

**CONTENT-BASED IMAGE RETRIEVAL USING
ENHANCED LOCAL TETRA PATTERNS**

KAVITHA .K

10PCA07

**A Project Report submitted to Avinashilingam Deemed
University for Women, Coimbatore in partial fulfillment of the
requirements for the Master's Degree in Computer Applications**

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**SIGNATURE OF THE
HEAD OF THE DEPARTMENT**

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ACKNOWLEDGEMENT

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ABSTRACT



ABSTRACT

The project entitled “**CONTENT-BASED IMAGE RETRIEVAL USING ENHANCED LOCAL TETRA PATTERNS**” is an efficient image indexing and retrieval problem for content-based image retrieval (CBIR) in Image Processing. Retrieving images from the huge Database by its name is highly difficult, so based on the content of the query image the process is done. Local Tetra Patterns (LTrPs) encode the relationship between the referenced pixel and its neighbors, based on the vertical (90°) and horizontal (0°) directions of the center pixel (g_c). The proposed method Enhanced Local Tetra Patterns (ELTrPs) includes the diagonal pixels (45°) directions with vertical (90°) and horizontal (0°) directions for derivative calculations. Initially, the first-order derivative is calculated and the direction is found for each center pixel. Likewise, for the directions the second-order derivative is applied to get 8-bit tetra pattern. Then, the tetra patterns for each direction are converted to binary patterns. And magnitude pattern is generated for the center pixel with the corresponding neighbor pixels magnitude difference. Later, histograms values for both binary and magnitude patterns are found for constructing the feature vector. Finally, query image feature vector and the database image feature vector are compared and the images are retrieved based on the best matches. Feature vector is obtained for query image and database images and the retrieval process is done. The performance of the proposed method is compared with the Local Tetra Patterns and Enhanced Local Tetra Patterns based on the results obtained using benchmark image databases viz., Corel 1000 database, and performance analysis shows that the proposed method improves the retrieval result measured in terms of precision, recall, and accuracy.

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INTRODUCTION



1. INTRODUCTION

The Content-Based Image Retrieval (CBIR) seems to have originated in 1992, when it was used by Ref[6] to describe experiments into automatic retrieval of images from a database, based on the colors and shapes present. Since the term has been used to describe the process of retrieving desired images from a large collection on the basis of syntactical image features. According to Ref[9] the techniques, tools and algorithms that are used originate from fields such as statistics, pattern recognition, signal processing, and computer vision. Content-based image retrieval (CBIR), also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR) is the application of the vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases.

Content-based means that the search will analyze the actual contents of the image rather than the metadata such as keywords, tags, and descriptions associated with the image. The term 'content' in this context might refer to colors, shapes, textures, or any other information that can be derived from the image itself. CBIR is desirable because most web based image search engines rely purely on metadata and this produces a lot of garbage in the results. Also having humans manually enter keywords for images in a large database can be inefficient, expensive and may not capture every keyword that describes the image. Thus a system that can filter images based on their content would provide better indexing and return more accurate results.

Content Based Image Retrieval (CBIR) is an automatic process to search relevant images based on user input. The input could be parameters, sketches or example images. A typical CBIR process first extracts the image features and store them efficiently. Then it compares with images from the database and returns the results.

1.1.1 Applications

Some software producers are trying to push CBIR based applications into the filtering and law enforcement markets for the purpose of identifying and censoring images with skin-tones and shapes that could indicate the presence of nudity, with controversial results.

Potential uses for CBIR include:

- Art collections
- Photograph archives
- Retail catalogs
- Medical diagnosis
- Geographical information and remote sensing systems.

1.1 PROBLEM DEFINITION

Problem is to retrieve n best images from the database that resembles the query image. Enhanced Local Tetra Patterns describes the spatial structure of the local texture using the direction of the center gray pixel. The method goes with two levels of derivative i.e., First-order and second-order derivative. First-order derivative find the direction of center pixel and corresponding neighbor pixel. In next level second-order derivative is calculated for the first order. The whole image is represented by building a histogram and by using similarity distance metric images are retrieved.

1.2 OVERVIEW OF THE PROJECT

Due to the Explosive growth of digital libraries due to Web cameras, digital cameras, and mobile phones equipped with such devices is making the database management by human annotation an extremely tedious and clumsy task. Thus, there exists a dire need for developing an efficient expert technique that can automatically search the desired image from the huge database.

Content-based image retrieval is one of the commonly adopted solutions for such applications. The feature extraction in CBIR is a prominent step whose effectiveness depends upon the method adopted for extracting features from given images. The CBIR utilizes visual contents of an image such as color, texture, shape, faces, spatial layout, etc., To represent and index the image database. These features can be further classified as general features such as color, texture, and shape, and domain-specific features such as human faces, fingerprints, etc. The difficulty to find a single best representation of an image for all perceptual subjectivity is due to the fact that the user may take photographs in different conditions such as view angle, illumination changes, etc. Texture analysis Ref[1] has been extensively used in computer vision and pattern recognition applications due to its potential in extracting the prominent features. Texture retrieval Ref[2] is a branch of texture analysis that has attracted wide attention from industries since this is well suited for the identification of products such as ceramic tiles, marble, parquet slabs, etc. Here, Retrieval process is based on image's pixel directions and derivatives using Enhanced Local Tetra Patterns. The standard local binary pattern Ref[10] and local ternary pattern Ref[13] encode the relationship between the referenced pixel and its surrounding neighbors by computing gray-level difference. Local Tetra Patterns Ref[12] encodes the relationship between the referenced pixel and its neighbors, based on the directions and derivatives.

SYSTEM CONFIGURATION



2. SYSTEM CONFIGURATION

This section describes the hardware and software specification used for both development and implementation phases of this project.

2.1 HARDWARE SPECIFICATION

Processor	:	Intel® Core(TM) 2 Duo
Processor Speed	:	2.80GHz
Hard Disk	:	80GB
Floppy Disk Drive	:	1.44MB
RAM	:	512MB
Keyboard	:	104 Keys
Mouse	:	Logitech
Monitor	:	14 inch HCL Color Monitor

2.2 SOFTWARE SPECIFICATION

Tool	:	MATLAB Version 7.11.0(R2010b)
Operating System	:	Microsoft Windows XP

2.3 ABOUT THE SOFTWARE

2.3.1 MATLAB:

MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Stimulant, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems.

