Fig. 2. Its dimension is R × 1. In this paper, R = 3.

b) Radial Basis Layer

The vector distances between input vector p and the weight vector made of each row of weight matrix W are calculated. Here, the vector distance is de fined as the dot product between two vectors [8]. Assume the dimension of W is Q×R. The dot product between p and the i-th row of W produces the i-th element of the distance vector ||W−p||, whose dimension is Q×1, as shown in Fig. 2. The minus symbol, "−", indicates that it is the distance between vectors.

Then, the bias vector b is combined with ||W-p|| by an element-by-element multiplication, represented as ".∗" in Fig. 2. The result is denoted as n = ||W− p|| .∗p. The transfer function in PNN has built into a distance criterion with respect to a center. In this paper, it is de fined as

radbas(n) = e −n 2 1

Each element of n is substituted into Eq. 1 and produces corresponding element of a, the output vector of Radial Basis Layer. The i-th element of a can be represented as

ai = radbas(||Wi − p|| .∗bi) 2

where Wi is the vector made of the i-th row of W and bi is the i-th element of bias vector b.

c) Some characteristics of Radial Basis Layer

The i-th element of a equals to 1 if the input p is identical to the ith row of input weight matrix W. A radial basis neuron with a weight vector close to the input vector p produces a value near 1 and then its output weights in the competitive layer will pass their values to the competitive function. It is also possible that several elements of a are close to 1 since the input pattern is close to several training patterns

d) Competitive Layer

There is no bias in Competitive Layer. In Competitive Layer, the vector a is firstly multiplied with layer weight matrix M, producing an output vector d. The competitive function, denoted as C in Fig. 2, produces a 1 corresponding to the largest element of d, and 0's elsewhere. The output vector of competitive function is denoted as c. The index of 1 in c is the number of tumor that the system can classify. The dimension of output vector, K, is 5 in this paper.

IV. Spatial Fuzzy C-Means Clustering

A conventional FCM algorithm does not fully utilize the spatial information in the image. In this paper, we present a fuzzy c-means (FCM) algorithm that incorporates spatial information into the membership function for clustering. The spatial function is the summation of the membership function in the neighborhood of each pixel under consideration. The advantages of the new method are the following: (1) it yields regions more homogeneous than those of other methods, (2) it reduces the spurious blobs, (3) it removes noisy spots, and (4) it is less sensitive to noise than other techniques. This technique is a powerful method for noisy image segmentation and works for both single and multiple-feature data with spatial information.

The following are the steps involved in SFCM based clustering algorithm

a) Calculate the cost function

$$J = \sum_{j=1}^{N} \sum_{i=1}^{c} U_{ij}^{m} \left| \left| x_j - v_i \right| \right.$$

Where it represents the membership of the pixels with 'c' number of clusters

b) The membership function is given as

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\left\| x_j - v_i \right\|}{\left\| x_j - v_k \right\|} \right)^{2/(m-}}$$

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\left\| x_j - v_i \right\|}{\left\| x_j - v_k \right\|} \right)^{2/(m-1)}}$$

c) To exploit the spatial information a spatial function is defined as

$$h_{ij} = \sum_{k \in NB(x_j)} u$$

d) The new membership function can be rewritten as

$$u'_{ij} = \frac{u_{ij}^{p} h_{ij}^{q}}{\sum_{k=1}^{c} u_{kj}^{p} h}$$

Where p & q are parameters to control relative importance of both functions.

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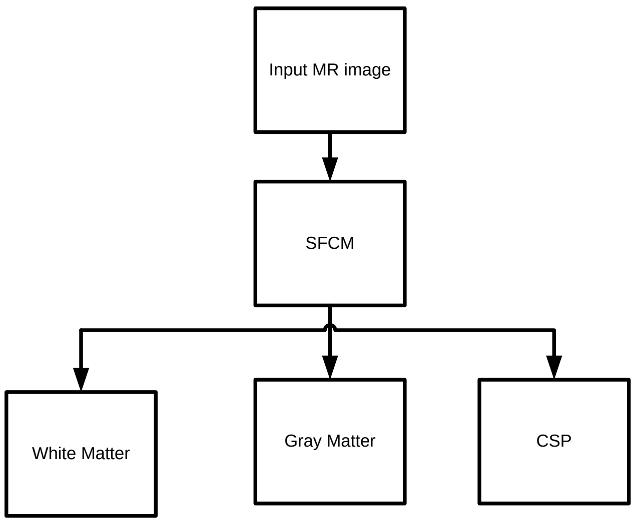

Figure 2 : Segmentation Flow

e) Methodology

PNN classification is used to better accuracy and to get better analysis. It requires less time for classification, high speed and better robustness. The following figure shows the flow of proposed method from the input image to exit. The initial step is should be the image processing step. Basically in image processing system, image acquisition and image enhancement are the steps that have to do. In this paper, these two steps are skipped and all the images are collected from available resource. The proposed model requires converting the image into a format capable of being manipulated by the computer. The MR images are converted into matrices form by using MATLAB.

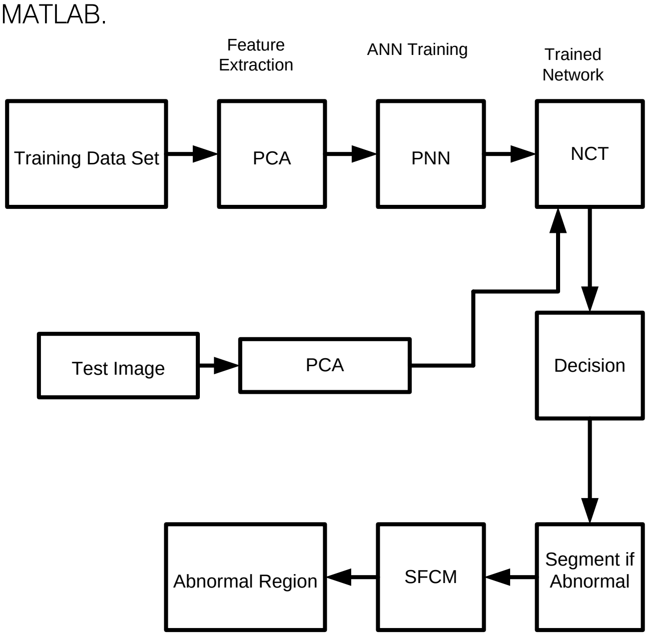

Figure 3 : Block diagram of the proposed method

Then, the PNN is used to classify the MR images. Lastly, performance based on the result will be analyzed at the end of the development phase. The proposed brain MR images classification method is shown in Fig. 3.

In addition to the brain classification a new spatial fuzzy C- means clustering approach is implemented to extract the abnormal regions of the given image is abnormal. The man advantage of using SFCM in this approach is extract the very keen regions from the abnormal region fast & accurately than the conventional FCM (Fuzzy C-means) algorithm. The proposed approach proves to be more effective for the given set of images.

V. Experimental Results

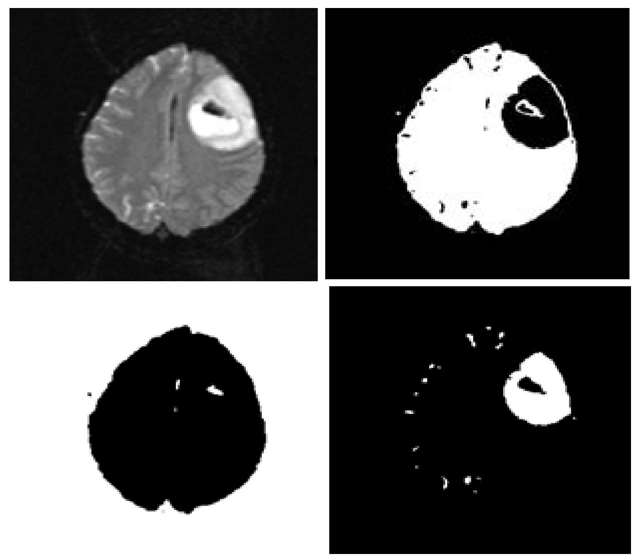

Figure 4 : (a) original Image (b) Cluster region 1 (c) Cluster region 2 (d) Cluster region 3

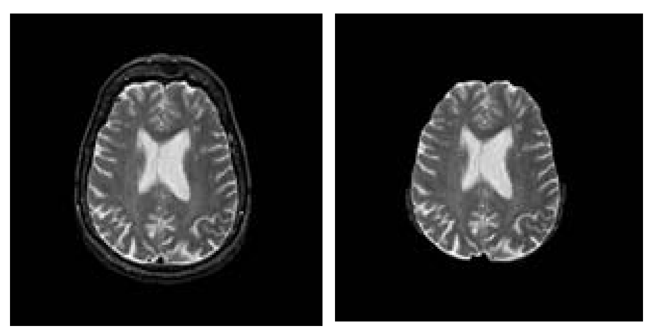

Figure 2 : (a) original Image (b) Skull Stripped Image

Table 1 : performance Analysis

Spread Value	Accuracy
1	72
2	78
3	100

VI. Conclusion

In the area of medical image processing, classification and analysis of MR brain image is the challenging task. The proposed PROBABILISTIC NEURAL NETWORKS is unique in terms of simple structure and performs fast on training with high speed when compare to conventional classification approaches. In this paper 23 different types of MR brain images are taken into consideration for training and testing to yield the better accuracy in terms of analysis and the respective the testing were conducted on different set of images. The reported PROBABILISTIC NEURAL NETWORKS classifier is examined under different spread values and these spread values also considered as the smoothing factor. In the experimental simulation results the accuracy of proposed classifier varies from 100% to 70% which depends on the taken spread values. In addition to the brain classification a new spatial fuzzy C- means clustering approach is implemented to extract the abnormal regions of the given image is abnormal.

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Supervised Content based image Retrieval using Fuzzy Texton and Shearlet Transform

By Sudhakar Putheti, Mohan Krishna Kotha & Srinivasa Reddy Edara
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Abstract- In this paper we proposed, a novel framework to assist and automate the diagnosis of diseases from computer-based image analysis method using Content-based image retrieval (CBIR). CBIR is the process of retrieving related images from large database collections by using low level image features such as color, texture and shape etc. we have used fuzzy texton and discrete shearlet transform to extract texture and shape features. The aim is to support decision making by retrieving and displaying relevant past cases visually similar to the one under examination with relevance feedback using Support Vector Machines.

Keywords: *content based medical image retrieval, fuzzy texton, texels, and support vector machines.*

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Sudhakar Putheti [α], Mohan Krishna Kotha [σ] & Srinivasa Reddy Edara [ρ]

Abstract- In this paper we proposed, a novel framework to assist and automate the diagnosis of diseases from computer-based image analysis method using Content-based image retrieval (CBIR). CBIR is the process of retrieving related images from large database collections by using low level image features such as color, texture and shape etc. we have used fuzzy texton and discrete shearlet transform to extract texture and shape features. The aim is to support decision making by retrieving and displaying relevant past cases visually similar to the one under examination with relevance feedback using Support Vector Machines.

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I. Introduction

The digital imaging revolution in the medical domain over the past three decades has changed the way that the present-day physicians diagnose and treat diseases. These images of various modalities are playing an important role in detecting the anatomical and functional information about different body parts for the diagnosis, medical research, and education. Modern medical information systems need to handle these valuable resources effectively and efficiently. Currently, the utilization of medical images is limited due to the lack of effective search methods; text-based searches have been the dominating approach for medical image database management [1, 2].

Content-based image retrieval (CBIR), also known as query by image content (QBIC) and content based visual information retrieval (CBVIR) is the application of computer vision to the image retrieval problem. Research in content-based image retrieval (CBIR) today is an extremely active discipline. There are already review articles containing references to a large number of systems and description of the technology implemented [1, 2]. A more recent review [3] reports a tremendous growth in publications on this topic. Applications of CBIR systems to medical domains already exist [4], although most of the systems currently available are based on radiological images.

When referred to text retrieval based on keyword, current technique has already met the demand of the users expectation. As to the demand of digital multimedia retrieval in the network, for instance image, video and many other digital multimedia retrieval. Nowadays there also have some digital multimedia format's search engines which are special for image and mp3 format, for example Google image search engine, but the retrieval methods of these search engines still use the techniques based on text and keywords match. The goal is to retrieve the images based on visual features such as color, texture and shape.

Formerly developed commercial content-based image retrieval systems characterized images by global features such as color histogram, texture values and shape parameters, however, for medical images, the systems using global image features failed to capture the relevant information [5].

Color is one of the most widely used low-level visual features and is invariant to image size and orientation [6]. Various texture representations have been investigated in pattern recognition and computer vision. Basically, texture representation methods can be classified into two categories: structural and statistical. Structural methods, including morphological operator and adjacency graph, describe texture by identifying structural primitives and their placement rules [7]. They tend to be most effective when applied to textures that are very regular. Statistical methods, including Fourier power spectra, co-occurrence matrices, Zernike moments, shift-invariant principal component analysis (SPCA), Markov random field, fractal model, and multi-resolution filtering techniques such as Gabor and wavelet transform, characterize texture by the statistical distribution of the image intensity [8].

Shape has been one of the most important and effective low level visual features in characterizing much pathology identified by medical experts [9]. The use of shape as a feature is less developed than the use of color or texture, mainly because of the inherent complexity of representing it [10]. Yet, retrieval by shape has the potential of being the most effective search technique in many application fields [11].

