ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Efficient Face Recognition Using Sift and SMS Reporting System

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Abstract:

Face Recognition is implemented so that we can identify a specific individual in a digital image by analyzing and comparing patterns. This includes analysis of an image and extraction of facial features which helps to discriminate it from others. Many techniques have been developed but Scale invariant feature transform (SIFT) is the one with which the accurate results are obtained. SIFT is advanced algorithm for Principal component analysis (PCA) .These features extracted are invariant to rotation, image scale and illumination. from images which are used to perform reliable matching. Being high distinctive features, every feature can be matched correctly with high probability against a huge database of features from many images. The results obtained state that SIFT algorithm is reliable when compared to Contour matching algorithm for heterogeneous images. Both the algorithms are experimentally evaluated on AT&T, YALE and IIT-KANPUR databases with moderate subject size. Contour matching is simple and takes less computational time, under various circumstances like pose, expression, orientation and varying illumination the SIFT provides efficient face recognition When the database is small then Contour matching outshines. Whereas for the large databases Scale Invariant Feature Transform (SIFT) outlasts and gives more than 90% recognition rate.

Index Terms:

Scale invariant feature transform (SIFT), Contour matching, Principal component analysis (PCA).

I.INTRODUCTION:

Face Recognition is one of most relevant applications of image analysis. It deals with unique facial characteristics of human beings. It has various applications like security systems, identity authentication and video retrieval. It involves the techniques of image processing, computer vision and pattern recognition. Face recognition is more cumbersome than classical pattern recognition as it deals with human faces. The human face has more information but working on this information consumes more time and it becomes less efficient. In Face Recognition we perform face detection as the prior thing. Variability in scale, orientation, pose and illumination makes face detection a challenging task.

Face appearance which changes with occlusion, facial expression also makes face detection more challenging. Face detection leads to feature extraction. When we extract relevant facial features from the detected face then it is called Feature extraction. Feature extraction is divided into two main clases based on two methodologies they are Holistic matching method and local Feature based matching method. Earlier various techniques have been implemented that apply statistical methods to the image of the face as a whole, and evaluate reduced number of values whereas methods in the second group analyses local geometrical features such as mouth and eyes or evaluates distance between them. In both cases, the recognition is done by comparing facial features extracted from the database images and the test images .

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I. Here we use Scale Invariant Feature Transform (SIFT) for face recognition. Earlier we used few methods like Linear Discriminant Analysis (LDA), Principle Component Analysis (PCA). Although PCA gives good recognition, it is takes more computational time and doesn't work when the background, orientation, scale, illumination changes. III.A 2DPCA is the advanced PCA which gives more efficient results when compared to PCA. The nonlinear extension of PCA is Kernel PCA (KPCA) which was developed by Scholkopf in 1998. Although it gives good results, PCA is expensive and complex as the database increases. IV. Linear Discriminant Analysis (LDA) is another approach for face recognition. LDA is a statistical approach to compare database samples with test image samples. Although these methods outperforms when the database is small but doesn't perform when the illumination, scale, orientation changes. V. To avoid these issues and get good outcomes we use Scale-Invariant Feature Transform (SIFT). (SIFT) is used for efficient heterogeneous face recognition, we evaluate SIFT algorithm on different databases along with this a GSM module is connected. When the face recognition is done, the authentication or un-authentication is notified on the mobile with a message by SMS reporting system.

II.LITERATURE SURVEY:

A. Scale Invariant Feature Transform:

The SIFT is developed by David Lowe in 1998 which is used to to extract the facial features for face recognition. SIFT is used to extract the features of training images and stored in the database for face recognition. A test image is captured and then matched by individually comparing each feature from the test image to the existing database. Then the Euclidiean distance between their feature vectors is calculated. To extract the features four steps are implemented they include Scale-Space generation, Key Point Localization, Orientation and Key Point Descriptor. In this Scale Space Generation the features are detected. The image is convolved with Gaussian filters at different levels, which results into several Gaussian images. Koenderink and Lindeberg proved that the only possible assumption is the Gaussian function. Scale space L(x,y,σ),is convoluted Gaussian function. G(x,y,σ),with an input image I(x,y)is defined by,

$$L(x,y,\sigma) = G(x,y,\sigma) * I(x,y) \qquad (1)$$

Where

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

is the Gaussian function.

The Difference of Gaussian images are generated by calculating the differences of the adjacent Gaussian images. DoG images . D(x,y,σ),can be computed from the difference of two adjacent scales separated by multiplication.