It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or Fortran.

The name MATLAB stands for matrix laboratory. MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

Main Features of MATLAB

MATLAB stands for matrix laboratory. The features of MATLAB are very similar to C++. The application MATLAB is totally developed by using the MATLAB programming language. There is a special MATLAB editor in which you are supposed to type your programs. It is also very simple to execute a MATLAB program. There is a simple code which you have to type in the prompt, >>. This is done in the Command Window. The following points give you a better picture of the features of MATLAB.

- The computations which are done in matrix and vector calculus are very efficient and accurate.
- For the usage of graphics, it is easy to create them. Graphics are mostly used by scientific and engineering domains.
- MATLAB is an object-oriented programming language.
- There are many tools which will help you create a better performing program and will help you get better graphics.
- Programmer can file I/O functions.

One can even develop an application using MATLAB programming language. To make it easy for the user there is a graphical interface which is built in.

SYSTEM ANALYSIS



3. SYSTEM STUDY AND ANALYSIS

System analysis is the general term that refers to an orderly and structured procedure for identifying and solving problems. It involves the study of existing system to understand how it functions. This knowledge will help us to identify what the new system should include. System analysis is concerned with becoming aware of the problem identifying the relevant data, analyzing and synthesizing the various factors and determining an optimal at a satisfactory solution or program of action.

3.1 EXISTING METHODOLOY

Subrahmanyam et al Ref [12] have proposed the idea of Local Tetra pattern as proposed in Local Binary pattern (LBP) Ref [11], Local Derivative Pattern LDP Ref [15], and Local Ternary Pattern [LTP] Ref [13], that extracts the information based on the gray values and coded using directions. Local Tetra Patterns encode (LTrPs) the relationship between the referenced pixel and its surrounding neighbors by computing gray-level difference. Based on the directions LTrPs are calculated using the first-order derivatives in vertical and horizontal directions. In addition, we propose a generic strategy to compute n th-order LTrPs using $(n-1)$ th-order horizontal and vertical derivatives for efficient CBIR and analyze the effectiveness of the algorithm by combining it with the Gabor transform. The performance of the method is compared with the LBP, LDP, and LTP based on the results obtained using benchmark image databases viz., Corel 1000 database.

3.1.1 DRAWBACKS OF EXISTING METHODOLOY

- The main disadvantage of Gabor filters based approaches is that they are computationally expensive.
- Method extracts the information based on the distribution of edges, which are coded using only two directions (Horizontal and Vertical).

3.2 PROPOSED METHODOLOGY

For improving the accuracy of the system proposed system includes or considering the coded of the edges by third direction with diagonal pixels. The proposed method encodes the relationship between the referenced pixel and its neighbors, based on the directions that are calculated using the first-order derivatives in all three directions. Given image I, the first-order derivatives along with 0° , 45° and 90° directions. We use Corel 1000 database for implementing the proposed algorithm for CBIR system. This database consists of a large number of images of various contents ranging from animals to outdoor sports to natural images. In this database, each image in the database is used as the query image. For each query, the system collects database images with the shortest image matching distance computed using distance function. If the retrieved image belongs to same category as that of the query image, then we say that the system has appropriately identified the expected image, or else, the system has failed to find the expected image. The performance of the proposed method is measured in terms of precision, recall, and accuracy.

3.2.1 ADVANTAGES OF PROPOSED S METHODOLOGY

- Matching accuracy is improved using the matching distance at query images.
- The performance of the system is improved in terms of the precision, recall, Average Retrieval Rate (ARR).

SYSTEM DESIGN



4. SYSTEM DESIGN

Design is the first process in the development phase of any engineered system. System design is a modeling process. The inputs to the design are the software requirements and the output will be the design specification applicable to all software design. System design is to deliver the requirements as specified in the feasibility report. The main objectives of the design are

- Practicality
- Efficiency
- Cost
- Flexibility
- Security

System design is a process of planning a new system or to the complement of the existing system. The design is based on the limitations of the existing system and the requirements specification gathered in the phase of system analysis. The major steps in the design phase are input design, output design.

4.1 INPUT DESIGN

The main objective of the input design is to provide user friendly interaction. The user has to make a minimum input when a whole process is automated.

Input design is concerned with the input screen design. Input design is the process of converting user-oriented inputs to a computer-based format. The images from the *Corel 1000 database* have been used. These images in this database are classified into different categories each of size 100 by domain professionals. Some researchers are of the opinion that the Corel database meets all the requirements to evaluate an image retrieval system, Fig. 1 shows the sample images of Coral 1000 database (one image from each category). Each image in the

database is used as the query image, query image and database images are converted into grayscale. These grayscale values are taken as the input for method.



Fig. 1. Sample images from database (one image per category).

4.2 OUTPUT DESIGN

Output design generally refers to the results and information that are generated by the system.

Here, output is based on the retrieved image belongs to same category as that of the query image, then we say that the system has appropriately identified the expected image, or else, the system has failed to find the expected image. The success and failure of the system depends on the output. The outputs generated by the system are checked for its consistency and the output is provided simple so that the user can handle them with ease.