Support Vector Machines (SVM) [12] is an approximate implementation of the *structural risk minimization* (SRM) principle. It creates a classifier with minimized *Vapnik- Chervonenkis* (VC) dimension. SVM minimizes an upper bound on the generalization error rate. The SVM can provide a good generalization performance on pattern classification problems without

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incorporating problem domain knowledge. One key design task, when constructing image databases is the creation of an elective relevance feedback component. While it is sometimes possible to arrange images within an image database by creating a hierarchy, or by hand-labeling each image with descriptive words, it is of-ten time-consuming, costly and subjective. Alternatively, requiring the end-user to specify an image query in terms of low level features (such as color and spatial relationships) is challenging to the end-user, because an image query is hard to articulate, and articulation can again be subjective.

Recent trials for content-based medical image retrieval were ASSERT system [13] for high resolution computed tomography (CT) images of the lung and image retrieval for medical applications (IRMA) system [14] for the classification of images into anatomical areas, modalities and viewpoints. Flexible image retrieval engine (FIRE) system handles different kinds of medical data as well as non-medical data like photographic databases [15].

The rest of the paper is organized as follows. In Section II, the proposed image retrieval method steps fuzzy texton detection, shear wavelet transform and support vector machines (SVM) for relevance feedback and texels calculation are discussed. Section III, Experiments, performance evaluations, and discussions are given.

II. Proposed Method

An efficient image retrieval technique is required to improve the success rate with the rapid increase in the usage of digital media. The block diagram of the proposed CBIR system is shown in Figure 1.

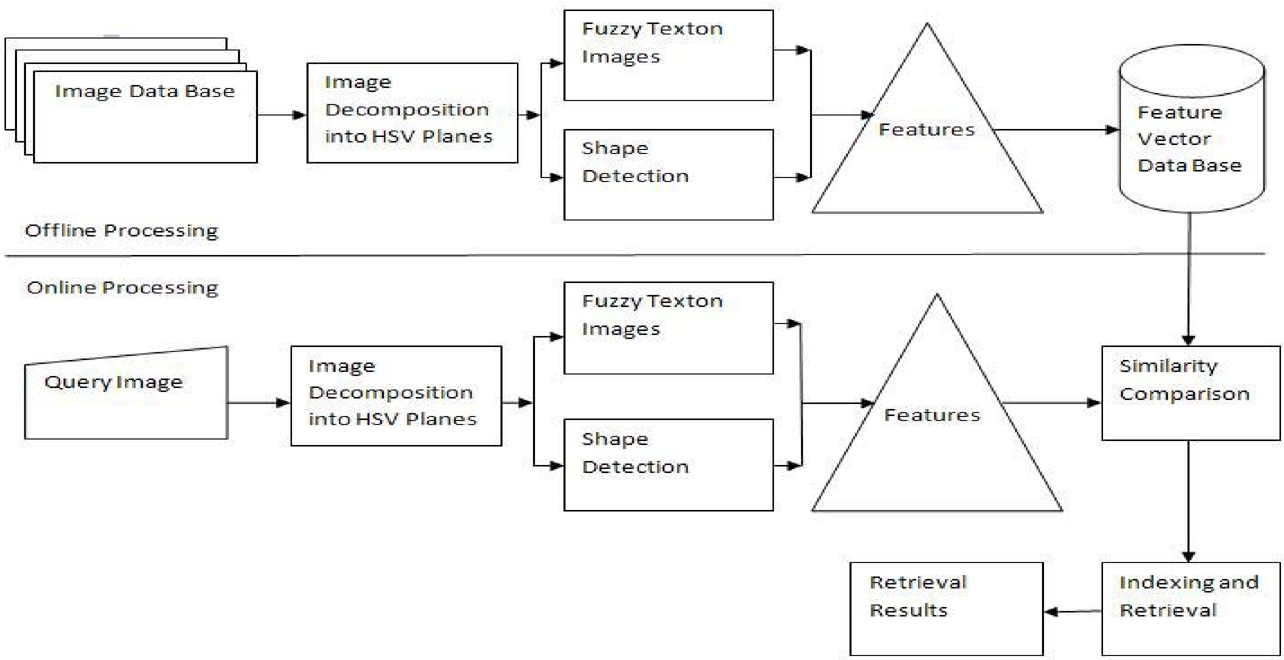

Figure 1 : The cbir system

It consists of two phases: database building (off-line) and query processing (on-line) phase.

a) Extraction of Fuzzy Texton Images

Fuzzy Texton is a way to describe the texture property further better than the Texton since Fuzzy texton uses the fuzzy texture unit (FTU) instead of texture unit (TU). By including fuzzy concept to the texton will generates all ranges of the values including '2' in the FTU [16, 17]. Then, it helps to generates different textures are 5^8 instead of 4^8. The main idea of the proposed method (TFT) is, Texton images are obtained by applying the 12 types of 3 x3 texton templates [18].

As per Julesz description a texton is a pattern which is shared by an image as a common property [19]. Textures which can be decomposed into elementary units, the texton are formed only if the adjacent elements lie within the neighborhood. The critical distances between texture elements which depend on the texture element size are used to incline the texton. Textons are classes of colors, elongated blobs of specific width, orientation, aspect ratios and terminators of elongated blobs. If texture elements are greatly expanded in one orientation, discrimination reduces. If the elongated elements are not jittered in orientation, texture gradients increase at boundaries. Thus with a small sub image of size 3 x 3 is used to obtain texton gradient. In the previous proposed technique TFT[18], we have proposed 12 textons of 3 x 3 grids. The computational complexity for using the overlapped components of 12 textons is also less to obtain final texton image.

The basic unit of the method is defined by a central pixel and its eight neighbors, forming a 3x3 pixel square. This minimal square image has the local texture information of the central pixel in all the directions.

In our case the size of the neighborhood is 3x3 pixels. This pattern of the image, consisting by 9 pixels, is denoted by a set V of nine elements, $V=\{V_0, V_1, V_2 \ldots V_8\}$, where V_0 represents the intensity value of the central pixel and V_i $(1 \leq i \leq 8)$ the intensity value of each neighboring pixel. The smallest complete unit which best characterizes the local texture aspect of a given pixel and its neighborhoods, in all eight directions of a square raster, is Texture Unit (TU) that is defined, by $TU=\{E_1, E_2, \ldots, E_8\}$, where:

$$E_i = \begin{cases} 0 & \text{if } V_i < V_0 \text{ and } V_i < p \\ 1 & \text{if } V_i < V_0 \text{ and } V_i > p \\ 2 & \text{if } V_i = V_0;\ 1 \leq i \leq 8 \\ 3 & \text{if } V_i > V_0 \text{ and } V_i < q \\ 4 & \text{if } V_i > V_0 \text{ and } V_i > q \end{cases} \qquad (1)$$

here p and q are user defined values and each element E_i occupies the same position as pixel *i*. An example is shown in Figure 1.

99	45	180
240	120	205
34	120	65

(a)

1	0	3
4		4
0	2	1

(b)

p	q	r
w		s
v	u	t

(c)

Figure 2 : (a) Hue levels of an image part. (b) Texture Unit associated to the central pixel. (c) Texture Unit Ordering

As to each element of the TU can be assigned one of three possible values 0, 1,2,3 or 4, the total number of Texture Units is $5^8 = 16777216$. These Units can be labeled and ordered in different ways; here we will label each TU as a 5-base number, named Texture Unit Number, N_{TU} according to next formula:

$$N_{TU} = \sum_{i=1}^{8} E_i \cdot 5^{\frac{i-1}{2}} \qquad (2)$$

Where the position of the Texture Unit box and E_i is the value of the box (0, 1, 2, 3 or 4). Moreover, the 8 elements can be ordered differently. If they are ordered clockwise, as shown in Figure 1(c), the first element can take eight possible positions, from the top left a to the middle left h, and then the 16777216 texture units can be labeled by the abode formula under eight different ordering ways (from a to h).

A more detail study of texture unit indicates that the absent TU's involve two's in their texture unit. This is the case when neighbors and central pixels have the same values. If there is a lack of two's then TU will take only 0,1,3 and 4 which means that the possible real number of different textures are 4^8 instead of 5^8, that is 65536 and 390625 the spectrum will be never totally covered, thus the power of the method is misused. It impacts on texture Unit number also. To overcome this, fuzzy texture is used in the proposed method. Fuzzy Texton is a way to describe the texture property further better than Texton.

Fuzzy Texton is a way to describe the texture property further better than the Texton since Fuzzy texton uses the fuzzy texture unit (FTU) instead of texture unit (TU). By including fuzzy concept to the texton will generates all ranges of the values including '2' in the FTU [20]. Then, it helps to generates different textures are 5^8 instead of 4^8. It covers total spectrum which is not possible by texton only (means without fuzzy) [21]. The main idea of the proposed method (TFT) is, Texton images are obtained by applying the 12 types of 3 x3 texton templates [22] as shown in figure 4 on HSV planes as shown in figure 3.

We used the Fuzzy Texture unit boxes (FTUB) and Fuzzy Texture Unit Numbers (FTUN) which are used by Aina Barceló. et. al [20]. In this proposed work, FTUB and FTUN are used during the period of quantifying the texton images. Then, the resultant textons are called as fuzzy texton images.

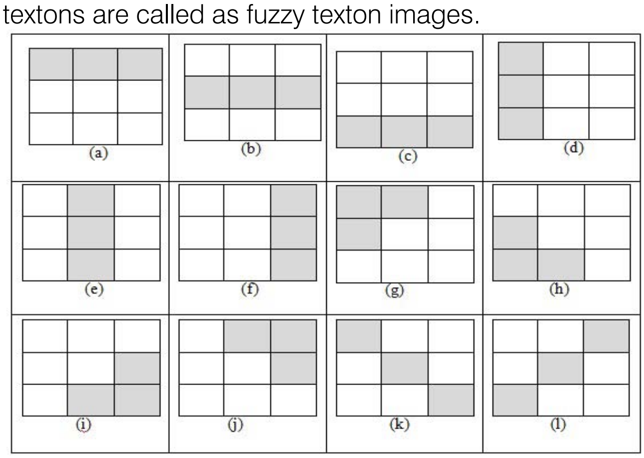

Figure 3 : 12 Types of 3 x 3 texton templates

Using fuzzy techniques provide a more flexible way of assigning values (E_i) to the TU boxes. From now on E_i will not be a unique value 0, 1, 2, 3 or 4, but it will have the five values associated at the same time, each one to its own degree. Each particular degree will be calculated with the aid of a membership function that has to be defined. Therefore, we will consider Fuzzy Texture Unit Boxes (FTUB) FE_i that are defined as follows:

$$FE_i = \{\mu_0(V_i), \mu_1(V_i), \mu_2(V_i), \mu_3(V_i), \mu_4(V_i)\}, \quad 1 \leq i \leq 8 \qquad (3)$$

Where in $\mu_0(V_i)$, $\mu_1(V_i)$, $\mu_2(V_i)$, $\mu_3(V_i)$ and $\mu_4(V_i)$ are the membership degrees of V_i [20] to the fuzzy sets 0, 1, 2, 3 and 4 respectively. In a similar way to the TU, the Fuzzy Texture Unit (FTU) is defined by:

$$FTU = \{FE_1, FE_2, FE_3, FE_4, FE_5, FE_6, FE_7, FE_8\} \quad (4)$$

As part of the detection process of fuzzy texton, our 3 x 3 grids can detects the textons in all directions and also corners of the textures. If three pixels are highlighted and have the same value then grid will form a fuzzy texton as shown in Figure 5.

b) Edge Orientation using Discrete Shearlet Transform

The approach used in this paper is based on a new multiscale transform called the shearlet transform. It is multidimensional version of the traditional wavelet transform, and is especially designed to address anisotropic and directional information at various scales. Indeed, the traditional wavelet approach, which is based on isotropic dilations, has a very limited capability to account for the geometry of multidimensional functions.

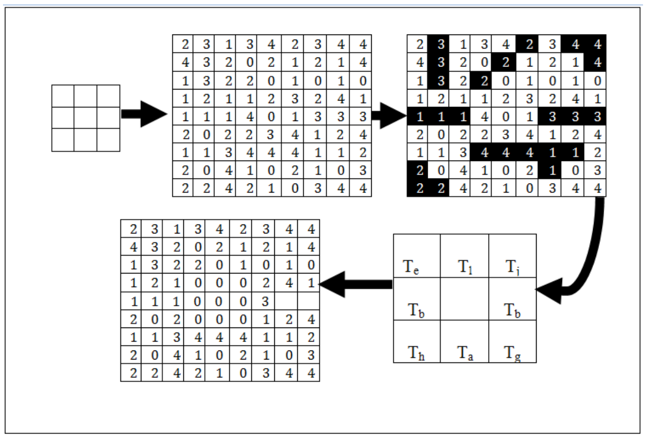

Figure 4 : Fuzzy Texton Detection Process

In contrast, the analyzing functions associated to the shearlet transform are highly anisotropic, and, unlike traditional wavelets, are defined at various scales, locations and orientations. As a consequence, this transform provides an optimally efficient representation of images with edges [23]. The shearlet transform has similarities to the curvelet transform, Shearlets and curvelets, in fact, are the only two systems which were mathematically known to provide optimally sparse representations of images with edges and the implementations of the curvelet transform correspond to essentially the same tiling as that of the shearlet transform. Both systems are related to contourlets [26], [27] and steerable filters [28], [29]. We refer to [30] for more details about the comparison of shearlet and other orientable multiscale transforms.