Factor k:

$$D(x,y,\sigma) = (G(x,y,k\sigma) - G(x,y,\sigma)) * I(x,y)$$
$$D(x,y,\sigma) = L(x,y,k\sigma) - L(x,y,\sigma) \qquad (2)$$

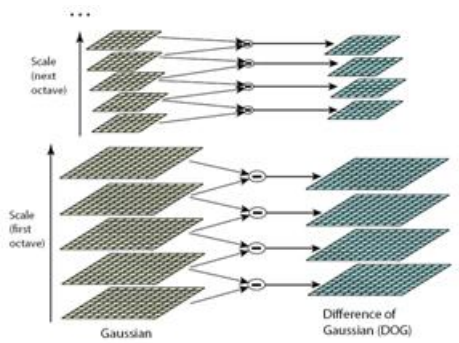

Fig.1 Difference of Gaussian (DoG) Images

A factor of 2 (next octave), and then this process is repeated. After each octave has DoG images, then the features are selected from the DoG images. In order to detect Local maxima and minima, each sample is compared with its eight neighnours in its current image and nine neighbours in the adjacent scales. The Taylor expansion is given by

$$D(x) = D + \frac{\partial D^T}{\partial x} x + \frac{1}{2} x^T \frac{\partial^2}{\partial x^2} x \qquad (3)$$

The Local Maxima is detected by taking derivatives of D and equating it to zero

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$$\hat{x} = -\frac{\partial^2 D^{-1}}{\partial x^2}\frac{\partial D}{\partial x} \quad (4)$$

Then the low contrast points are eliminated for better calculation of features by taking this equation

$$D(\hat{x}) = D + \frac{1}{2}\frac{\partial D^T}{\partial x}\hat{x} \quad (5)$$

The extremas whose |D(x^)|< 0.3 are rejected. Orientation Assignment determines the direction of key point which ensures the feature's rotation. The direction of the key point is calculated by the image information of key point's neighborhood. For each sample L(x,y), the modulus value M(x,y) and the orientation θ(x,y) are computed using pixel differences and are given by:

$$m(x,y) = \sqrt{(L(x+1,y) - L(x-1,y))^2 + (L(x,y+1) - L(x,y-1))^2} \quad (6)$$

$$\theta(x,y) = \tan^{-1}((L(x,y+1) - L(x,y-1))/(L(x+1,y) - L(x-1,y))) \quad (7)$$

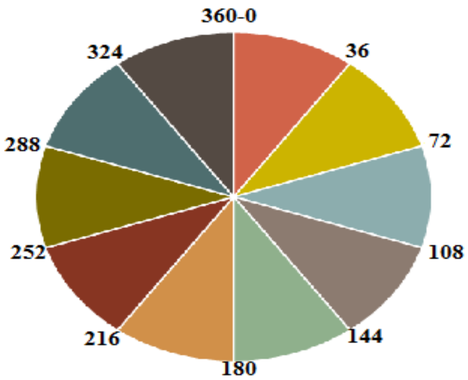

Fig.2 Orientation Assignment

Once the modulus and angles are computed, the algorithm divides 00 to 3600 into 36 bins, where each bin contains 100. Then histogram of gradients of each bin is constructed. Each sample added to the histogram is weighted by its gradient magnitude Gaussian window with an σ that is 1.5 times that of the scale of the key point. The peak of orientation histogram direction of the area around the key point. If any other value is greater than 80% of the highest peak, then a keypoint is created with that orientation. Hence multiple key points can be created at the same location and scale but with different orientation. Key Point Descriptor is constructed for each key point.

It is obtained by computing the gradient magnitude and orientation in a region around the key point location. Key point descriptor is created at each image point of the 16x16 key point neighborhoods. Each window is divided into four areas, where each window of 4x4 sub regions depicts the area. For each area, the histogram is divided into eight directions using the gradient value. The length of feature descriptor is 4 x 4 x 8=128 elements.

III. PROPOSED MODEL:

The proposed model for face recognition is shown in Fig.1 which consists of three stages: Key Points Extraction, Key points Validation and Matching Algorithm.