SYSTEM DEVELOPMENT



5. SYSTEM DEVELOPMENT

5.1 MODULES

1. First-order derivatives
2. Tetra patterns
3. Magnitude Patterns
4. Retrieval process

5.2 MODULE DESCRIPTION

1. First-order derivatives(ELTrP)

Subrahmanyam et al [Ref 11] have proposed the local tetra patterns (LTrPs) for 0° and 90° . Given image \mathbf{I} , Let g_c denote the center pixel in \mathbf{I} , and let g_h and g_v denote the horizontal and vertical neighborhoods of g_c , respectively. Then, the first-order derivatives for local tetra pattern can be written as

$$I_{0^\circ}^1(g_c) = I(g_h) - I(g_c)$$

$$I_{90^\circ}^1(g_c) = I(g_v) - I(g_c)$$

and the direction of the center pixel can be calculated as $LTrP(g_c) = I_{Dir}^1(g_c)$

$$I_{Dir}^1(g_c) = \left\{ \begin{array}{l} 1, I_{0^\circ}^1(g_c) \geq 0 \text{ and } I_{90^\circ}^1(g_c) \geq 0 \\ 2, I_{0^\circ}^1(g_c) \geq 0 \text{ and } I_{90^\circ}^1(g_c) < 0 \\ 3, I_{0^\circ}^1(g_c) < 0 \text{ and } I_{90^\circ}^1(g_c) \geq 0 \\ 4, I_{0^\circ}^1(g_c) < 0 \text{ and } I_{90^\circ}^1(g_c) < 0 \end{array} \right\}$$

In this module retrieval of the images is based on the existing algorithm, it calculates the first-order derivatives for (0°) (45°) (90°). Before apply the first order derivatives we convert the image into gray scale image. Same as existing method, consider given image \mathbf{I} , Let g_c denote the center pixel in \mathbf{I} , and let g_h, g_v

and g_d denote the horizontal, vertical and diagonal neighborhoods of g_c , respectively. Fig:3 of Appendix B .

Then, the first-order derivatives ELTrP at the center pixel g_c can be written as

$$I_{0^0}^1(g_c) = I(g_h) - I(g_c)$$

$$I_{90^0}^1(g_c) = I(g_v) - I(g_c)$$

$$I_{45^0}^1(g_c) = I(g_d) - I(g_c)$$

and the direction of the center pixel can be calculated as $ELTrP(g_c) = I_{Dir.}^1(g_c)$

$$I_{Dir.}^1(g_c) = \left\{ \begin{array}{l} 1, I_{0^0}^1(g_c) \geq 0 \text{ and } I_{90^0}^1(g_c) \geq 0 \text{ and } I_{45^0}^1(g_c) \geq 0 \\ 2, I_{0^0}^1(g_c) \geq 0 \text{ and } I_{90^0}^1(g_c) \geq 0 \text{ and } I_{45^0}^1(g_c) < 0 \\ 3, I_{0^0}^1(g_c) \geq 0 \text{ and } I_{90^0}^1(g_c) < 0 \text{ and } I_{45^0}^1(g_c) \geq 0 \\ 4, I_{0^0}^1(g_c) \geq 0 \text{ and } I_{90^0}^1(g_c) < 0 \text{ and } I_{45^0}^1(g_c) < 0 \\ 5, I_{0^0}^1(g_c) < 0 \text{ and } I_{90^0}^1(g_c) \geq 0 \text{ and } I_{45^0}^1(g_c) \geq 0 \\ 6, I_{0^0}^1(g_c) < 0 \text{ and } I_{90^0}^1(g_c) \geq 0 \text{ and } I_{45^0}^1(g_c) < 0 \\ 7, I_{0^0}^1(g_c) < 0 \text{ and } I_{90^0}^1(g_c) < 0 \text{ and } I_{45^0}^1(g_c) \geq 0 \\ 8, I_{0^0}^1(g_c) < 0 \text{ and } I_{90^0}^1(g_c) < 0 \text{ and } I_{45^0}^1(g_c) < 0 \end{array} \right.$$

2. Tetra patterns (Second-order $ELTrP^2$)

In this module the image is divided into eight parts based on the direction of the center pixel. It is consider every pixel as the center pixel for other pixel. In $LTrP^2$ image was divided into four parts. Calculate the tetra patterns based on the on the direction of the pixel. In whole image we calculate the tetra pattern for each pixel. Enhanced tetra pattern $ELTrP^2$ is calculated using the following equation.

$$ELTrP^2(g_c) = \{f_1(I_{Dir}^1(g_c), (I_{Dir}^1(g_1), (I_{Dir}^1(g_2), \dots, f_1(I_{Dir}^1(g_c), (I_{Dir}^1(g_p))))\}_{P=8}$$

$$f_1(I_{Dir}^1(g_c), (I_{Dir}^1(g_p))) = \begin{cases} 0 & I_{Dir}^1(g_c) = I_{Dir}^1(g_p) \\ I_{Dir}^1(g_p) & \text{else} \end{cases}$$

Eight-bit tetra pattern is obtained for each center pixel in the above equation. We are calculating the tetra pattern based on the distribution of edges, which are coded using only two directions (positive direction or negative direction). Thus, it is evident that the performance of these methods can be improved by differentiating the edges in more than two directions. This observation has motivated us to propose the eight direction code, referred to as local tetra patterns (LTrPs) for CBIR. Fig:4 of Appendix B.

After finding the Second-order $ELTrP^2$ for the directions the patterns are converted into Binary Patterns.

2.1 Binary Patterns

In $LTrP$, the tetra patterns for each direction (4 directions) were converted to three binary patterns. Here, in $ELTrP$ for each direction (8 directions) the tetra patterns are converted to 7 binary patterns. Let the direction of center pixel obtained using (8) be “1”; then, can be defined by segregating it into 7 binary patterns as follows:

$$LTrP^2|_{Direction=\phi} = \sum_{p=1}^P 2^{(p-1)} \times f_2(LTrP^2(g_p))|_{Direction=\phi}$$

$$f_2(LTrP^2(g_p))|_{Direction=\phi} = \begin{cases} 1, & \text{if } LTrP^2(g_p) = \phi \\ 0, & \text{else} \end{cases}$$

Where $\phi = 2,3,4,5,6,7,8$.

If the direction of the center pixel is “2”; then $\phi = 1,3,4,5,6,7,8$, likewise the ϕ value changes according to the corresponding directions. Thus, Fifty six ($8 \times 7=56$) Binary patterns are obtained. Fig:5 of Appendix .

3. Magnitude Patterns

The magnitude component of the local difference operator to propose the magnitude LBP, along with the sign LBP for texture classification. They proved that, although the sign component extracts more useful information as compared with the magnitude component, exploiting the combination of sign and magnitude components can provide better clues, which are not evident in any one individual component. *LTrP*, has proposed the 13 binary pattern by using the magnitudes of horizontal and vertical first-order derivatives. Fig:6 of Appendix B.