In this paper, we combine the shearlet framework with several well established ideas from the image processing literature to obtain improved and computationally efficient algorithms for edge analysis and detection. Our approach may be viewed as a truly multidimensional refinement of the approach of Mallat et al., where the isotropic wavelet transform is replaced by an anisotropic directional multiscale transform. As a result, the shearlet transform acts as a multiscale directional difference operator and provides a number of very useful features: Improved accuracy in the detection of edge orientation. Using anisotropic dilations and multiple orientations, the shearlet transform precisely captures the geometry of edges. It is a multiscale transform, based on the same affine mathematical structure of traditional wavelets. The discretization of the shearlet transform provides a stable and computationally efficient decomposition and reconstruction algorithm for images. An algorithm for edge detection based on shearlets was introduced in [24, 25], where a discrete shearlet transform was described with properties specifically designed for this task. In fact, the discrete shearlet transform which was presented above for image denoising, produces large side lobes around prominent edges which interfere with the detection of the edge location. By contrast, the special discrete shearlet transform introduced in [24, 25] is not affected by this issue since the analysis filters are chosen to be consistent with the theoretical results in [31, 32], which require that the shearlet generating function ψ satisfies certain specific symmetry properties in the Fourier domain.

The first step of the shearlet edge detector algorithm consists in selecting the edge point candidates of a digital image u[m1,m2]. They are identified as those points $(\overline{m_1}, \overline{m_2})$ which, at fine scales j, are local maxima of the function

$$M_j u[m_1, m_2]^2 = \sum_l \left(SHu[j, l, m_1, m_2]\ \right)^2 \quad (5)$$

Here $SHu[j, l, m_1, m_2]$ denotes the discrete shearlet transform. According to the properties of the continuous shearlet transform summarized above, we expect that, if $(\overline{m_1}, \overline{m_2})$is an edge point, the discrete shearlet transform of u will behave as

$$|SHu[j, l, \overline{m_1}, \overline{m_2}]| \sim C2^{-\beta j} \quad (6)$$

Where β ≥ 0. If, however, β < 0 (in which case the size of |SHu| increases at finer scales), then $(\overline{m_1}, \overline{m_2})$will be recognized as a spike singularity and the point will be classified as noise. Using this procedure, edge point candidates for each of the oriented components are found by identifying the points for which β ≥ 0. Next, a non-maximal suppression routine is applied to these points to trace along the edge in the edge direction and suppress any pixel value that is not considered to be an edge. At each edge point candidate, the magnitude of the shearlet transform is compared with the values of its neighbors along the gradient direction (this is obtained from the orientation map of the shearlet decomposition). If the magnitude is smaller, the point is discarded; if it is the largest, it is kept. Extensive numerical experiments have shown that the shearlet edge detector is very competitive against other classical or state-of-the-art edge detectors, and its performance is very robust in the presence of noise. An example is displayed in Figure 12, where the shearlet edge detector is compared against the wavelet edge detector (which is essentially equivalent to the Canny edge detector) and the Sobel and Prewitt edge detectors. Notice that both the Sobel and Prewitt filters are 2D discrete approximations of the gradient operator. The performance of the edge detectors is assessed using the Pratt's Figure of Merit, which is a fidelity function ranging from 0 to 1, where 1 is a perfect edge detector. This is defined as

$$FOM = \frac{1}{max\,(N_e, N_d)} \sum_{k=1}^{N_d} \frac{1}{1+\alpha d\,(k)^2} \qquad (7)$$

where N_e is the number of actual edge points, N_d is the number of detected edge points, d(k) is the distance from the k-th actual edge point to the detected edge point and α is a scaling constant typically set to 1/9. The numerical test reported in the figures show that the shearlet edge detector consistently yields the best value for FOM.

These properties lead directly to a very effective algorithm for the estimation of the edge orientation, which was originally introduced in [25]. Specifically, by taking advantage of the parameter associated with the orientation variable in the shearlet transform, the edge orientations of an image u, can be estimated by searching for the value of the shearing variable s which maximizes $SH_{\psi}\, u(a,s,p)$ at an edge point p, when a is sufficiently small. Discretely, this is obtained by fixing a sufficiently fine scales (i.e., $a = 2^{-2j}$ sufficiently "small") and computing the index $\tilde{l}$ which maximizes the magnitude of the discrete shearlet transform $SHu[j,l,m]$ as

$$\tilde{l}(j,m) = argmax_l |SHu[j,l,m]| \qquad (8)$$

Once this is found, the corresponding angle of orientation $\theta_{\tilde{l}}(j,m)$ associated with the index $\tilde{l}(j,m)$ can be easily computed. As illustrated in [25], this approach leads to a very accurate and robust estimation for the local orientation of the edge curves. To illustrate the general principle, consider the simple image in Figure 13 consisting of large smooth regions separated by piecewise smooth curves. The junction point A, where three edges intersect, is certainly the most prominent object in the image, and this can be easily identified by looking at values of the shearlet transform. In fact, if one examines the discrete shearlet transform $SHu[j_0,l,m_0]$, at a fixed (fine) scale j_0 and locations m_0, as a function of the shearing parameter l, the plot immediately identifies the local geometric properties of the image. Specifically, as illustrated in Figure 13(b), one can recognize the following four classes of points inside the image. At the junction point $k_0 = A$, the function $|SHu[j_0,l,m_0]|$ exhibits three peaks corresponding to the orientations of the three edge segments converging into A; at the point $m_0 = B$, located on a smooth edge, $|SHu[j_0,l,m_0]|$ has a single peak; at a point $m_0 = D$, inside a smooth region, $|SHu[j_0,l,m_0]|$ is essentially flat; finally, at a point $m_0 = C$ "close" to an edge, $|SHu[j_0,l,m_0]|$ exhibit two peaks, but they are much smaller in amplitude than those for the points A and B. A similar behaviour was observed, as expected, for more general images, even in the presence of noise. Based on these observations, a simple and effective algorithm for classifying smooth regions, edges, corners and junction points of an image was proposed and validated in [52].

c) Support Vector Machine for Relevance Feedback

Consider the binary classification problem {(xi, yi)}, for i=1 to N, where xi are the labeled patterns and yi∈ {−1, +1} the corresponding labels. Based on this training set, we want to train an SVM classifier. The SVM classifier maps the patterns to a new space, called kernel space, using a transformation x → ϕ(x), in order to get a potentially better representation of them. This new space can be nonlinear and of much higher dimension than the initial one. After the mapping, a linear decision boundary is computed in the kernel space. In the context of SVM methodology, the problem of classification is addressed by maximizing the margin, which is defined as the smallest distance, in the kernel space, between the decision boundary and any of the training patterns. This can be achieved by solving the following quadratic programming problem:

$$max\left[\sum_{i=1}^{N} a_i - \frac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N} a_i\, a_j\, y_i y_j\, k(x_i, x_j)\right]$$

over a_i, i=1,…,N (9)

Such that $0 \le a_i \le C$ and

$$\sum_{i=1}^{N} a_i\, y_i = 0 \qquad (10)$$

Where

$$k(x_i, x_j) = \varphi(x_i)^T \varphi(x_j) \qquad (11)$$

is the kernel function and C is a parameter controlling the trade-off between training error and model complexity. The most popular non-linear kernel functions used for SVMs belong to the class of Radial Basis Functions (RBFs). From all RBF functions, the most commonly used is the Gaussian RBF, which is defined by:

$$k(x_i, x_j) = exp\left(-\gamma \|x_i - x_j\|^2\right)$$

After the training of the classifier, the value of the decision function for a new pattern x is computed by:

$$y(x) = \sum_{i=1}^{N} a_i\, y_i k(x_i, x) + b$$

Where b is a bias parameter the value of which can be easily determined after the solution of the optimization problem [33]. The value |y(x)| is proportional to the distance of the input pattern x from the decision boundary. Thus, the value y(x) can be regarded as a measure of confidence about the class of x, with large positive values (small negative values) strongly indicating that x belongs to the class denoted by +1 (−1). On the contrary, values of y(x) around zero provide little information about the class of x.

d) Extraction of Texels

After the extraction of fuzzy texton images need to extract the texels from them. The local properties [18] used to extract the feature vectors used here come under two categories: one is regarding color information and other is about texture. Some of the important features of texture properties (cluster properties) are Local Homogeneity, Cluster Shade and Cluster Prominence.

i) Local homogeneity

$$\sum_{i,j=0}^{n} \frac{1}{1+(i-j)^2} c(i,j) \qquad (14)$$

ii) Cluster shade

$$\sum_{i,j=0}^{n} \left(i - M_x + j - M_y\right)^3 c(i,j) \qquad (15)$$

iii) Cluster Prominence

$$\sum_{i,j=0}^{n} (i - M_x + j - M_y)^4 c(i,j) \qquad (16)$$

where $M_x = \sum_{i,j=0}^{n} iC(i,j)$ and $M_y = \sum_{i,j=0}^{n} jC(i,j)$

There are three important properties regarding color information. They are Color Expectancy, Color Variance and Skewness.

i) Color Expectancy

$$E_i = \frac{1}{N} \sum_{j=1}^{N} C_{ij} \qquad (17a)$$

ii) Color Variance

$$\delta_i = \left(\frac{1}{N} \sum_{j=1}^{N} (C_{ij}\, E_i)^2\right)^{\frac{1}{2}} \qquad (17b)$$

iii) Skewness

$$\sigma_i = \left(\frac{1}{N} \sum_{j=1}^{N} (C_{ij}\, E_i)^3\right)^{\frac{1}{3}} \qquad (18)$$

In the framework of CBIR with RF, in each round of RF we have to solve a classification problem as the one described above, where a number of images, represented as feature vectors, correspond to the feedback examples provided by the user so far, and each image is labeled by −1 or +1 corresponding to irrelevant or relevant, respectively. The initial query is considered to be one of the relevant images and is labeled by +1. From the above, it is obvious that we can train an SVM classifier based on the feedback examples and use it to distinguish between the classes of relevant and irrelevant images. Each image in the database will be presented to the trained classifier and the value of the decision function (Eq. (5)) will be used as the ranking criterion. The higher the value of the decision function for an image, the more relevant this image is considered by the system.

III. Results and Discussion

The effectiveness of the proposed retrieval system is evaluated on fundus image database, Skin cancer image database and Endoscopy image database. The sample images from the fundus image database are shown in the figure 5.

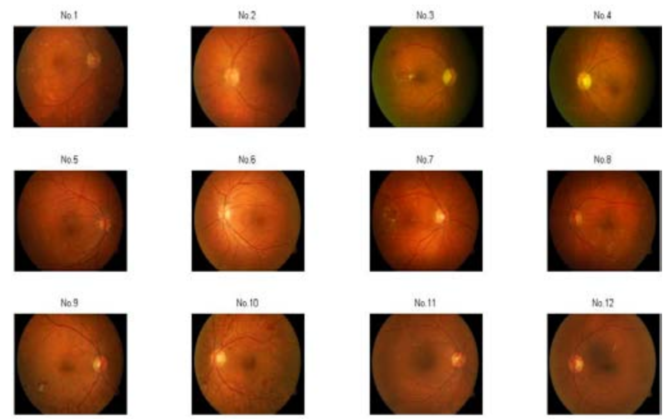

Figure 5 : Fundus images

The Skin cancer sample images from the database of Skin images are shown in figure 6.

Figure 6 : Skin images

The sample images from the Endoscopy image database are shown in the figure 7

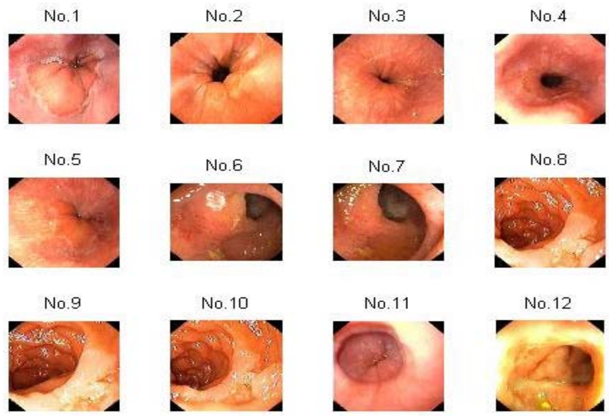

Figure 7 : Endoscopy images

a) Distance Measure

We can use different distance metrics for matching such as an N-dimensional feature vector F = [F1, F2...FN]. It is extracted from every image of database and stored in database. Let Q = [Q1, Q2, Q3,…,QN] be the feature vector of query image. A simple distance measure [34] whose time complexity is very less when compared with others like Euclidean (no square or square root operations) when we consider large databases, is given by

$$(\mathrm{F}, \mathrm{Q}) = \sum_{i=0}^{N} \frac{|F_i - Q_i|}{1 + F_i + Q_i} \qquad (19)$$

b) Performance Measure

Most common measurements are used to evaluate the performance of image retrieval methods are Precision, Recall and Accuracy curves [35].

$$\text{Precision } P(N) = \frac{I_N}{N} \qquad (20)$$

$$\text{Recall } R(M) = \frac{I_M}{M} \qquad (21)$$

$$\text{Accuracy } A(N) = \frac{(P(N) + R(N))}{2} \qquad (22)$$

Where I_N is the number of images retrieved in the top N positions that are similar to the query image and M is the total number of images in the database similar to the query image.

