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Comparative Analysis of Facial Image Feature Extraction Algorithms

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***Abstract*—Image mining can be defined as the extraction of hidden information from the databases. It is used to detect unfamiliar patterns, abstract inherent and useful knowledge from images stored in the large databases. The application areas of image mining are computer vision, image retrieval, image processing, artificial intelligence machine learning and face recognition. Face recognition is an application that can be used to identify faces. Face recognition algorithms identify faces by extracting features from an image. It is mainly used to perform two primary tasks such as verification and identification. Face recognition techniques uses algorithms which are used to analyze specific facial features like eyes, eyebrows and lips. Application areas of face recognition are computerized arrest and booking system (CABS), identification solutions, homeland defense, airport security, financial services etc. Facial expression is defined as the emotion expressed on a person's face. For example sad, happy, fear, angry, disgust etc are the expression done on human face. The features of facial image expressions are eye, eyebrows and lips. In order to extract these features from facial images, this research work uses two algorithms; they are face part detection and Susan algorithm. Face part detection is mostly done on facial expression regions, like eyes, eyebrows, and lips are extracted from the input image. Here, edge-based feature extraction are done for recognizing six different expressions, those are angry, fear, happy, neutral, sadness and surprise. The performance of face part detection and Susan algorithms are analyzed by using the accuracy and execution time factors. This work is implemented in MATLAB 7.0.**

***Keywords*—Facial Images; Feature extraction; Face part detection; Susan; Convolution; Masking, Binary converter; Gabor features.**

I. INTRODUCTION

Image mining is used to find patterns and relationships from collection of images. It is the process of searching and discovering valuable information in large volumes of image data. Different tasks of image mining are image segmentation, image compression, image clustering, image classification and image retrieval. The applications of image mining are done in face recognition [10]. Face recognition is an application that can be used to identify faces. Application areas of face recognition include CABS, identification solutions, homeland defense, airport security and financial services. CABS is defined as computerized arrest and booking system. It helps in finding out criminal analysis and investigations. It is used to capture and store images in a minute. Identification solutions are done on identification of documents like passports, driver's license and ID cards with the use of face recognition. Homeland defense is done to prevent from terrorists attacks, ie to protect dams, bridges, water reservoirs etc to the recognition of identified terrorists. The use of airport security is such that the identification of terrorists is found before they enter into airplane or some protected place. Financial services are defined as the idea of security. Here security is done to a simple personal identification number (PIN) or password.

Image mining is more than just an extension of data mining to image domain. Data mining is used to find hidden information. It refers to extract or drawing out knowledge from large quantity of data. Data mining techniques are classification, clustering, association rules, regression, and summarization and so on. Most important data mining domains are text mining, image mining, spatial mining, medical mining, web mining and so on. Face recognition is to identify faces. Face recognition has been widely applied in security system, credit-card verification, and criminal identifications teleconference and so on [11]. Facial expression is defined as the feeling expressed on a person's face. For example sad, happy, fear, angry, disgust etc are the expression done on human face [3]. Facial feature extraction is defined as the process of locating specific points in a given image. Facial feature extraction is an effective method to extract facial features like eyes, eyebrows and lips depending on their locations with the face regions. Face recognition has been widely applied in security system, credit-card verification, and criminal identifications, teleconference and so on. The features under consideration are eyes, eyebrows and mouth [12]. Furthermore, a new method to extract facial features is developed based on feature location with respect to face dimensions. The proposed algorithm has been tested on various images and its performance is found. Experimental results show that face part detection method gives accurate results with

good accuracy and timing compared to Susan algorithm.

The main objective of this research work is to compare the efficiency of the face part detection algorithm and Susan algorithm for extracting features from facial images. This paper is organized as follows. Section 2 gives the related works. The face part detection and Susan algorithms are described in Section 3. Section 4 analyzes the experimental results and conclusion is given in Section 5.