ELTrP concept has motivated by *LTrP* to proposed the 57 binary patterns using

$$M_{I^1}(g_p) = \sqrt{\left(I_{0^0}^1(g_p)\right)^2 + I_{90^0}^1(g_p)^2}$$
$$LP = \sum_{p=1}^P 2^{(p-1)} \times f_3 \left(M_{I^1}(g_p) - M_{I^1}(g_c) \right) |_{P=8}$$

4. Retrieval process

In this module we retrieve the images based on the best matches. Before finding the best matches should find the Histogram for both Binary and magnitude pattern and feature vector is calculated for the every image in the database. For retrieval process following steps are followed

- Finding Histogram
- Query Matching

4.1 Finding Histogram

The original LBP (Local binary pattern) operator is invariant to monotonic gray-scale changes of the images. This is due to the thresholding operation and as thresholding is replaced by a fuzzy membership function, the resulting histogram is no more completely invariant to such changes. However, as only differences of

gray values are considered by the operator, adding a constant to the gray values does not change the soft histogram representation. Moreover, because of the robustness property induced by the fuzzy membership function, a small change of the gray scale causes only a small change in the operator output. Another possible weakness of the soft histogram representation in comparison with original LBP is the increased computational complexity. When computing the original LBP histogram, only one bin needs to be updated at each pixel location. The soft histograms for local binary patterns outlined in this paper can be seen as a P-dimensional variant where each dimension, corresponding to one sampling point in the neighborhood, contains two bins (“greater than center pixel” and “less than center pixel”). Also, independently of this work, a similar extension of the texture spectrum operator was recently proposed.

For the local pattern with neighborhoods, combinations of LBPs are possible, resulting in the feature vector length of 2^8 . The computational cost of this feature vector is very high. In order to reduce the computational cost, we consider the uniform patterns. The uniform pattern refers to the uniform appearance pattern that has limited discontinuities in the circular binary representation. In this paper, those patterns that have less than or equal to two discontinuities in the circular binary representation are referred to as the uniform patterns, and the remaining patterns are referred to as nonuniform. Thus, the distinct uniform patterns for a given query image would be. The possible uniform patterns for 8 neighbor is $P(P-1)+2$ i.e. “58”. *LTrP* ($13*58=767$) combinations are taken same way for *ELTrP* ($57*58=3306$) combinations are taken for whole image to find histogram. After identifying the local pattern, the whole image is represented by building a histogram using

$$H_s(l) = \frac{1}{N_1 \times N_2} \sum_{j=1}^{N_1} \sum_{k=1}^{N_2} f_4 (PTN(j, k), l)$$

$$l \in [0, P(P - 1) + 2]$$

$$f_4(x, y) = \begin{cases} 1, & \text{if } x = y \\ 0, & \text{else} \end{cases}$$

Where, $N_1 \times N_2$ represents the size of the input image. Finally we combine the histograms calculated from the equations.

4.2 Query Matching

The feature vector for the query image Q represented as f_Q is obtained from feature extraction.

Similarly, each image in the database is represented with the feature vector, f_{DB_j} , where $j= 1,2 \dots,|DB|$. The goal is to select the n best images that resemble the query image. This involves the selection of n top-matched images by measuring the distance between the query image and the images in database $|DB|$. In order to match the images, we use d_I similarity distance metric computed using

$$D(Q, DB) = \sum_{i=1}^n \left| \frac{f_{DB_{ji}} - f_{Q_i}}{1 + f_{DB_{ji}} + f_{Q_i}} \right|$$

where $f_{DB_{ji}}$ is the i th feature of the j th image in database $|DB|$. Fig:7 and Fig:8 of Appendix B

EXPERIMENTAL ANALYSIS



6. EXPERIMENTAL ANALYSIS

6.1 EXPERIMENTAL ANALYSIS

The performance is evaluated for proposed system with the existing system. In order to analyze the performance of the proposed method, experiment is done on *benchmark image database viz., Corel 1000 database*. This database consists of a large number of images of various contents ranging from animals to outdoor sports to natural images. These images have been reclassified into different categories each of size 50 by domain professionals, due to its large size and heterogeneous content. For the experiment, 600 images from the database have been collected. These images are collected from 6 different domains, namely, beaches, buses, dinosaurs, flowers, horses, and mountains. Each category has 100 images with resolution of either 256 X 384 or 384 X 256. In this experiment, each image in the database is used as the query image. By [Ref 14] the performance of the proposed method is measured in terms of precision, recall and accuracy, as shown below.

I. Precision

$$precision = \frac{\text{No of relevant images retrived}}{\text{Total No of images retrived}}$$

Images	No of relevant images retrieved		Precision	
	Existing	Proposed	Existing	Proposed
1	15	19	0.75	0.95
2	13	18	0.65	0.9
3	16	16	0.8	0.8
4	9	15	0.45	0.75
5	18	20	0.9	1
6	14	16	0.7	0.8

Table1:Precision [Fig:9 of Appendix B].

II. Recall

$$recall = \frac{\text{No of relevant images retrived}}{\text{Total No of relevant in the Database}}$$

Images	No of relevant images retrieved		Recall	
	Existing	Proposed	Existing	Proposed
1	15	19	0.15	0.19
2	13	18	0.13	0.18
3	16	16	0.16	0.16
4	9	15	0.09	0.15
5	18	20	0.18	0.2
6	14	16	0.14	0.16

Table :2 Recall [Fig:10 of Appendix B].

III. Accuracy

$$accuracy = \frac{precision + recall}{2}$$

Images	No of relevant images retrieved		Accuracy	
	Existing	Proposed	Existing	Proposed
1	15	19	0.37875	0.47975
2	13	18	0.32825	0.4545
3	16	16	0.404	0.404
4	9	15	0.22725	0.37875
5	18	20	0.4545	0.505
6	14	16	0.3535	0.404

Table :3 Accuracy [Fig:11 of Appendix B].