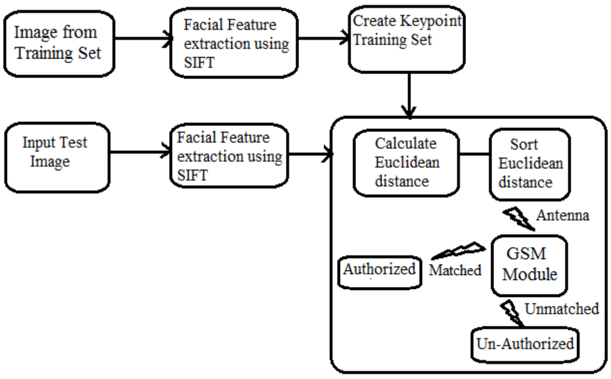

Fig.3 Proposed Model

Key Points Extraction: In this stage the highly distinctive facial features are extracted from the images. Key points of both the training images and test images are extracted. These extracted Point Location and Eliminating Edge Response.The camera is initialized and all the training set images are captured and stored into database.Then by using (SIFT) the facial features are extracted, this process is done in four stages and once the features are extracted the keypoints of the training set images are created.the same process is repeated for test images.

• Calculating Euclidean Distances: Once the key points for both the training and test images are extracted, the Euclidean distance is calculated by comparing every test image key point with entire set of

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International Journal & Magazine of Engineering, Technology, Management and Research
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key points of the training images and then Euclidean distance array.is obtained.

$$ED = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \qquad (10)$$

x1,y,1 and x2,y2 are x and y coordinates of the test and training image. •Sort Euclidean Distance: Once the array of Euclidean distances is generated by comparing all the test image key points with entire set of training image key points, it will be sorted to find first two closest neighbors.

• Acceptance of Key Points: From the Euclidean distances array, ratio of two distances is calculated. This ratio helps to reject the false key points. Key point validation returns entire training set images with number of matched key points. First step of matching algorithm is to sort the training images with maximum count on the basis of the matching threshold Mt. The training images whose maximum count is greater than matching threshold Mt , indicates that the images are closely matched. Second step is to determine the perfect match from the set of closely matched training images. To find exact match, Sum of Absolute Differences between key points of the closely matched training images and test image has been calculated. More formally, Itest and Itrain represents the test and training image, respectively. Distinctive Features for the test and training image are represented as:

- $K_T^{Itest} = \{k_1^{Itest}, k_2^{Itest}, k_3^{Itest}, \dots \dots k_N^{Itest}\}$
- $K_{TN}^{Itrain} = \{k_1^{Itrain}, k_2^{Itrain}, k_3^{Itrain}, \dots \dots k_M^{Itrain}\}$

N and M indicates number of key points in the test and training images. Key points of the training images sorted on the basis of the MT will be represented as:

- $K_{ST}^{Istrain} = \{k_1^{Istrain}, k_2^{Istrain} k_3^{Istrain} \dots \dots k_M^{Istrain}\}$

Sum of of the key points of the test image and sorted training images.Sum of Absolute Differences of key points, SADK between coordinates of the key points of the test image and sorted training images ST of size Sz is calculated using following expressions.

Absolute Differences of key points, SADK between coordinates

$$D_{diff(x'y')} = \left(\sum_{i=0}^{N-1}\sum_{j=0}^{1}\left|\left(I_{test(i,j)}\right)\right|\right) - \left(\sum_{x=0}^{M-1}\sum_{y=0}^{1}\left|\left(I_{strain(x,y)}\right)\right|\right) \qquad (11)$$

$$Recognized\ Image = \min(SADK_{ST})$$

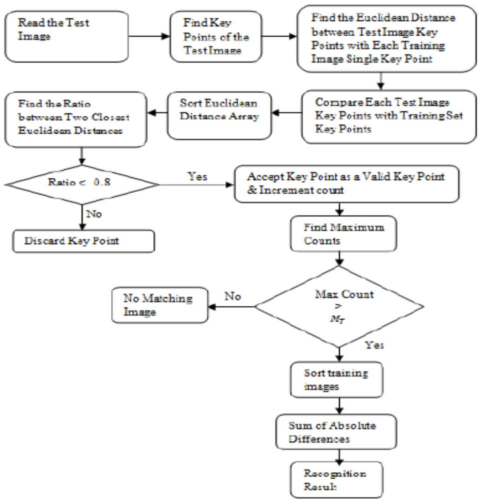

Fig.4 Flow Chart of Face Recognition

IV.EXPERIMENTAL RESULTS:

To attain the investigation of Face recognition using SIFT, various experiments have been conducted on different databases executed on an Intel Core 2 Duo CPU running on 2.26 GHz with 8 GB RAM with windows OS (64 Bit) and Open CV 1.1(Visual Studio 2008) . With the mentioned hardware response time is 0.4secs for the database. In every database, there are 20 subjects and each subject had 5 different facial views representing different poses, varying lighting conditions and e xpressions. Each image is digitized and stored as 92 x 112 pixel array. The file is in JPG format. The experiment is conducted on different databases, here separate training and test images have been taken. Each training set is set up by a selection of 3 samples for each person randomly, which includes 60 images totally and the testing set consist of the remaining. In this experiment, highly distinctive key points are extracted for all the images in the training data set. The co-ordinates of these key points are kept in the array.