II. RELATED WORKS

Cheng Du [1] analyzed facial feature extraction methods. In this paper he described how to extract the feature points from faces automatically and also he extracted features on human face and improved the accuracy of face recognition. He finally analyzed the experiment results the face localization method presented in this paper can place feature points from faces accurately and quickly.

Daw-tung-lin [2] discussed facial expression recognition using PCA and hierarchical radial basis function network. In this paper, he examined principal component analysis method to perform facial expression recognition and also classified radial basis function network based on local features like eyes, and mouth.

G. Foschi [4] described feature extraction for image mining. In this paper, he described the extraction of various features and also helps to identify the best features from the images. He also examined features and also he tested the images and proved that features are used to identify patterns from images.

Haiyuan wu [6] presented automatic facial feature points detection. He examined facial feature point extraction and identified exact location of different feature point on face which includes detection of eyes, mouth, nose, eyebrows, etc. He also examined feature point extraction from faces and proposed the method with good accuracy with less computational time and reduced complexity.

S.P.Khandait [7] analyzed automatic facial feature extraction and expression recognition based on neural network. In this paper he described the problem of facial feature extraction from an image and classified facial expression and emotion of a person. Here he used neural network for classifying the expressions of face into seven categories like surprise, neutral, sad, disgust, fear, happy and angry and performed better with accuracy for training sets and training sets.

Vijayarani S et.al [16] analyzed various edge detection algorithms for facial images in image mining. In this paper they examined about two different edge detection algorithms such as canny and mar-hildreth. They also discussed about face detection, image processing method, relative works and performance factor are analyzed. Image smoothing is done for noise reduction, detection and edge localization are the steps involved in edge detection. Finally from the experimental results it is clearly shown that the Canny edge detection algorithm performs well when compared to Mar-Hildreth edge detection algorithms.

Vijayarani S et.al [17] analyzed the performance analysis of canny and sobel edge detection algorithms in image mining. In this paper they discussed two edge detection algorithms namely Canny edge detection and Sobel edge detection algorithm that are used to extract edges from facial images which is used to detect face. Many edge detection techniques are carried out by performing with different set of images. They also discussed face recognition, filtering and edge detection methods. Accuracy is measured by using confusion matrix and execution time and they found that canny performs best than sobel. Performance factors are analyzed namely accuracy and time are used to find out which algorithm works better. Finally, from the experimental results it is proved that the Canny edge detection algorithm works better than Sobel edge detection algorithms.

III. PROPOSED METHODOLOGY

The two algorithms face part detection and susan algorithm are used for extracting the features from facial images. Face part detection uses convolution technique and this method is experimented using bounding boxes. Susan algorithm uses masking technique and this method is experimented using corner points. Both the methods are used for feature extraction. Here feature extraction is done for local regions like eyes, eyebrows and lips. Based on the accuracy and timing it is showed that face part detection detects best compared to Susan algorithm. The system architecture of the proposed methodology is shown in Figure 1

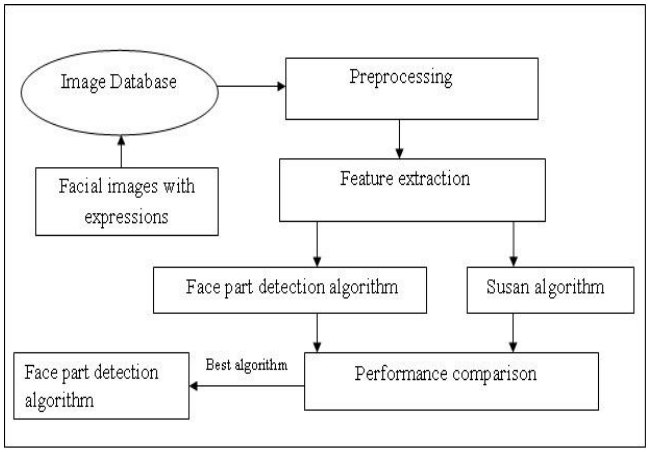

Figure 1. System architecture

IMAGE DATABASE Image database is a computerized system where images are stored in an organized form. Many image databases are available for example MRSID, ATERAS, PATFIT, JAFFE etc. In this paper we have used JAFFE database. JAFFE database is described as Japanese female face expression database. It contains Japanese face

model images and here we have experimented fifteen images by using two algorithms.