In all cases the framework provides higher precision, recall and accuracy.

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Content base Image Retrival using Color Histogram and Global Features

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Abstract- In the world we live in today we can safely say that the internet revolution, digital representation and transportation of data had offered efficient solution for information delivery. But these phenomenal developments brought their own concern and problems in area of searching, security, monitoring and use of information by qualified end users. In early days the information was generally obtained and processed in the form of text but nowadays people are aware of the truth that information can be obtained in the form of graphics, which are a more precise and a more inclusive illustration of information. In this paper a new technique is introduced for fast Content based Image Retrieval with the help of colors and global features. Image retrieval on the base of color histogram is a very useful and common technique but in some cases this technique is not reliable. In proposed technique some new things are added with the color histogram to make it more efficient and reliable for Content based image retrieval.

Keywads: image acquisition, image features, binary representation of image, image quantization, image histogram.

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

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Keywords: image acquisition, image features, binary representation of image, image quantization, image histogram.

I. Introduction

The rapidly decreasing price of storage, processing and bandwidth has already made digital media increasingly popular over conventional analog media. Each day the amount of internet users increases very fast. Each day a lot of information (text, image, video, audio, etc) travels between people. People want the fastest and easiest ways of information sharing but they don't know how. [1].

Though the increment of internet users is very fruitful for the spread of information but along with it also came some difficulties. This day by day increment of internet users is a hurdle in front of the fast retrieval of information. In this paper a new technique is proposed for the fast image retrieval. The proposed technique has three stages, each stage containing some tasks to be performed by system. First stage is related with image acquisition, second stage is related with Global Features extraction of query image and database images and histograms of each image. In the third and last stage take some comparison between histograms and global features of images.

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II. Previous Work

Today many companies work on CBIR to achieve fast and accurate results. Each CBIR consists of three parts

a) Image acquisition
b) Image feature extraction
c) Similarity matching

a) Image Acquisition

Image acquisition means that how a computer treats an image. We all know very well that the computer only understands the binary language. This means that the computer first converts an image into binary image for its understanding. Image acquisition is a combination of some mathematical operations which is used to digitize the image in order to create an enhanced image that is more functional or pleasing to a human spectator, or to do some of the analysis, segmentation, detection, and recognition tasks.

b) Image Features Extraction

In pattern recognition and in image processing, feature extraction is a special form of dimensionality reduction.

i. *Feature Extraction via Boundary Detection*

This method uses K-nearest neighbor technique to find out the boundary. The binary matrix (image) is scanned until the output (boundary) does not come out. [2]

In this method first find out the foreground pixels P and the set of connected foreground pixels. After that feature vector is found out which is also called Fourier descriptor. This Fourier descriptor helps to find out Fourier coefficient and through this Fourier coefficient it is ensured whether the boundary is fully covered or not. This is done by checking whether the first and last position coordinates values are equal or not.

ii. *Feature Extraction based on Color*

Retrieving image on the basis of color similarities is a very common technique. Many researchers work on this technique but mostly of them are variations on the basic idea.

There are too many color models used in this world but two of them are most commonly used RGB and HSV. The methods which extract to features on the bases of colors worked upon the following descriptors.

a. *Color Histogram*

Comparison of all colors between two images is very complex and time consuming. Color histogram is the most helpful technique to resolve such problems of time.

In this method color histogram of each image is taken and then stored in database. In this Method each color axis is divided in to number of "bins.

Bins are just like a plot. A three dimensional RGB (8*8*8) histogram contains total 512 bins. At the time of image indexing, the color of each pixel is find out, and its corresponding bin's count incremented by one. [3].

In this method the desired portion of each color (red, green, blue) is specify from user through this desired portion the color histogram is calculated. After that system search out those images from database whose color histogram closely match the desired or query image color histogram.

The total number of bits in each pixel of an image represents the total number of elements in a histogram. For e.g. suppose that a pixel of n number of bits, then

$$\textit{Total elements of histogram} = 2^n$$

$$\textit{Pixels values} = 0 \text{ to } 2^n - 1$$

The color histogram is mostly used for large data sets as follows.

$$h = Histogram$$

$$mean = \sum_{i=o}^{255} i * h(i) / \sum_{i=o}^{255} h(i)$$

$$variance = \sqrt{\frac{\sum_{i=o}^{255} h(i) * (i - mean)^2}{\sum_{i=o}^{255} h(i)}} \quad (1)$$

b. *Color Coherent Vector*

One drawback of Color histogram is that it does not think about spatial data of an image. But Color coherent vector resolve this problem by patronized the color histogram into two types: Coherent and Incoherent Pixel value related with small color region fall into incoherent type and pixel value related with large color region fall into coherent type. [4] This classification is done for each color in an image in this method.

c. *Color Moments*

The term color moments defines the means, standard deviation and variance of an image. These terms are widely used in image processing. These terms are mostly used on matrix form of image.

iii. *Feature Extraction via PCA Algorithm*

In this method each row is containing into a long thin vector for reducing the 2D (two dimensional) data into one dimensional format. In the test data the common part of each image is calculated and to get the unique part of image is obtained by subtracting the common and calculated part of images from the original image. After this the method finds out covariance matrix. In this system the feature vector is also called Eigen faces. [6]

iv. *Feature Extson via Slope Magnitude Method*

Slope Magnitude technique is also a widely used technique for Shape features extraction. This method of features extraction worked on connection between edges. Because the connection between edges are very important to represent the boundaries of a object shape. G radiant operator is used in this method to find out the connected boundaries of object to extract the features. After that slope magnitude method is applied on the gradient of images in both horizontal and vertical directions to find out the feature vector. But one drawback of this method is that the dimension of query image and all other images would be equal. [7].

v. *Feature Extraction using Transforms*

There are too many transforms which are widely used for the feature detection. Most commonly used transforms are given below.

a. *Feature Extraction using Fast Fourier Transforms*

The Fast Fourier Transform FFT works in frequency domain. The FFT work on the means values of real and imaginary part of complex number of polar coordinates to find out the feature vector. To generate feature vector FFT consider all real and imaginary part of Red, Green and Blue planes. In a complex plane each complex number is shown as a point which helps to generate the components of feature vector based on complex plane. [8].

b. *Feature Extraction using Discrete Cosine Transforms*

This method takes combination of coefficient of consecutive odd and even coefficient of each column to make the feature vector and put the odd coefficient on y-axis and even coefficient on x-axis.

c) *Similarity Measurement*

Similarity measurement represents the degree of similarity between two images. This part of CBIR depends upon the previous part (feature extraction) of CBIR. This means that if features of image are extracted perfectly then the output of similarity measurements will also come perfect.

There are too many methods to measure the similarities between two images. Some most widely used methods are discussed below:

i. *Euclidean Distance* method is used to find out distance measures. These distance measurements indicated the similarities. The low value of distance measurement represent the close (good) similarity relation otherwise the high value of distance measurement represent the open (bad) similarity relation between two images. The metric used in Euclidean distance is called Euclidean metric to find out the distance measurements. In one dimensional, Euclidean distance method works on the basis of the following formula. [9]

$$\sqrt{(x - v)^2} = | x - v | \qquad (2)$$

Euclidean distance method is reportedly faster than the other distance measurement methods. The one drawback of this method is that it does not work properly in high noisy signals.

ii. *Neural Network* Used the concept of Classifiers by themselves for Similarity measurements. Classifiers use the set of statistical data to find out the closest match. Neural Networks work like a brain. Our brain is combination of neurons to memorize the different activities of our life. In neural network these neurons are called nodes and for matching pattern the sequence of traversal through the nodes is very important. In neural network there are three kinds of nodes to perform different functions. (Input nodes, hidden and Output nodes) [10] as shown in figure.

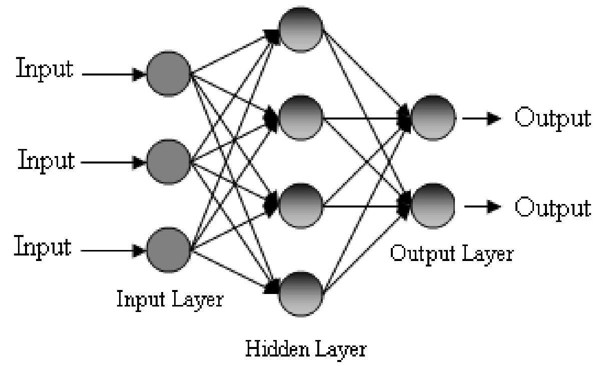

Figure 1: Neural Network System

iii. *Mahalanobis Distance* is a statistical distance measuring metric. This method is used to analyze the patterns on the bases of correlation between variables. This method work on unknown and known sample set to find out the similarities. Known set is the image database and unknown set is the query image. This method works with observation of more than one variable and the strength of their respective relationships. [10] [11]

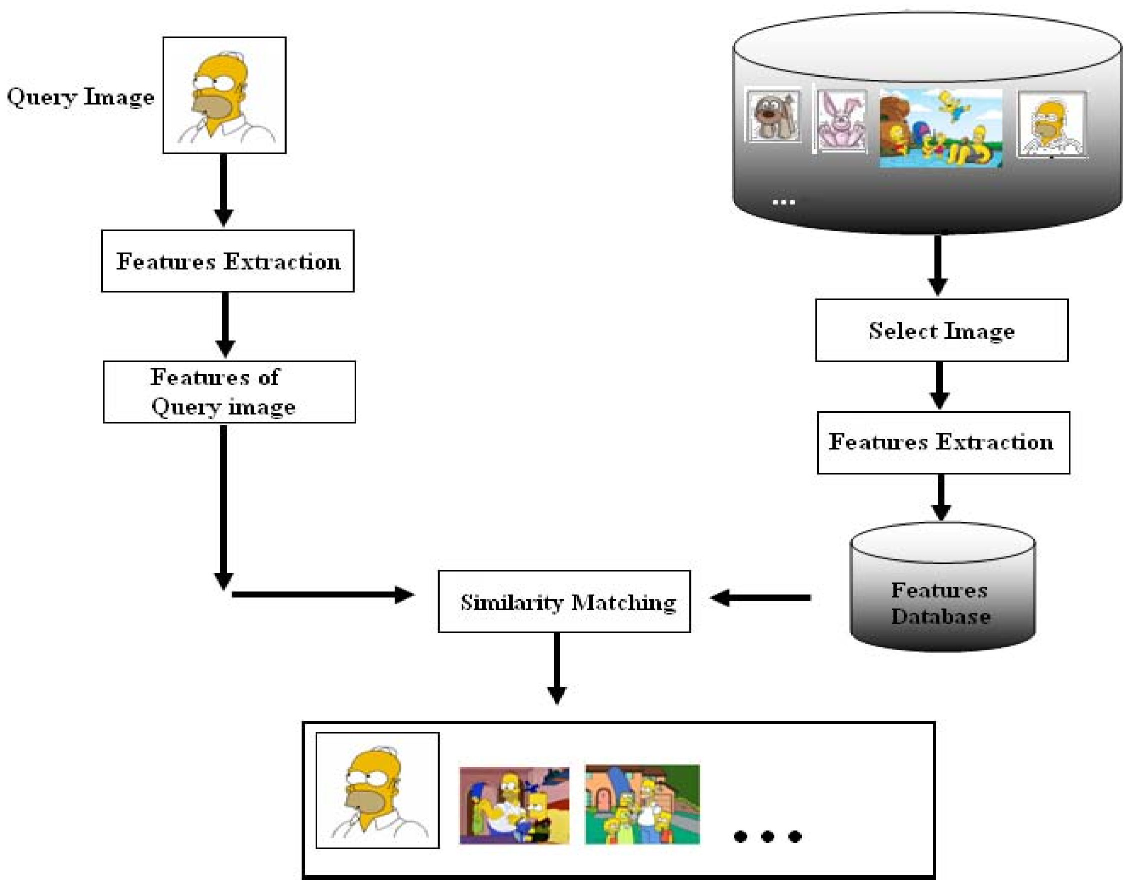

Figure 2 : Block Diagram of Content Base Image Retrieval system

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III. Proposed Work

a) First part

In the first part of proposed method a technique is choose which automatically performed the image querying and retrieval and also chooses the database (location) for those images and their histograms which are used for comparison with query image and their histogram. Once a database (location) is decided for images then collect images to fill up the database. For the completion of this step different websites are used to collect different type images to make a huge collection. After that image sizes were reduced in to 16 * 16 to achieve the less time consumption for processing of proposed method.

b) Image Quantization

This part of proposed method is related with quantization of color distribution into histogram to reduce the time and complexity of comparison of all colors between two images.

In this part the proposed method divided the different color axes into "bins" (some type of data). The total number of bins and their width is very important to achieve the right output. Total number of bins depends upon the size of three dimensional RGB models. For example for a three dimensional 8 * 8 * 8 histogram contain 512 bins, 16 *16 * 16 contains 4096 bins and 256 * 256 * 256 contains 1677716 bins. In figure a RGB three dimensional 8 * 8 * 8 histogram is shown.

After that color of each pixels were find out and its corresponding bin's count and as you know always considered to bin's count incremented by one.

In this part the histograms of all database images and query image were taken and saved.