The results are considered to be better if the values of precision, recall and accuracy are high. From Fig: 10, 11 & 12 of Appendix B and Table: 1, 2 &3 , it can be observed that the Enhanced Local Tetra Patterns out performs then Local Tetra pattern. Based on these figures, it is evident that the Enhanced Local Tetra Patterns significantly improves retrieval results in terms of precision, recall, and accuracy on image database

**CONCLUSION & SCOPE FOR FUTURE
ENHANCEMENT**



7. CONCLUSION AND SCOPE FOR FUTURE ENHANCEMENT

7.1 CONCLUSION

The ELTrPs encodes the images based on the direction of pixels that are calculated by first and second-order derivatives. Binary pattern is derived by tetra pattern (second-order derivative) and magnitude pattern is obtained by magnitude of the centre pixel. Histogram is built for the derived patterns and feature vector for query image and database images is constructed. At the end, the performance of the proposed method is compared with the Local Tetra Patterns and Enhanced Local Tetra Patterns based on the results obtained using benchmark image databases viz., Corel 1000 database, and performance analysis shows that the proposed method improves the retrieval result measured in terms of average precision, average recall, and average retrieval rate (ARR).

7.2 SCOPE FOR FUTURE ENHANCEMENT

Due to the effectiveness of the proposed method, it can be also suitable for other pattern recognition applications such as face recognition, fingerprint recognition, etc. In future by considering the RGB color values for derivative calculations instead of converting RGB to grayscale values followed by the proposed approach.

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BIBLIOGRAPHY

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4. CBIR: <http://cvit.iiit.ac.in/projects/cbir/>
5. Performance evaluation:
<http://airccse.org/journal/sipij/papers/2111sipij08.pdf>