PREPROCESSING Preprocessing is the basic concept of filtering. It involves feature selection and extraction of features in image mining. Preprocessing is the first step done before feature extraction of images. Preprocessing is the stage where filtering is done to remove noise. Different filter performs different tasks. Different filters used in this work are median filter, adaptive filter, linear filter and predefined filter. Median filter is one of the best filtering techniques and in median filter noise is removed and added using med filter. Preprocessing is done to remove unwanted noise and it gives clarity to the images.

FEATURE EXTRACTION Feature extraction is the process of defining a set of features which represents the information that is key for analysis and classification. Color, texture and shape features contain the primitive image descriptors in content-based image retrieval systems. The color feature is one of the most commonly used features in image retrieval. The color of an image is represented using color model to describe color information. The most commonly used color models are RGB (red, green, blue) and HSV (hue, saturation, value). Texture is one of the most important features in visual pattern recognition. Texture is described in various terms as smooth, uniform, flat, coarse, grainy, even, uneven and random. Shape is used as edge detection to extract features. Shapes are used to determine the edges of the faces that have been detected as image contour and it is experimented on image database. Feature extraction is done for extracting features from face images. In this paper feature extraction is done for extracting features like eyes, eyebrows and mouth. Here face part detection and Susan algorithm is used to detect features. Face part detection is used as bounding box to extract features. Face part detection uses convolution technique and it gives absolute accuracy and timing. Susan algorithm is done for extracting features like eyes, eyebrows and lips. Here Susan algorithm is used to detect features. Susan algorithm uses corner points to extract features. But here the corner points are not extracted correctly. By comparing both algorithms face part detection is proved the best algorithm.

FACE PART DETECTION ALGORITHM Face part detection detects features. It is used for feature extraction to extract features using their correspondent values. This method uses an efficient approach for the recognition on the basis of some extracted features [13]. For face part detection, this system follows a step by step procedure that comprises face detection, and feature extraction. Once face detection is performed, feature of regions like lips, eyebrows and eyes are extracted. In feature extraction edge projection analysis, distance measure and feature vector is formed considering height and width of left eye, height and width of left eyebrow, height and width of right eye, height and width of right eyebrow, and height and width of mouth along with distance between left eye and eyebrow, distance between right eye and eyebrow and distance between lips. The results are obtained after implementation and this result gives accurate performance for the feature extraction using face part detection algorithm. The pseudo code of this algorithm is given in Table 1.

Table1. Pseudo Code for Face part detection algorithm

1. Imread(input image.format).
2. Apply face detection code on the input image and detect faces.
3. Extract each face as a separate image.
4. regionprops(image, 'boundingbox') using convolution technique.
5. Extract features as eyes,lips and eyebrows.
6. Set Im2bw for binary image.
7. Apply Gabor function for feature extraction.
8. Calculate the values by testing the images.
9. End.

STEPS INVOLVED IN FACE PART DETECTION ALGORITHM Feature extraction is the process of extracting features and used to classify the images into different classes. Convolution technique is used in this algorithm. Convolution technique works by multiplying vectors and returns values by using length and width and also it is used to detect face, removes noise and smoothens the edges. Gabor features are done using Gabor filters and here image decomposition is done by converting real part and imaginary part. The eyes, eyebrows and lips are being extracted from the image and results are shown in the form of bounded rectangles. The following steps are shown below:

- Input the images using JAFFE database and
- Convert the images into binary converter.
- Find the 2-d convolution of the target and template image.
- Find the mean and variance of the template image.
- Find the pixel value from the search region having the values of convolution.
- Draw the bounding rectangles by using the values of the convolution technique.