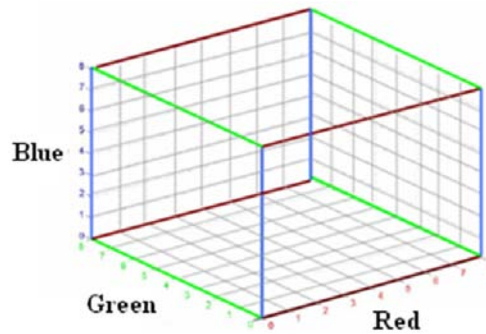
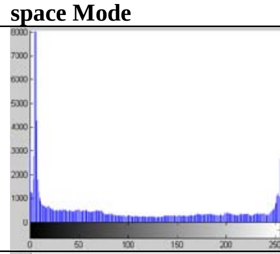
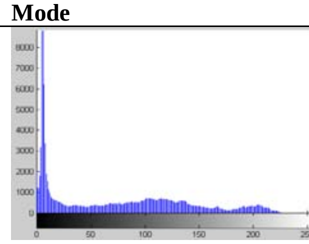
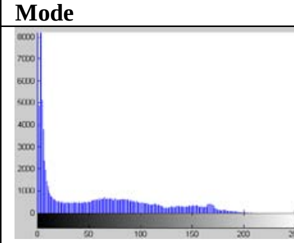
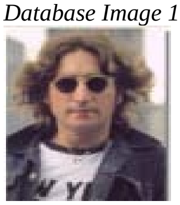
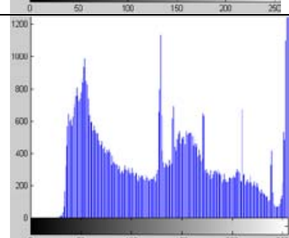
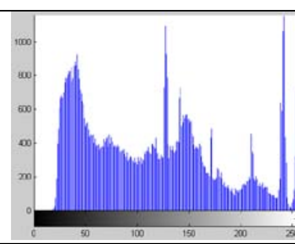
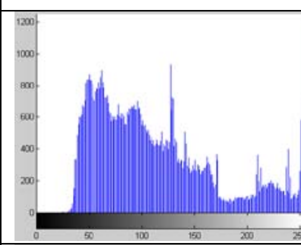
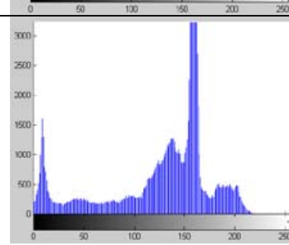
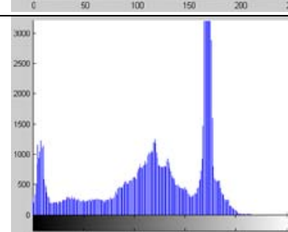
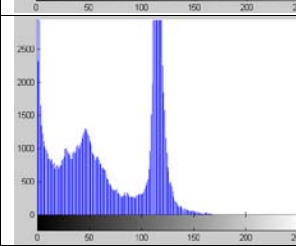
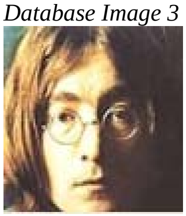
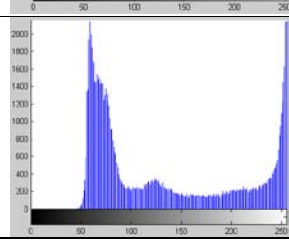
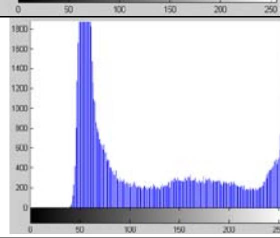
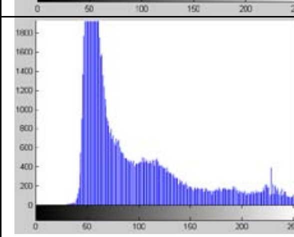


Figure 3 : Three Dimensional RGB Histogram (8*8*8)

Table 1 : Histograms of all Query Images and all Database Images

Images	Image Histogram in R space Mode	Image Histogram in G space Mode	Image Histogram in B space Mode
Query Image 			
Database Image 1 			
Database Image 2 			
Database Image 3 			
And So on …	…	…	…

c) Global Features Extraction

After taking histograms of all images the proposed method find out the global features of all images including query image in this part.

Global features are also known as texture features (Cross correlation, Color properties (color skew ness, color variance, color expectancy)).

Table.2 shows the global features of query image and database images.

d) Comparison Between Global Features Of Query Image And Database Images

In the previous part the global features of all images were extracted and stored in a table.

Now in this part the proposed method find out the matched images by taking comparison between global features of database images and query image. This comparison was not giving the accurate result just like a one step toward accuracy.

Table.2 shows this difference on the basis of global features.

Table 2 : Difference B/W Global Features (Color Variance, Color Expectancy, Color Skew Ness, Color Correlation) of Query Image And Database Images

Images	Color Variance	Color Expectancy	Color Skewness	Color Correlation
Query Image	23	45	88	25
Image 1	33	49	84	20
Image 2	45	45	82	26
Image 3	23	69	78	35
Image 4	23	65	88	34
Image 5	25	56	81	21
Image 6	27	65	83	23
Image 7	21	45	90	24
Image 8	18	45	92	26
Image 9	34	45	84	20
Image 10	76	34	82	26
Image 11	23	21	78	35
Image 12	34	34	88	34
Image 13	45	47	81	21
Image 14	67	78	83	23
Image 15	12	45	90	24
Image 16	23	46	92	26
Image 17	56	46	84	20
Image 18	56	45	82	26
Image 19	23	67	78	35
Image 20	23	56	89	34
Image 21	78	65	81	21
Image 22	34	45	83	23
Image 23	31	45	97	24
Image 24	33	45	76	26
Image 25	21	34	89	21
Image 26	22	21	85	23
Image 27	34	21	67	24
Image 28	22	34	89	26
Image 29	23	45	95	20
Image 30	23	45	71	26

e) Percentile Matching

After comparison of global features of images the proposed method now applied the percentile to achieve accuracy in output. Through match percentile the proposed method select those images which are nearest to the query image.

To find out match percentile two things are needed. One is the total number of images and second thing is the rank of retuned images.

Match Percentile = (Total number of images – Rank of returned images)/(Total number of images-1) (3)

The percentile is applied on each image of database. Table shows the percentile results of each image.

The proposed method considered only those images whose percentile is greater than or equal to 75%.

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Table 3 : Percentile results of images

Images	Color Variance (CV)	Color Expectancy (CE)	Color Skewness (CS)	Color Correlation (CC)	Total Percentile (TP)
Query Image	23	45	88	25	20
Image 1	33	49	84	20	22
Image 2	45	45	82	26	28
Image 3	23	69	78	35	30
Image 4	23	65	88	34	32
Image 5	25	56	81	21	34
Image 6	27	65	83	23	45
Image 7	21	45	90	24	78
Image 8	18	45	92	26	44
Image 9	34	45	84	20	67
Image 10	76	34	82	26	76
Image 11	23	21	78	35	66
Image 12	34	34	88	34	67
Image 13	45	47	81	21	22
Image 14	67	78	83	23	34
Image 15	12	45	90	24	54
Image 16	23	46	92	26	33
Image 17	56	46	84	20	35
Image 18	56	45	82	26	56
Image 19	23	67	78	35	25
Image 20	23	56	89	34	45
Image 21	78	65	81	21	23
Image 22	34	45	83	23	33
Image 23	31	45	97	24	45
Image 24	33	45	76	26	41
Image 25	21	34	89	21	46
Image 26	22	21	85	23	22
Image 27	34	21	67	24	23
Image 28	22	34	89	26	34
Image 29	23	45	95	20	44
Image 30	23	45	71	26	29

f) Comparison between Query image histogram and matched images histograms

This part of proposed method was only used to find out the exact output. In this part comparison between query image and matched database images were done only to find out the best matching results with the help of image's histogram comparison.

Table 4 : Shows the difference b/w matched images and query image

Images matched with Query image	Difference according Histogram
Image	88
Image	76
Image	78
Image	80
image	84

Mean difference of best matching result (image) or output should be zero or nearest to zero than others.

Table 5 : Shows the mean difference b/w query image and matched images.

Images matched with Query image	Mean difference
Image	35
Image	12
Image	34
Image	23
image	14

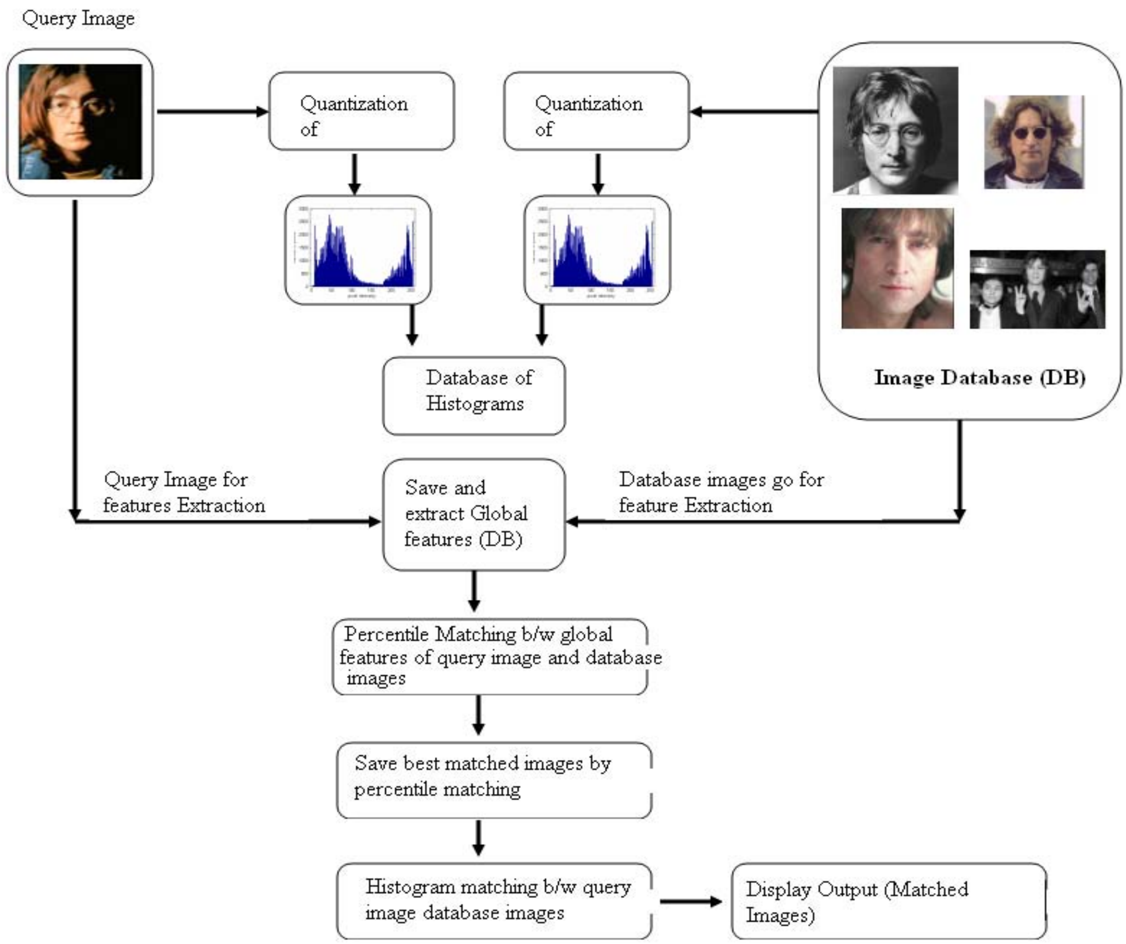

Figure 4 : Block Diagram of Proposed CBIR System

IV. Conclusion

Color Histogram is very helpful technique which works on the basis of color distribution of image. But one drawback of color histogram is that it only considers the color and not considers object's locations. Therefore for those images which have same colors distribution but image appearance (object's location) is not same not give the good results.

Hence to enhance the efficiency the proposed method used some other measurements (Global Features) of image and color histogram. By using this idea higher successful rate is obtained.

The drawback of color histogram is minimized by using global features of images.

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Enhanced Image Fusion Technique For Segmentation of Tumor Using Fuzzy C Means Cluster Segmentation

By Mohammed Rifaie Mohammed & Prof. E. Sreenivasa Reddy

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Abstract- This paper presents the MRI brain diagnosis support system for structure segmentation and its analysis using spatial fuzzy clustering algorithm. The method is proposed to segment normal tissues such as white Matter, Gray Matter, Cerebrospinal Fluid and abnormal tissue like tumor part from MR images automatically. These MR brain images are often corrupted with Intensity Inhomogeneity artifacts cause unwanted intensity variation due to non- uniformity in RF coils and noise due to thermal vibrations of electrons and ions and movement of objects during acquisition which may affect the performance of image processing techniques used for brain image analysis.

GJCST-F Classification: I.2.3 I.5.1

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Abstract- This paper presents the MRI brain diagnosis support system for structure segmentation and its analysis using spatial fuzzy clustering algorithm. The method is proposed to segment normal tissues such as white Matter, Gray Matter, Cerebrospinal Fluid and abnormal tissue like tumor part from MR images automatically. These MR brain images are often corrupted with Intensity Inhomogeneity artifacts cause unwanted intensity variation due to non- uniformity in RF coils and noise due to thermal vibrations of electrons and ions and movement of objects during acquisition which may affect the performance of image processing techniques used for brain image analysis. Due to this type of artifacts and noises, sometimes one type of normal tissue in MRI may be misclassified as other type of normal tissue and it leads to error during diagnosis. The proposed method consists of pre processing using wrapping based curvelet transform to remove noise and modified spatial fuzzy C Means segments normal tissues by considering spatial information because neighbouring pixels are highly correlated and also construct initial membership matrix randomly. The system also uses to segment the tumor cells along with this morphological filtering will be used to remove background noises for smoothening of region. The project results will be presented as segmented tissues with parameter evaluation to show algorithm efficiency.