APPENDIX



APPENDIX A

SYSTEM FLOW DIAGRAM

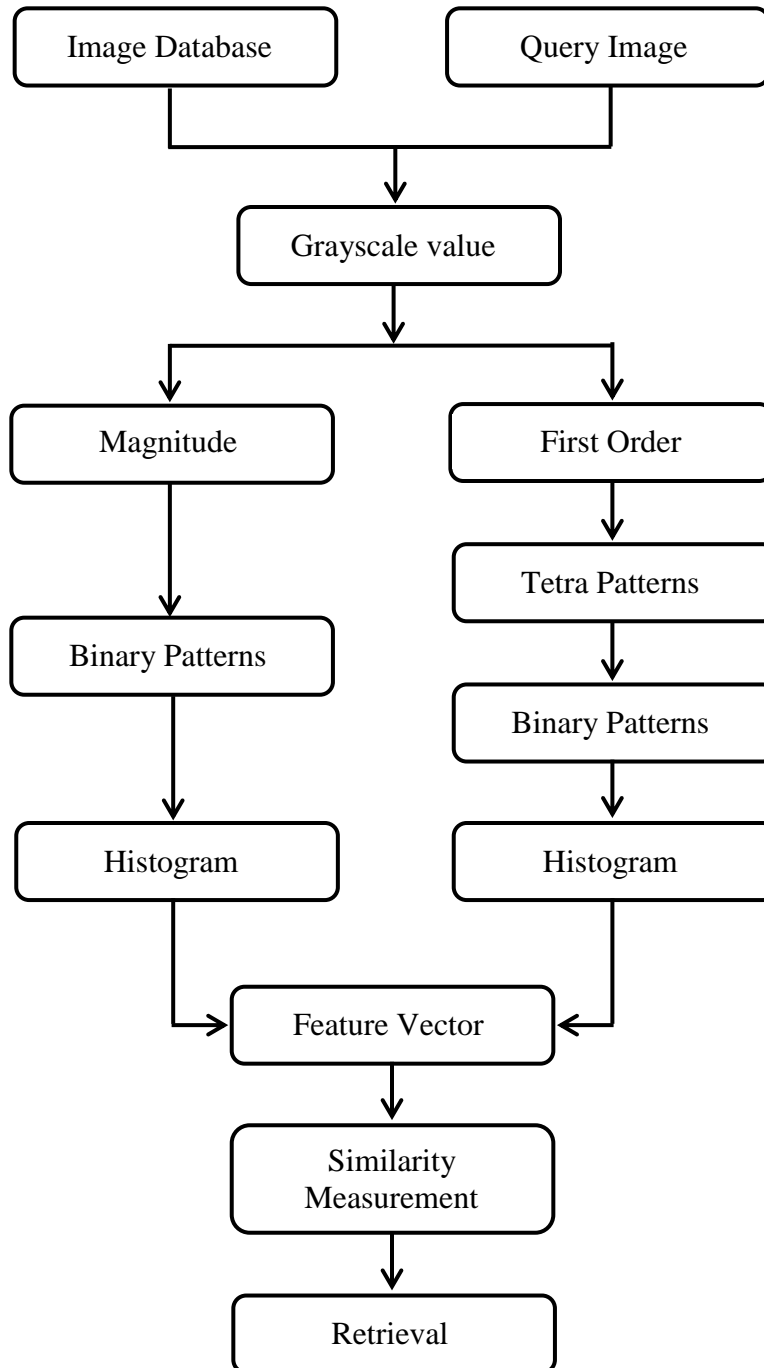


Fig :1 System framework

APPENDIX B

SCREENSHOTS

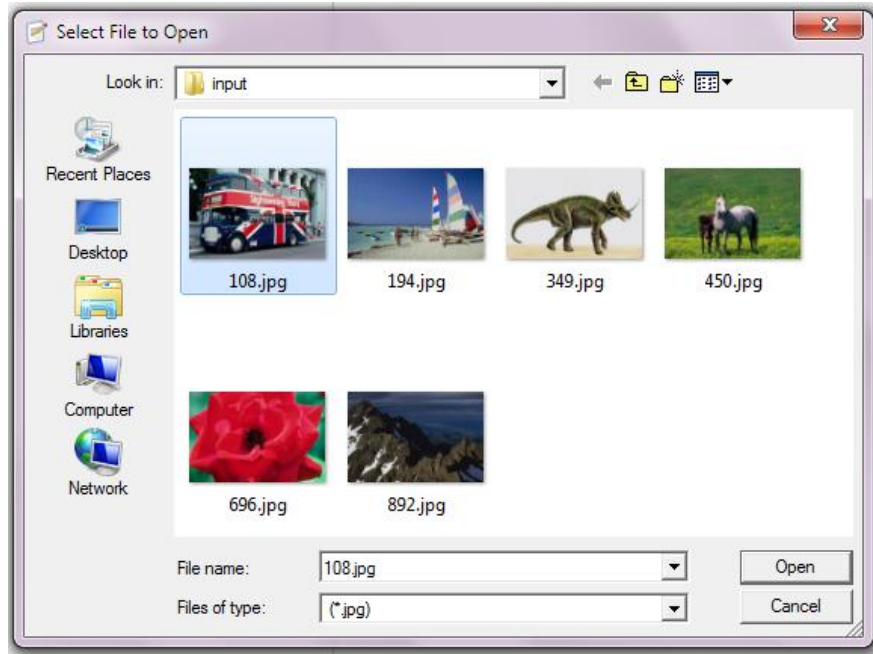


Fig :1 Input image is selected

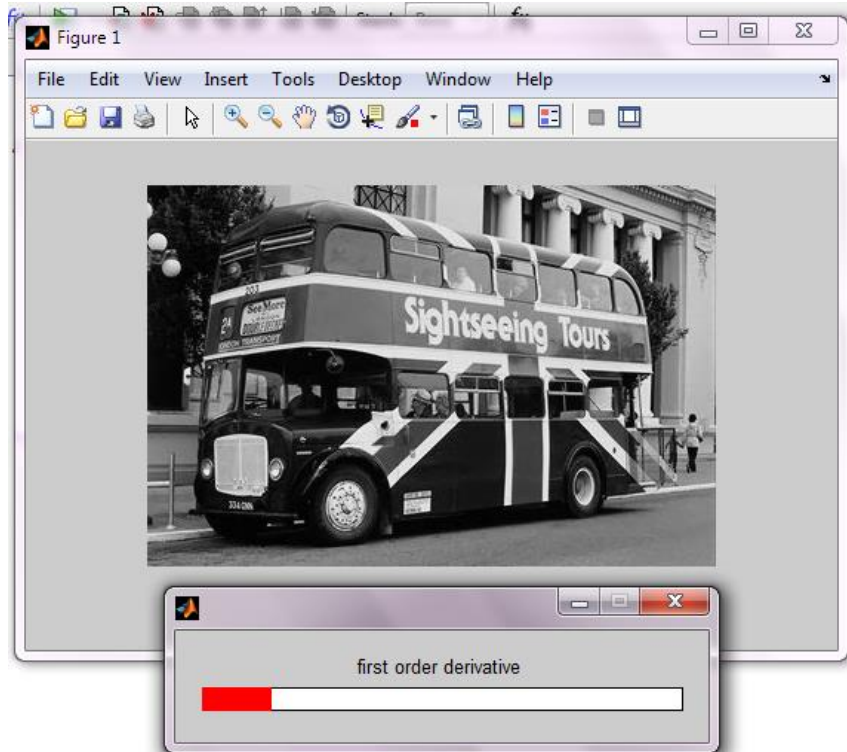


Fig :2 Input image is converted into grayscale and process is done

```

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first order derivative

Columns 1 through 11

    1     2     2     1     2     2     2     2     2     2     8
    1     6     8     5     6     1     8     8     6     2     6
    5     4     7     5     7     1     6     6     8     7     6
    3     1     1     1     8     4     7     8     6     1     6
    1     1     1     1     6     1     5     8     1     8     6
    1     1     2     1     6     5     4     6     3     6     1
    5     4     1     1     6     8     8     8     4     1     1
    8     4     1     2     1     6     8     1     1     8     8
    1     1     5     1     1     1     2     8     8     4     7
    1     2     5     1     1     8     8     8     1     1     1
    1     8     8     5     1     6     6     8     1     2     8
    1     6     2     1     8     4     6     6     5     4     6
    1     1     1     1     8     4     8     1     2     8     8
    1     1     1     8     7     2     8     8     8     8     8
    1     3     4     8     8     8     8     8     7     1     1
    5     4     1     6     2     8     6     1     1     3     8
    1     1     1     6     8     7     2     2     8     8     8
    1     1     1     6     8     4     8     8     8     8     4
    5     5     1     1     6     2     8     8     6     2     2
    1     1     5     8     8     8     6     1     6     2     1

```

Fig :3 First-order derivative

```

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tetra pattern for (1,1) Cell,is
    [8]    [0]    [2]    [8]    [0]    [0]    [5]    [0]

tetra pattern for (1,2) Cell,is
    [0]    [2]    [8]    [0]    [2]    [5]    [0]    [6]

tetra pattern for (1,3) Cell,is
    [0]    [8]    [8]    [1]    [0]    [1]    [6]    [6]

tetra pattern for (1,4) Cell,is
    [8]    [8]    [8]    [0]    [8]    [6]    [6]    [6]

tetra pattern for (1,5) Cell,is
    [0]    [0]    [0]    [2]    [0]    [6]    [6]    [2]

tetra pattern for (1,6) Cell,is
    [0]    [0]    [0]    [0]    [0]    [6]    [2]    [2]

tetra pattern for (1,7) Cell,is
    [0]    [0]    [0]    [0]    [7]    [2]    [2]    [3]

tetra pattern for (1,8) Cell,is
    [8]    [8]    [8]    [8]    [1]    [2]    [3]    [8]

```

Fig :4 Tetra patterns

```

file_path=uigetfile('input','.jpg');
Command Window
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binary pattern
'00010001' '00100000' '01000110'
'01001000' '00010000' '00100111'
'00100000' '11001100' '00000011'
'00000000' '11100010' '00000001'
'00000000' '11100001' '00000000'
'00000000' '01100000' '10010000'
'00000000' '00100000' '00011111'
'10000000' '00000000' '01101000'
'01010000' '00000100' '00100000'
'00000010' '01001001' '10000100'
fx '01010011' '00000100' '10101000'
OVR