The bounding rectangles form around the matched template which is used to deduce the value of top-left corner pixel from the rectangles by using width and height of the template size. These pixel values are used to evaluate the bounding box using rectangle shaped ones. The distance is calculated between eyes, eyebrows and mouth [9]. In this paper face part detection are constructed. For JAFEE Face Database for facial images and it gives exact and accurate results. The above diagram shows the steps of face part detection as shown in Figure 2.

SUSAN ALGORITHM Susan algorithm is defined as smallest univalue segment assimilating nucleus. This algorithm is used for identifying feature points using edges and corners. Here feature extraction is done for eyes, eyebrows and lips. Facial features like eyes, eyebrows and lips are different for individual

person. Moreover, facial features change when people change their facial expression [14].Therefore it is difficult to extract the facial feature points from input images. In this paper, we choose the operator SUSAN (Smallest Univalve Segment Assimilating Nucleus) to extract the edge and corner points of feature areas. The position of two eye balls eyebrows and mouth corners are extracted from face image. When locating the feature points, the searching area of the points are set for the feature areas of eyes, eyebrows and lips [8]. The pseudo code of this algorithm is given in Table 2.

Table2. Pseudo Code for Susan algorithm

1. Imread(input image.format).
2. Place the circular masks around the pixels.
3. Apply circular masks to extract features.
4. Points = Susan(I,msize,mask) using masking technique.
5. Extract features as eyes, lips and eyebrows.
6. Corner points = point (points>Smax/4).
7. Convert binary values as (0 and 1).
8. Calculate the values by training and testing the images.
9. End.

MASKING TECHNIQUE Masking technique is done in this algorithm and here the pixels masks are used for face image using eyes, eyebrows and lips and these features are extracted in this technique. The principle operator SUSAN is used to make a mask on the circle area of one point with the radius and then observe every point in the whole image on the consistency of this point with all points contained in the mask area [5]. According to the properties of operator SUSAN, it can be used not only to detect the edge, but also used to extract the corner point. Each region containing facial feature, the SUSAN corner detector is applied to detect the facial feature points [15]. This extraction method consists of several steps as follows:

- The location of the whole face is taken, then the detection of facial features is done by feature points.
- The regions of human face and its features are detected from the input image.
- Then binary converter is done for finding regions without grayscale only black and white images are converted in to binary converter.
- In each region containing facial feature, the SUSAN corner detector is applied to detect the facial feature points. Here, the feature extraction is done for eyes, eyebrows and mouth using the corner points.

Susan corner points are constructed for JAFEE Face Database for facial images. It shows the results of facial feature extraction done using morphological image Processing operation and hence face localization is achieved. The above diagram shows the architecture of Susan algorithm as shown in figure 3:

IV. EXPERIMENTAL RESULTS

This work is implemented in Matlab tool. Matlab provides the required data mining functions and methodologies [3]. The JAFFE database is done here and it contains one hundred and eighty one images. The experimental results are showed for fifteen images and comparison of classification algorithms are done based on the performance measures of experimental results, classification accuracy and execution time.

A. CLASSIFICATION ACCURACY

By comparing face part detection and Susan algorithm it is proven that face part detection extracts features correctly. In the above experimental result the face part detection uses fifteen images and all the fifteen images have the features extracted as eyes, eyebrows and lips. The bounding box is done in figure 4 and here it detects features correctly for all fifteen images. The bounding box extracts two eyes, eyebrows and lips and it is extracted using convolution technique for all the images. It is clearly shown that the face part detection detects features correctly. In the above experimental results the Susan algorithm uses fifteen images and all the fifteen images the features extracted are eyes, eyebrows and lips. The corner points are done here and it does not detect correctly for all fifteen images. The corner points showed in figure 5 does not show the corners absolutely. In eight images mouth are not detected and also eyebrows are not extracted for all images. Only eyes are extracted in all the fifteen images.

Table3. Accuracy Measure

Algorithms	Accuracy
Face part detection algorithm	78%
Susan algorithm	72%

From the accuracy measure it is proved that face part detection algorithm performs better than Susan algorithm with its highest accuracy values.