I. Introduction

MRI images showed the brain structures, tumor's size and location. From the MRI images the information such as tumors location provided radiologists, an easy way to diagnose the tumor and plan the surgical approach for its removal. MRI's use radiofrequency and magnetic field to result image's human body without ionised radiations. Imaging plays a central role in the diagnosis of brain tumors. On MRI, they appear either hypo (darker than brain tissue) or iso tense (same intensity as brain tissue) on T1-weighted scans, or hyper intense (brighter than brain tissue) on T2-weighted MRI. In medical, doctors don't have method that can be used for brain tumor detection standardization which leads to varying conclusions between one doctor to another . Edge-based method is by far the most common method of detecting boundaries, discontinuities in an image and segmentation.

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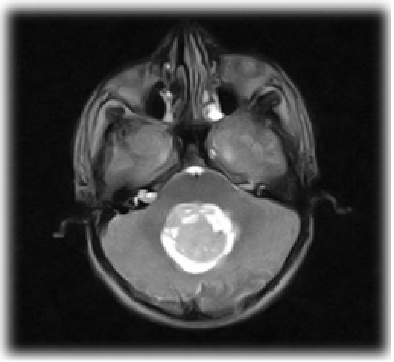

The parts on which immediate changes in grey tones occur in the images are called edges. Edge detection techniques transform images to edge images benefiting from the changes of grey tones in the images. As a result of this transformation, edge based brain segmentation image is obtained without encountering any changes in physical qualities of the main image. This image processing consist of image enhancement using histogram equalization, edge detection and segmentation process to take patterns of brain tumors, so the process of making computer aided diagnosis for brain tumor grading will be easier. With the advances in imaging technology, diagnostic imaging has become an indispensable tool in medicine today. X-ray angiography (XRA), magnetic resonance angiography (MRA), magnetic resonance imaging (MRI), computed tomography (CT), and other imaging modalities are heavily used in clinical practice. Such images provide complementary information about the patient. While increased size and volume in medical images required the automation of the diagnosis process, the latest advances in computer technology and reduced costs have made it possible to develop such systems.

II. Image Fusion

Multisensor Image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. Image fusion has become a common term used within medical diagnostics and treatment. The term is used when multiple images of a patient are registered and overlaid or merged to provide additional information. In radiology and radiation oncology, these images serve different purposes. For example, CT images are used more often to ascertain differences in tissue density while MRI images are typically used to diagnose brain tumors.

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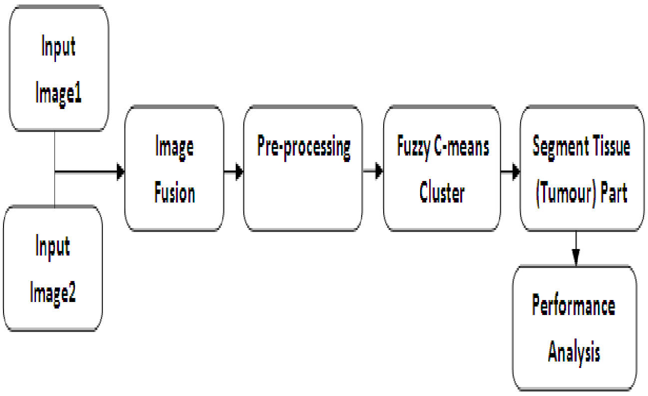
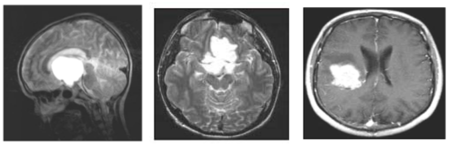


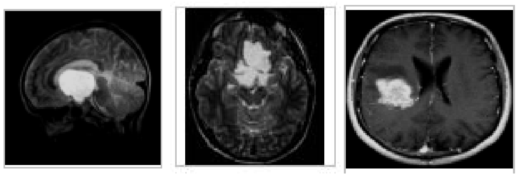
Figure : Block Diagram

a) CT Scan Image

Computed tomography (CT or CAT scan) is a noninvasive diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce horizontal, or axial, images (often called slices) of the body. A CT scan shows detailed images of any part of the body, including the bones, muscles, fat, and organs. CT scans are more detailed than standard X-rays.

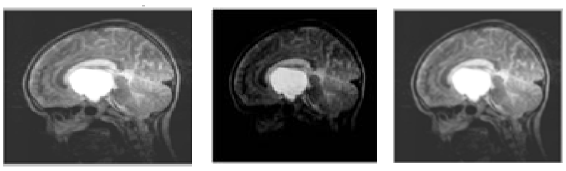


Magnetic resonance imaging (MRI) is a noninvasive medical test that helps physicians diagnose and treat medical conditions. MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. The images can then be examined on a computer monitor, transmitted electronically, printed or copied to a CD. MRI does not use ionizing radiation (x-rays).



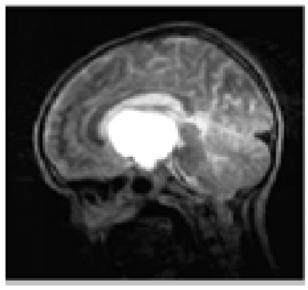
b) Image fusion is carried out in four steps

- Construct a pyramid transform for each source image.
- Compute match (M_{AB}) and saliency (S_A, S_B) measures for the source images at each pyramid sample position.
- Combine source pyramids to form a pyramid for the composite image.
- Recover the composite image through an inverse pyramid transform.



III. Preprocessing

Image restoration is the operation of taking a corrupted/noisy image and estimating the clean original image. Corruption may come in many forms such as motion blur, noise, and camera misfocus. Image restoration is different from image enhancement in that the latter is designed to emphasize features of the image that make the image more pleasing to the observer, but not necessarily to produce realistic data from a scientific point of view. Image enhancement techniques (like contrast stretching or de-blurring by a nearest neighbor procedure) provided by "Imaging packages" use no a priori model of the process that created the image. With image enhancement noise can be effectively be removed by sacrificing some resolution, but this is not acceptable in many applications. In a Fluorescence Microscope resolution in the z-direction is bad as it is. More advanced image processing techniques must be applied to recover the object. De-Convolution is an example of image restoration method. It is capable of: Increasing resolution, especially in the axial direction removing noise increasing contrast.

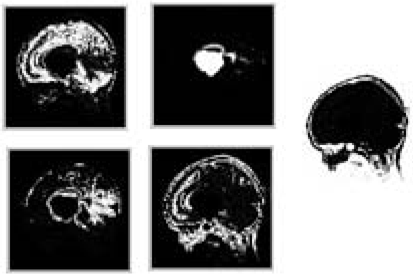


a) Fuzzy Clustering in Medical Fusion Image:-

In fuzzy clustering, every point has a degree of belonging to clusters, as in fuzzy logic, rather than belonging completely to just one cluster. Thus, points on the edge of a cluster, may be in the cluster to a lesser degree than points in the center of cluster. An overview and comparison of different fuzzy clustering algorithms is available. Any point x has a set of coefficients giving the degree of being in the kth cluster $w_k(x)$. With fuzzy c-means, the centroid of a cluster is the mean of all points, weighted by their degree of belonging to the cluster: The degree of belonging, $w_k(x)$, is related inversely to the distance from x to the cluster center as calculated on the previous pass. It also depends on a parameter m that controls how much weight is given to the closest center.

b) The fuzzy c-means algorithm is very similar to the k-means algorithm:

- Choose a number of clusters.
- Assign randomly to each point coefficients for being in the clusters.
- Repeat until the algorithm has converged (that is, the coefficients' change between two iterations is no more than ,the given sensitivity threshold)
- Compute the centroid for each cluster.
- For each point, compute its coefficients of being in the clusters.



The algorithm minimizes intra-cluster variance as well, but has the same problems as k-means; the minimum is a local minimum, and the results depend on the initial choice of weights. Using a mixture of Gaussians along with the expectation-maximization algorithm is a more statistically formalized method which includes some of these ideas: partial membership in classes.

c) Quantitative Result Of PSNR

Number of tumor cluster	Area in mm^2	MSE	Processing time for Cmeans	PSNR
2	14.0467	0.1589	7.1678	56.1190
4	19.5342	4.7302e-04	6.7529	81.3820
2	12.6224	0.0583	5.6700	60.4738

Z Noise (%)	Artifact (%)	Noisy Image	Denoised Image PSNR (dB)
1	20	28.6387	37.0348
1	20	28.3089	36.8780

IV. Result Analysis

To each cluster by means of a Membership Function, which represents the fuzzy behaviour of this algorithm. To do that, we simply have to build an appropriate matrix named U whose factors are numbers between 0 and 1, and represent the degree of membership between data and centers of clusters.

a) Conclusions and Future Work

In conclusion, image fusion techniques in terms of medical image modalities and organs of study have been discussed in this survey. The extensive developments in medical image fusion research summarized in this literature review indicate the importance of this research in improving the medical services such as diagnosis, monitoring and analysis. The FCM algorithm uses reciprocal distance to compute the fuzzy weights. When a feature vector is of equal distance from two cluster centers, it weights the same on the two clusters no matter what is the distribution of the clusters. It cannot differentiate the two clusters with different distributions of feature vectors. Therefore, the FCM algorithm is more suited to data that is more or less evenly distributed around the cluster centers. The FCM algorithm lumps the two clusters with natural shapes but close boundaries into a large cluster. For some difficult data such as WBCD data, it is hard to for the FCM to cluster the very closed classes together without the help of other mechanisms such as elimination of small clusters. The FCFM algorithm uses Gaussian weights, which are most representative and immune to outliers. Gaussian weights reflect the distribution of the feature vectors in the clusters. For a feature vector with equal distance from two prototypes, it weighs more on the widely distributed cluster than on the narrowly distributed cluster.

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Seismic Data Compression using Wave Atom Transform

By Subba Reddy Borra, G. Jagadeeswar Reddy & E.Sreenivasa Reddy
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GJCST-F Classification: I.5.4

SEISMICDATACOMPRESSIONUSINGWAVEATOMTRANSFORM

Strictly as per the compliance and regulations of:

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Subba Reddy Borra [α], G. Jagadeeswar Reddy [σ] & E.Sreenivasa Reddy [ρ]

Abstract- Seismic data compression (SDC) is crucially, confronted in the oil Industry with large data volumes and Incomplete data measurements. In this research, we present a comprehensive method of exploiting wave packets to perform seismic data compression .Wave atoms are the modern addition to the collection of mathematical transforms for harmonic computational analysis. Wave atoms are variant of 2D wavelet packets that keep an isotropic aspect ratio. Wave atoms have a spiky frequency localization that cannot be attained using a filter bank based on wavelet packets and offer a significantly sparser expansion for oscillatory functions than wavelets ,curvelets and Gabor atoms .Wave atoms capture the coherence of patterns across and along oscillations where as curvelets capture coherence along oscillations only. Wave atoms precisely interpolate between Gabor atoms and (constant support) and directional wavelets (wavelength ~ diameter) in the sense that the period of oscillations of each wave packet (wavelength) is related to the size of essential support by parabolic scaling law. Wave atom transform achieves the best result by some numerical examples.

Keywords: seismic data compression (SDC), curvelets, wavelets, wave atom.

I. Introduction

Modern seismic surveys with higher accuracy memorization that led to ever increasing amounts of seismic data [1and 2]. Management of these large datasets becomes important for transmission, storage processing and Interpretation. To make the storage more efficient and to reduce the broadcast and cost, many seismic data compression (SDC) algorithms have been developed. During the oil and gas exploration process, the main strategy used by the companies is the construction of sub surface images, which are used both to identify the reservoirs and also to plan the hydrocarbons distillation .The construction of those images begins with seismic survey that produces a huge amount of seismic data. Then, obtained data is transmitted to the processing center generate the subsurface image.

A typical seismic survey can produce hundreds of terabytes of data. Compression algorithms are subsequently desirable to make the storage more effective, and to reduce time and costs related to network and satellite broadcast. Multi-resolution methods are genuinely associated to image processing, biological, computer Vision and systematic computing. The curvelet transform is a multiscale directional transform that permits almost best non-adaptive sparse representation of objects with edges. It has generated enhancing importance in the community of applied mathematics and signal processing over the years. A review on the curvelet transform includes its history beginning from wavelets, its logical relationship to other multi resolution multidirectional methods like contourlets and shearlets, its basic theory and discrete algorithm. Further, we agree recent applications in video/image processing, seismic exploration, fluid mechanics, imitation of partial different equations, and compressed sensing [3].