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After obtaining the training images and the test images, the Euclidean distance between these two set of images is calculated. The Euclidiean distance array is set, which helps to find the two closest neighbors and to reject the unwanted/fake key points. Then the maximum no.of matched keypoints between training images and test images are counted. The training images which have the maximum i.e greater than threshold are sorted. Then the image with the least Sum of Absolute Difference is known to be the recognized image. The GUI is set to display the recognized image and the message "Authenticated" and "Un-Authentication" is displayed in the cell phone which is sent by SMS reporting system present on the GSM module.

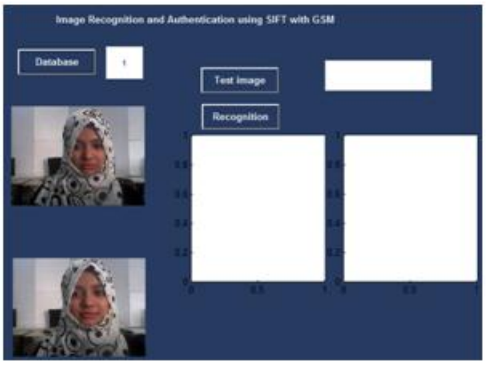

Fig.5 Training Image

Fig.6 Test Image

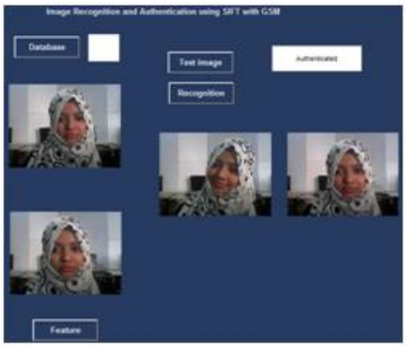

Fig .7 Authenticated Image

Fig .8 Un-Authenticated Image

V. PERFORMANCE EVALUATION:

Performance Evaluation of SIFT algorithm for the Images can be easily studied by taken no.of images on x-axis and desired one on y-axis.

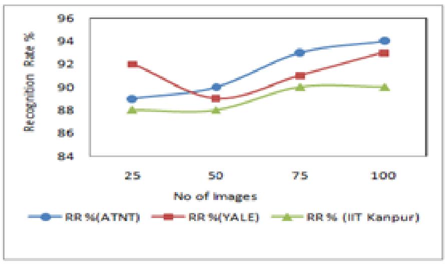

Fig.9 Recognition Rate

To demonstrate the efficiency of the proposed method, recognition rate for the database has been calculated. From the figure it is very clear that with each heterogenous database recognition rate is more than 90%.False Rejection Rate is the measure of incorrectly rejected un-authorised image. Whereas the False Acceptance Rate will be the measure of the incorrectly accepted un-authorised image.

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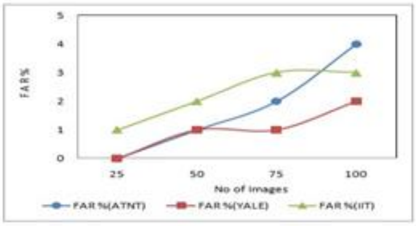

Fig.10 False Acceptance Rate

From the Fig.9 and Fig.10 it can be seen that even though number of training images are increasing, FRR % and FAR % are very very less. The performance of the databases which are taken in our project are compared graphically.

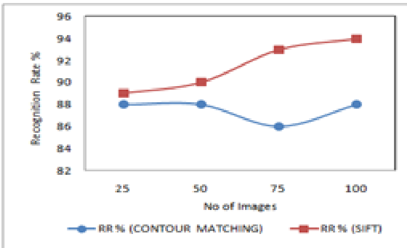

Fig.11 Comparission of Databases

CONCLUSIONS AND FUTURE SCOPE:

Attendance System with face recognition and SMS reporting system using SIFT algorithm and GSM module has been studied. Face recognition using Scale Invariant Feature Transform (SIFT) outperforms and gives 90% recognition rate. Face recognition is done very accurately and efficiently by using SIFT under varying brightness, scale, orientation and pose. Whereas, the earlier methods fail to detect when there is a change in these aspects. We have experimented with many data bases. The Experimental results show that face recognition using SIFT is reliable and robust. Although, Face recognition outruns when the database increases but in the case of twins it gets confounded which is futhur resolved by the implementation of Neural Networks.

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