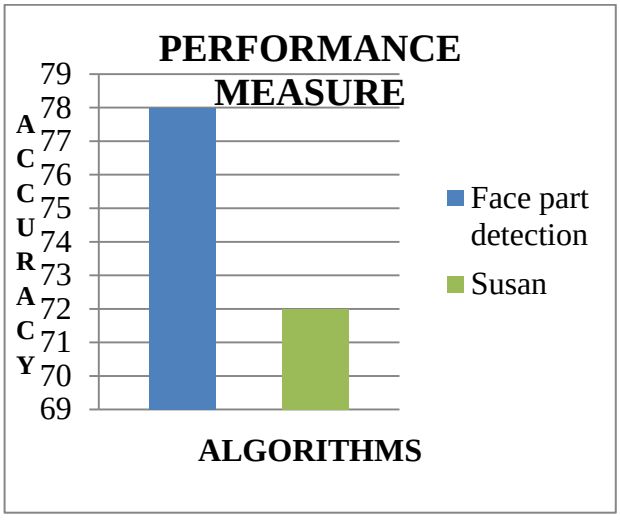

Chart1: Accuracy Measure

From the graph it is showed that face part detection performs better than Susan algorithm by their accuracy values.

B. EXECUTION TIME

Table4: Algorithm Comparison for Performance Measure

Algorithm	Execution Time (in Sec.)
Face part detection algorithm	12
Susan algorithm	27

From the table it is proved that Face part detection performs better than Susan algorithm with its less computing time.

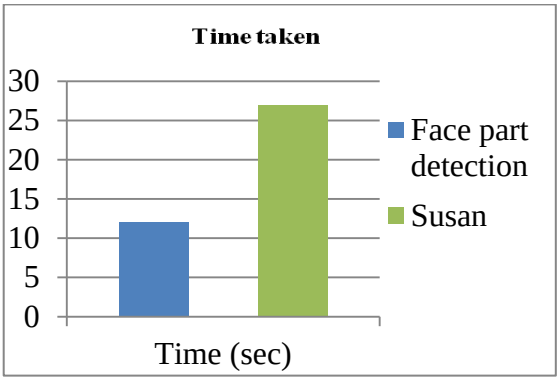

Chart 2: Execution Time

From the above chart it is shown that Face part detection performs better than Susan algorithm with less computing time.

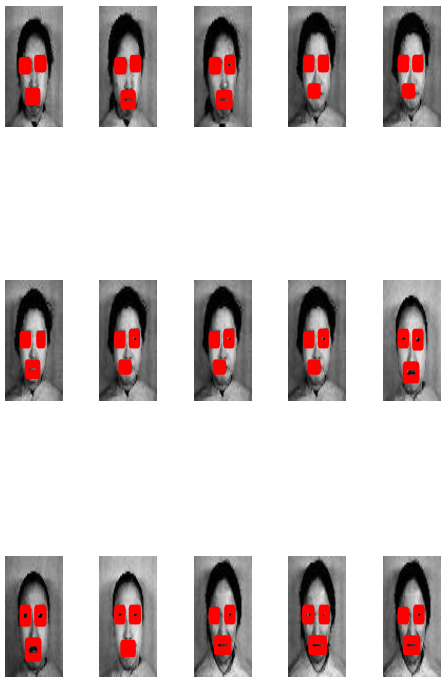

Figure 3: Features Extracted Using Face Part Detection

Figure 4: Features Extracted Using Susan Algorithm

From the above experimental results it is proved that Face part detection is best in detecting features when compared to Susan algorithm based on the accuracy and time measures.

V. CONCLUSION

This research work has performed comparative analysis of two feature extraction algorithms. Features are extracted Facial image expression datasets and the algorithms used in this analysis are face part detection and susan algorithm. From the experimental results it is observed that the performance of face part detection is better than susan in terms of its accuracy and execution time.

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