For seismic data compression(SDC) ,the most important consideration is how to represent seismic signals efficiently ,that is to say ,using few coefficients to faith fully represent the signals ,and therefore preserve the useful information after maximally possible compression .It is easy to comprehend that compression effectiveness is used for different expansion bases. Many orthogonal transforms have been used for data compression .Discrete Fourier Transform (DCT) was the first generation orthogonal transform used in Data compression. Haar Transform use of rectangular basis functions .Slant Transform is an attempt to match basis vectors to the areas stable luminance slope. It has better decor relation efficiency .Discrete cosine Transform is one of the extensive families of sinusoidal transforms. The mainly efficient transform for decor relating input data is the Karhunen loeve Transform also known as Hotelling transform and Eigenvector transform [4].

Curvelets as a multi-scale, anisotropic multi-dimensional transform were introduced, very quickly to be used for seismic data processing and migration using a mapping migration method .Curvelets can build the local slopes information into the representation of the seismic data, and which was proved to be effective in the sparse decomposition of seismic data.

For example, wavelet [5 and 6] based compression algorithm can represent seismic data using only a fraction of the original data size. In this paper, Wave atom transform presents its advantage

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over wavelets, curve lets[7] for conventional image compression .Their features are well suited to seismic data properties and have led to better results in terms of signal –to –noise ratio. Wave atoms come from the property that they also provide an optimally sparse representation of wave propagators, a mathematical effect of autonomous interest, with applications to fast numerical solvers for wave equations.

II. Image Compression – Transforms

a) *Wavelets*

During the last decade the appearance of many transforms called Geometric wavelets have paying attention of researchers working on image analysis. These novel transforms propose a new representation comfortable than the traditional wavelets multi-scale representation .We are responsive that for a particular type of images ,we can do better by choosing for this kind of specific images, a more suitable tool than classical wavelets[8,9 and10].

The orthogonal transforms have been broadly studied and used in image analysis and processing. To defeat the limitations of Fourier analysis many extra orthogonal transforms have been developed .The most important criteria to be fulfilled by the basis functions are localization in equally space and spatially frequency and orthogonality. Various efficient and sophisticated wavelet-based schemes have been developed. In Image compression, the use of orthogonal transform is dual. Primary, it décorrelates the image components and allows to identify the redundancy .Subsequent, it offers a high level of compression of the energy in the spatial frequency domain .These two properties permit to select the most related components of the signal in order to accomplish competent compression. Many orthogonal transforms possess these three characteristics and have been used for data compression.

Wavelets are much modified to isotropic structure; they are not modified for anisotropic structure. This transform cannot effectively represent textures and exceptional details in images for lacking of directionality. 2D wavelet transforms produce high energy coefficients along the contours[11 and 12]. To overcome this limitation, a few solutions have been proposed . A first solution consists in using directional filter banks tuned at fixed scales, orientations and positions. Another solution is exploit an adaptive directional filtering based on a numerical model. So, two important approaches fixed and adaptive have been developed. Figure. 1. shows difficulties of wavelet transform to represent regularity of a contour compared to new multi-scale transformed where geometric anisotropy and rotations are taken into description.

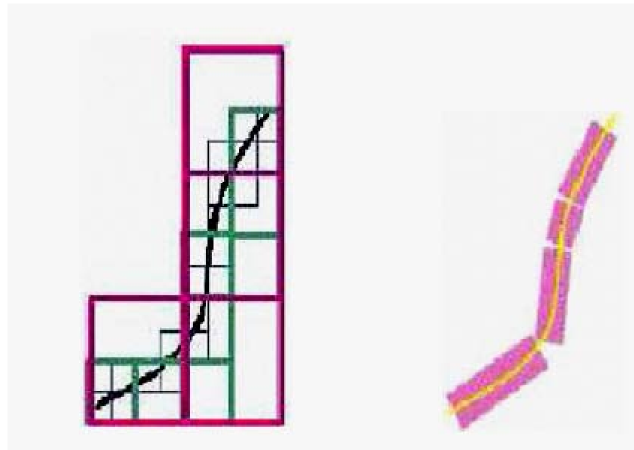

Figure 1 : Comparison between wavelet and adapted transform

b) *Ridgelets and Curvelets*

Ridgelet transform [13 and 14] have been developed to analyze objects whose significant information is concentrated approximately linear discontinuities such as lines. Ridgelet coefficients are obtained by a One Dimensional wavelet transform of all projections of the image resulting from Radon Transform .Ridgelet transform is that wavelet analysis on One Dimensional slices of the Radon Transform, where the angle is fixed.

Continuous Ridgelet Transform is defined as

$$Rf(a,\theta,b) = \iint f(x_{1,}x_2)\psi_{a,\theta,b}(x_1,x_2)dx_1dx_2 \qquad (1)$$

Where $\psi_{a,\theta,b} = a^{-1/2}\psi((x_1 * \cos(\theta) + x_2 * \sin(\theta) - b)/2)$ is a One Dimensional Wavelet.

Ridgelets are expressed through Radon Transform as:

$$Rf(a,\theta,b) = \int Rf(r,\theta)a^{-1/2}\psi(t-b)/a\ dt \qquad (2)$$

Where R f is Radon transform defined by

$$Rf(t,\theta) = \int f(x_1,x_2)\delta(-x_1\sin\theta + x_2\cos\theta - t)dx_1dx_2 \qquad (3)$$

A curvelet is defined as function $x = f(x_1,x_2)$ at the scale 2^{-j}, orientation θ_l and position $x_k^{(j,l)} = R_{\theta,l}^{-1}(k_1 2^{-j}, k_2 2^{-j/2})$ *by:*

$$c(j,l,k) = \langle f, \theta_j, l, k \rangle = \int_{R2} f(x)\varphi_{i,l,k}(x)dX \qquad (4)$$

Curve let computation steps:

Step 1: Decomposition into sub bands
Step 2: Partitioning
Step: Ridgelet analysis(Radon Transform + Wavelet transform 1D)
Block size can change from a sub band to another one; the following algorithm will be applied

Step 1: Apply a wavelet transform (J sub bands).

Step 2: Initialize the block size: $B_{min} = B_j$.

Step 3: For j=1, -----, J do

Step 4: Partition the sub bands W_j in blocks B_j .

Step 5: if (J modulo 2=1) then $B_{j+1} = 2B_j$ otherwise $B_{j+1} = B_j$

Step 6: Apply Ridgelet transform to each block.

Figure. 2. Shows the curve let tiling in space and frequency domains

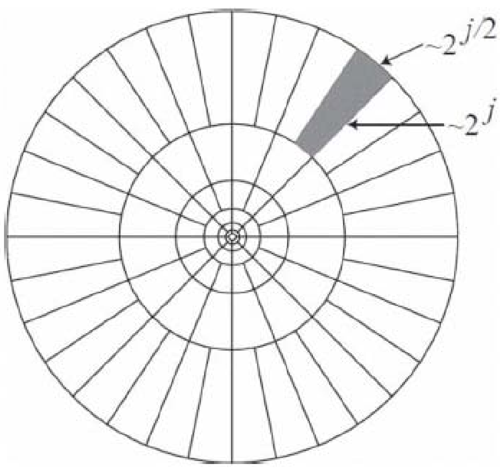

Figure 2 : Curvelet tiling in space and frequency domains.

c) Wave atoms

In the standard wavelet transform, only the estimate is decomposed, when, we pass from phase to another. While in the wavelet packets, the decomposition could be pursued into the other sets, which is not optimal .The optimality is linked to the greatest energy of decomposition. The notion is then to fetch for the way yielding to the maximum energy through the different sub bands.

Wave atom [15] is a novel member in the family of oriented, multiscale transforms for image processing and also numerical analysis. For the sake of completeness, we remember here some fundamentals notations following

$$\hat{f}(\omega) = \int e^{-ix\omega} f(x)dx \qquad (5)$$

$$f(x) = \frac{1}{(2\pi)^2} \int e^{ix\omega} \hat{f}(\omega)d\omega \qquad (6)$$

Wave atoms are noted as, with subscript. The indexes are integer -valued related to a point in the phase-space defined as follows. $x_\mu = 2^{-j}n, \omega_\mu = \pi 2^j m$ $C_1 2^j \leq \max_{i=1,2}|m_i| \leq C_2 2^j$, they suggest two parameters are enough to index a lot of known wave packet architectures. The index indicates whether the decomposition is multi scale (α=1) or not (α=0); and β indicates whether basis elements are localized and poorly directional (β=1) or, on the opposite side extended and fully directional (β=0)[16,17 and18].

We think that the description in terms of α and β will clarify the connections between various transforms of modern harmonic analysis. Wavelets correspond to α=β=1, for ridge lets α=1, β=0[19 and 20], Gabor transform α=β=0 and curvelets correspond to α=1,β=1/2. Wave atoms are defined for α=β=1/2. Figure. 3. Illustrates this classification

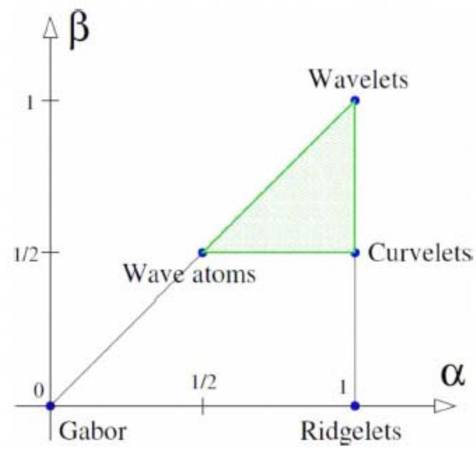

Figure 3 : (α β) diagram

In order to introduce the wave atom, let us first consider the 1D case .In practice, wave atoms are constructed from tensor products of adequately chosen 1D wavelet packets. A one-dimensional family of real - valued wave packets $\psi^j_{m,n}(x), j \geq 0, m \geq 0, n \in Z$, centered in frequency around $\pm\omega_{j,m} = \pm\pi 2^j m$, with $C_1 2^j \leq \max_{i=1,2}|m_i| \leq C_2 2^j$ and centered in space around $x_{j,n} = 2^{-j}n.$, is constructed. The one dimensional version of the parabolic scaling inform that the support of $\psi^j_{m,n}(\omega)$ be of length O (2^{2j}), while $\omega_{j,m} = O(2^{2j})$. The desired corresponding tiling of frequency is illustrated at Figure. 4. Filter bank-based wavelet packets is considered as a potential definition of an orthonormal basis satisfying these localization properties. The wavelet packet tree, defining the partitioning of the frequency axis in 1D, depth j when the frequency is 2^{2j}, as shown in Figure. 4.

Figure. 4.Presents the wavelet packet tree corresponding to wave atoms. The bottom graph depicts Villemoes wavelet packets [20 and 21] on the positive frequency axis. The dot below the axis indicates a frequency where a change of scale occurs .The labels "LH" and "RH" indicates that left-handed and right-handed window respectively

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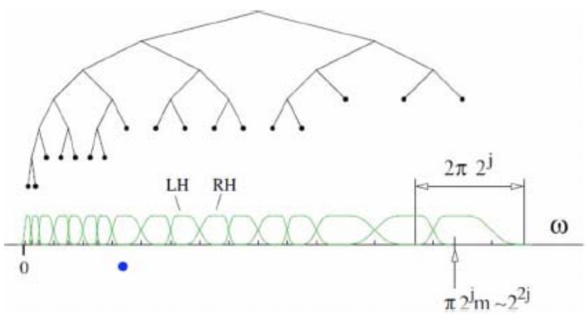

Figure 4 : Wavelet packet tree corresponding to wave atoms

In 2D domain the construction presented above can be modified to certain applications in image processing or numerical analysis: The orthobasis variant. [22,23 and24]. A two-dimensional orthonormal basis function in frequency plane with four bumps is formed by individually taking products of 1D wave packets .Mathematical formulation and implementations for 1D case are detailed in the earlier section.2D wave atoms are indexed by μ=(j,m,n), where m=(m_1,m_2) and n=(n_1,n_2). creation is not a simple tensor product since there is only one scale subscript j .This is similar to the non-standard or multi-resolution analysis wavelet bases where the point is to enforce same scale in both directions in order to retain an isotropic aspect ratio.

$$\varphi_{\mu}^{+}(x_1, x_2) = \psi_{m1}^{j}(x_1 - 2^{-j} n_1)\ \psi_{m2}^{j}(x_2 - 2^{-j} n_2). \quad (7)$$

The Fourier transform of (7) is separable and its dual orthonormal basis is defined by Hilbert transformed [25] wavelet packets in (9)

$$\hat{\varphi}_{\mu}^{+}(\omega_1, \omega_2) = \hat{\psi}_{m1}^{j}(\omega_1) e^{-i2^{-j} n_1 \omega_1}\ \hat{\psi}_{m2}^{j}(\omega_2) e^{-i2^{-j} n_2 \omega_2} \quad (8)$$

$$\varphi_{\mu}^{-}(x_1, x_2) = H\psi_{m1}^{j}(x_1 - 2^{-j} n_1)\ H\psi_{m2}^{j}(x_2 - 2^{-j} n_2). \quad (9)$$

Combination of (8) and (9) provides basis functions with two bumps in the frequency plane, symmetric with respect to the origin and thus directional wave packets oscillating in a single direction are generated.

$$\varphi_{\mu}^{(1)} = \frac{\varphi_{\mu}^{+} + \varphi_{\mu}^{-}}{2},\ \varphi_{\mu}^{(2)} = \frac{\varphi_{\mu}^{+} - \varphi_{\mu}^{-}}{2} \quad (10)$$

Together form the wave atom frame and are jointly denoted by $\varphi\mu$. Wave atom algorithm is based on the apparent generalization and its complexity is O (N^2 LogN).