```

Fig :5 Binary patterns

```

file_path=uigetfile('input','.jpg');
Command Window
File Edit Debug Desktop Window Help
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magnitude pattern
Columns 1 through 4
'00101001' '10101111' '00101010' '01101111'
'01101011' '10111111' '00000100' '10001001'
'00101001' '11101101' '00101011' '00101011'
'01101011' '00100010' '11111011' '11110101'
'01101001' '00101011' '00000110' '10011111'
'00101010' '10111011' '00100111' '10111111'
'00001011' '11111111' '01101000' '00100100'
'11100011' '10010111' '00100000' '11011101'
'10110000' '00000000' '10101111' '00000000'
'10111110' '00101011' '10001101' '11111011'
Columns 5 through 8
'10101111' '00101111' '00100011' '01101111'
'00111011' '00011111' '00001111' '11101011'
'01101111' '10111111' '11100111' '10010111'
'01101001' '01111111' '10100110' '11011111'
'01101000' '11101001' '10111010' '11100101'
'00010110' '00001111' '00001111' '00000111'
'11101011' '00000110' '11111111' '10111111'
'10100001' '00101011' '00100001' '10111100'
fx '00000010' '11111111' '11100101' '11111111'
OVR

```

Fig :6 Magnitude patterns

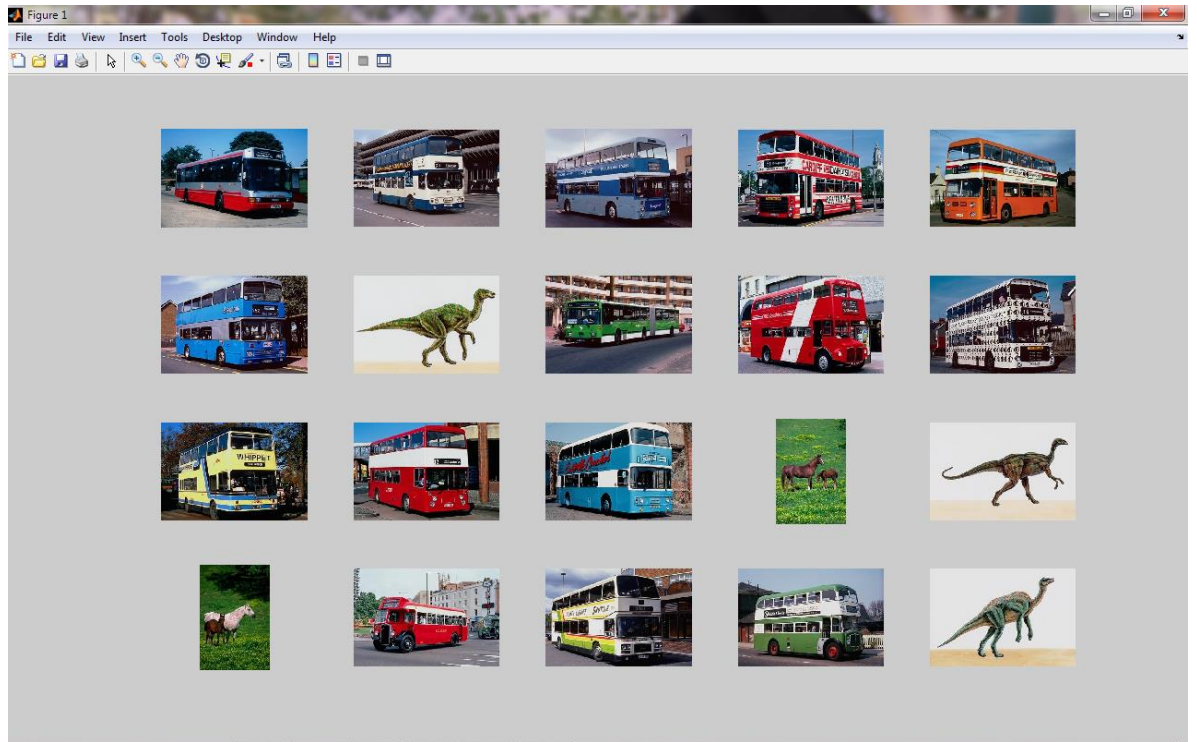


Fig :7 Output for Existing System

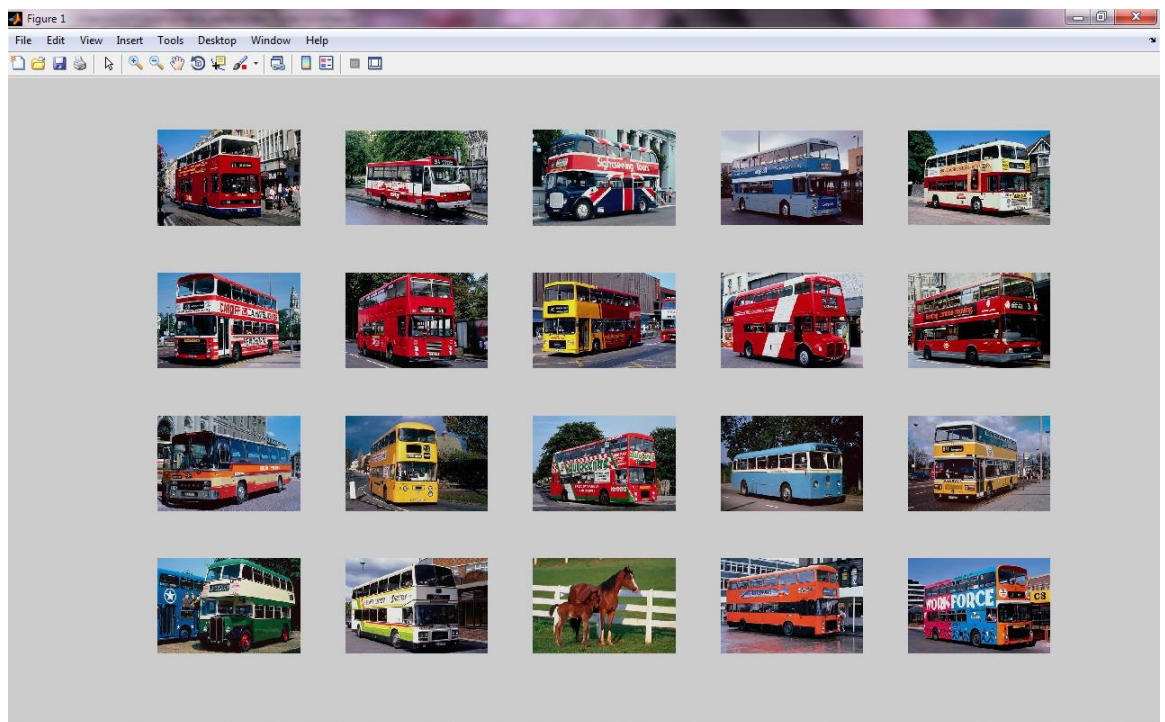


Fig :8 Output for Proposed System

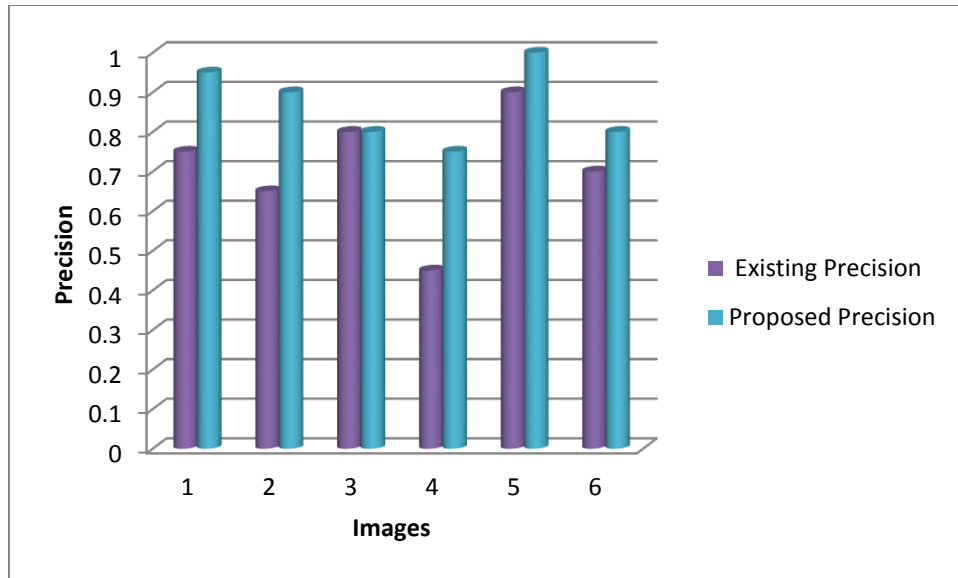


Fig :9 Precision

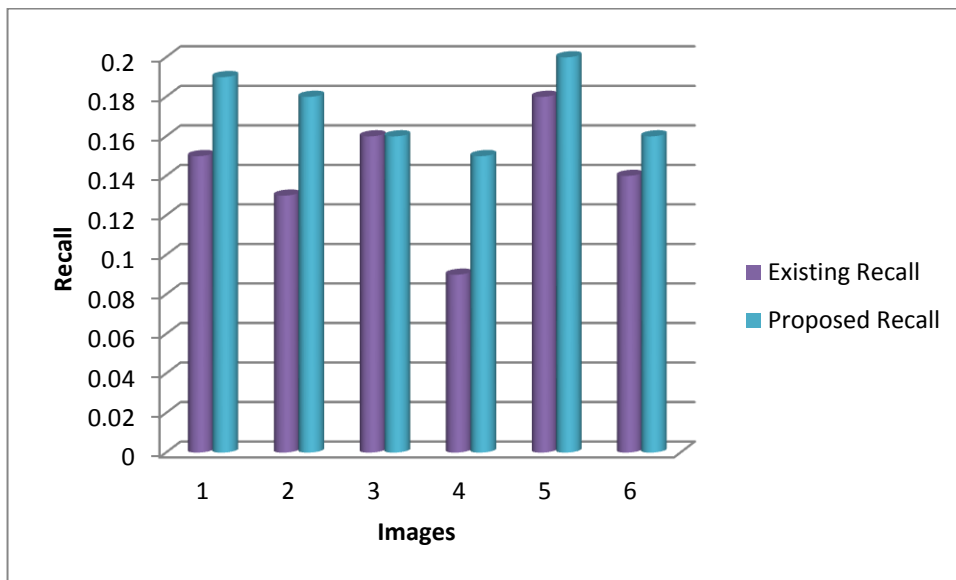


Fig :10 Recall

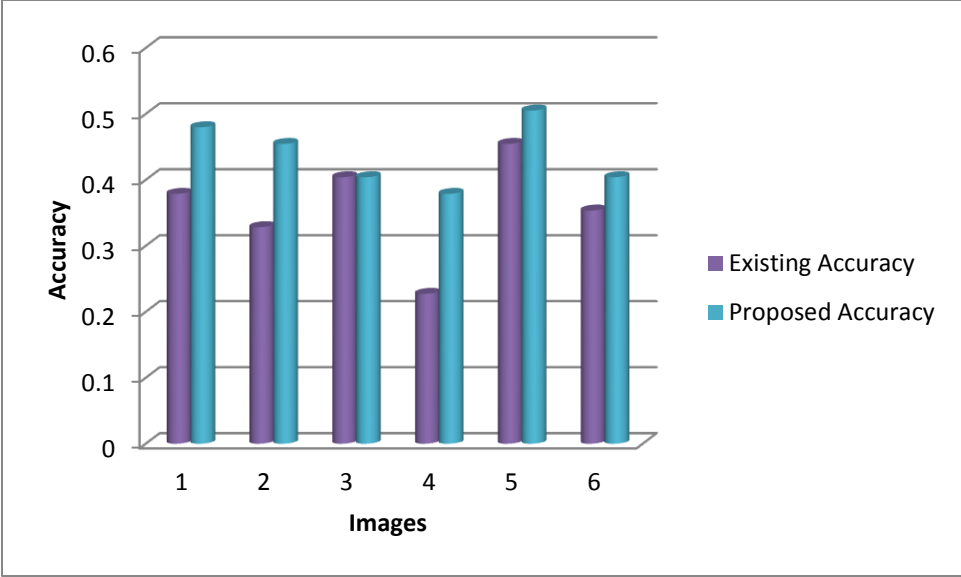


Fig: 11 Accuracy