In practice, one may want to work with the original orthonormal basis $\varphi_{\mu}^{+}(x)$ instead of tight frame. Since $\varphi_{\mu}^{+}(x) = \varphi_{\mu}^{1}(x) + \varphi_{\mu}^{+2}(x)$ each basis function $\varphi_{\mu}^{+}(x)$ oscillates in two distinct directions, instead of one. This is called the orthobasis variant.

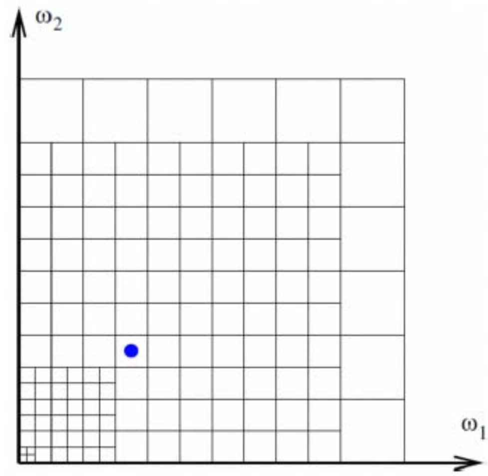

Figure 5 : Wave atom tiling of the frequency plane

Figure. 5. Represents the wave atom tiling frequency plane. The size of the squares doubles when the scale j increases by one .At a given scale j, squares are indexed by m1, m2 opening from zero near the axis.

In practice, the algorithm for wave atoms [26, 27, 28 and 29] is based on the obvious generalization of the 1D wrapping strategy to two -dimensions -except for slight complication. The admissible tiling's of the frequency plane at scale j are restricted by

$$\max_{i=1.2} |m_i| = 4n_j + 1 \quad (11)$$

For some integer n_j depends on j. we check that this property holds with $n_0 = 0, n_1 = 1$ and $n_2 = 2.$ The rationale for this restriction is that a window needs to be right-handed in both directions near a scale doubling ,and that this parity needs to match with the rest of the lattice .The rule is that $\hat{\varphi}_{m,+}^{j}$ is right -handed for m odd and left-handed for m even, so for instance $\hat{\psi}_2^2(\omega_1)\ \hat{\psi}_2^2(\omega_2)$ would not be admissible window near a scale doubling, where as $\psi_3^2(x_1)\ \psi_3^2(x_2)$ is admissible (by a dot in Figure. 5.).

III. Results and Discussion

This section demonstrates some numerical examples to explain the properties and potential of the wave atom frame and its ortho basis variation.

Now we illustrate the potential of the wave atoms with example. In the example, we consider the compression properties, i.e the decay rate of the coefficients of images under the wave atom bases. Besides the wave atom orthobasis and the wave atom frame, we include other two bases for comparison: the daubechies db5 wavelet, and a wavelet packet that uses db5 filter and shares the same wavelet packet tree with our wave atom or thobasis.

The quality of reconstructed image is usually specified in terms of peak signal to noise ratio (PSNR).

The PSNR values were calculated using the following expression:

$$psnr = 20\log 10 \frac{M_1 \times M_2 \times \max(f(i,j))}{\sum_{i=1}^{M_1}\sum_{j=1}^{M_2}[f(i,j)-f^{'}(i,j)]^2} dB \quad (12)$$

Here M1 and M2 are the size of the image. f (i,j) is the Original image, f′(i,j) is the decompressed image.

Table 1 : PSNR of wavelet, curvelet and wave atom

S.no.	No. of coefficients used for decompression	PSNR of decompressed image in dB		
		wavelet	*curvelet*	*waveatom*
1	5536	38.6992	38.0497	42.9066
2	6536	39.2739	38.5499	43.5110
3	7536	39.8192	39.0153	44.0314
4	8536	40.3407	39.4428	44.4903
5	9536	40.8406	39.8336	44.9026

Table 2 : Compression Ratio comparison of wavelet, curvelet and wave atom

S.no.	No. of coefficients used for decompression	Compression ratio		
		wavelet	*curvelet*	*waveatom*
1	5536	47	342	94
2	6536	43	311	86
3	7536	39	285	78
4	8536	36	262	72
5	9536	33	242	67

Table 3 : Execution time comparison of wavelet, curvelet and wave atom

S.no.	No. of coefficients used for decompression	Execution time in seconds		
		wavelet	*curvelet*	*waveatom*
1	5536	0.484	4.902	0.929
2	6536	0.491	8.334	3.260
3	7536	0.756	9.612	3.384
4	8536	0.178	2.907	1.413
5	9536	0.272	3.174	0.930

From Table 1, we note that PSNR of waveatom Decompressed image is high for any no of coefficients used for reconstruction. From Table 2, it is observed that, curvelet representation has more redundant data compared to waveatoms and wavelets. Table 3 shows that, execution time required is less in case of wavelets compared to waveatoms and curvelets. Hence waveatom is the best alternative of the other two techniques.

Figure. 6, 7, 8 and 9 show input image ,wavelet reconstruction, curvelet reconstruction and wave atom reconstruction respectively and Figure . 10 and 11 show graphical representation of PSNR vs. No. of coefficients used for reconstruction and PSNR vs. compression ratio respectively for the three considered compression techniques. It is observed from the below figures, that waveatom compression technique outperforms than wavelet and curvelet techniques.

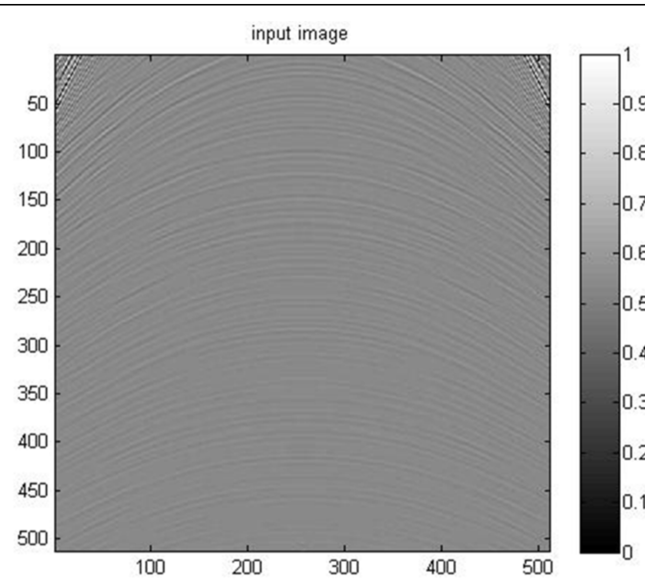

Figure 6 : Input Image

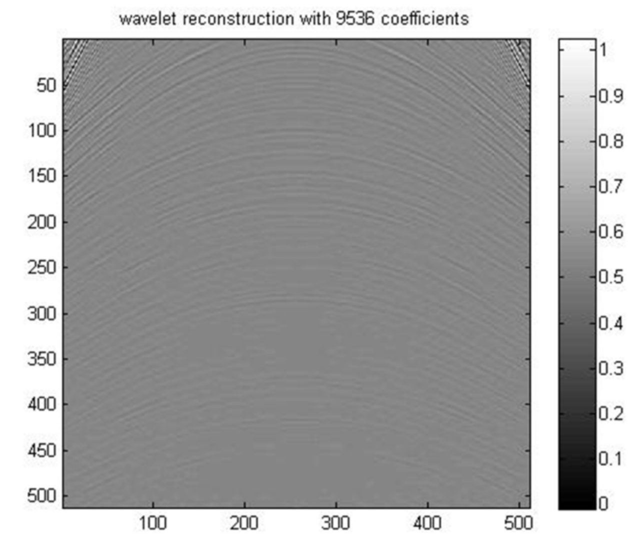

Figure 7 : Wavelet reconstruction

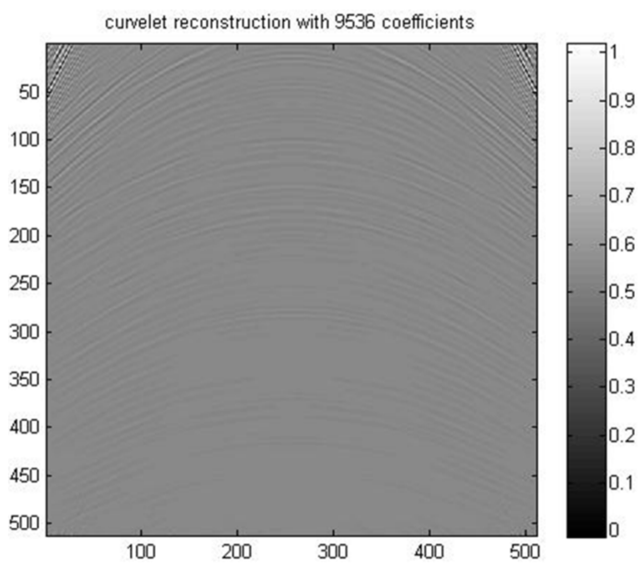

Figure 8 : Curvelet reconstruction

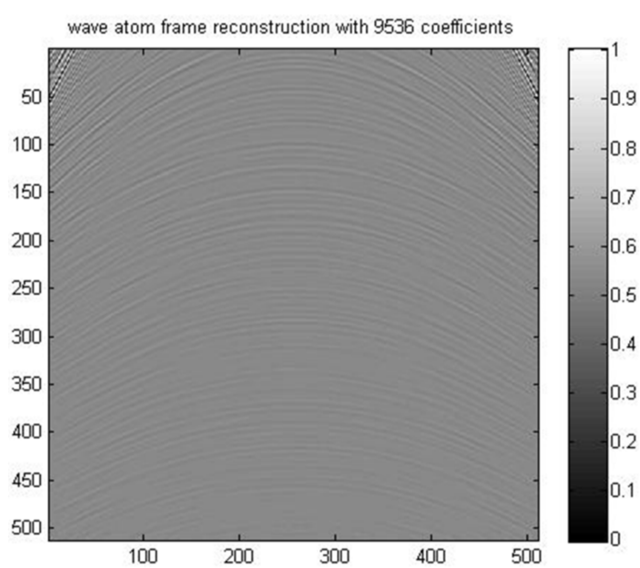

Figure 9 : Wave atom reconstruction

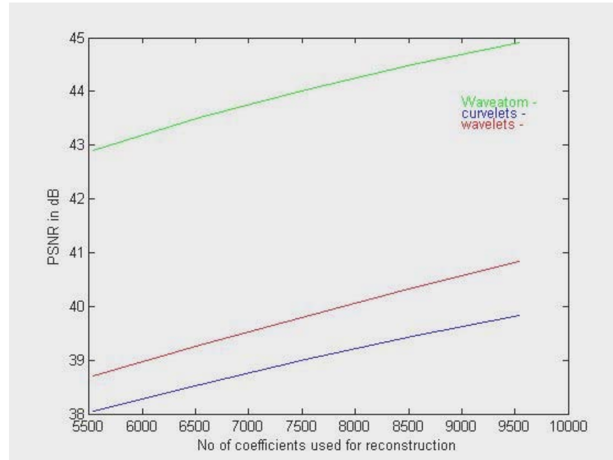

Figure 10 : PSNR vs. No. of coefficients used for reconstruction

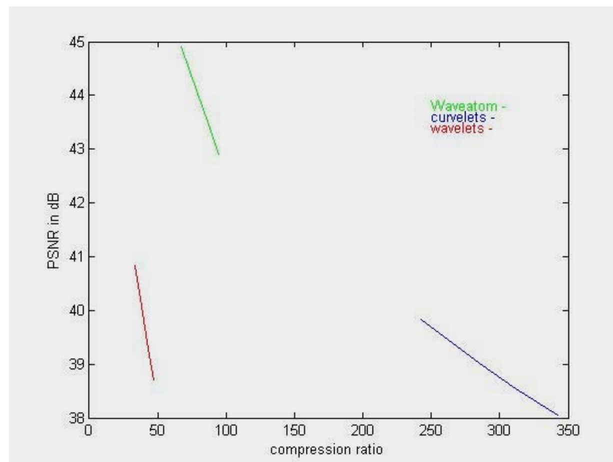

Figure 11 : PSNR vs. Compression Ratio

IV. Conclusions

We have shown that for a seismic data images, we can find a transform that is more appropriate than Curvelets and wavelets. Using Wave atom transform we obtained better PSNR and Compression Ratio than other transforms.

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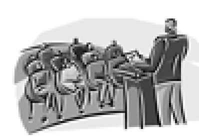

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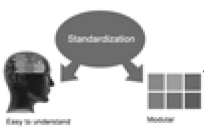

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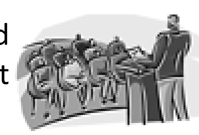

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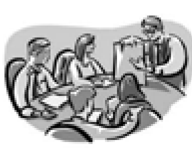

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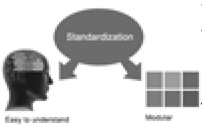

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Informal Guidelines of Research Paper Writing

Key points to remember:

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

Final Points:

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

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

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

General style:

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

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

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

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

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

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

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

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

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

Abstract:

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

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

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

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

Approach:

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

Introduction:

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

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

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

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

Materials:

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

Methods:

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

Approach:

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

What to keep away from

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

Results:

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

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

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
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- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

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

Figures and tables

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

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

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
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- Submit to generally acknowledged facts and main beliefs in present tense.

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

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