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Face Recognition and Detection Using Hausdorff Distance, SURF and SVM

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Abstract:
In the pattern recognition and computer vision field, an intriguing and a challenging problem that is widely studied is biometric based recognition by face. Biometric refers to authentication techniques that rely on measurable physical and behavioural characteristics that can be automatically verified. There are several types of biometric identification schemes namely fingerprint, hand geometry, retina, iris, signature, vein, voice, and face. Face biometric is the analysis of facial characteristics. Face Recognition is an application of biometric and it has utilizations in authentication by biometric, video surveillance, security and so forth. Face recognition system is a computer application which is capable of identifying or verifying an individual from a digital image or a video frame. One way to do this is by comparing the facial features selected from the input image and a facial image stored in database. In earlier years, several techniques for recognition by face biometric were prospected. Nevertheless, these techniques were affected from dilemma such as pose, illumination variations, increased distance between individual's face and camera can blur the image and noise was also one of the reason due to which earlier techniques were with destitute performance. In this paper face recognition and detection is done by using Hausdorff Distance with SURF and SVM. The implementation of research is on image processing toolbox under Matlab software.

Keywords: Face Recognition, SVM, SURF, Hausdorff Distance

I. INTRODUCTION

Biometrics can be construed as the set of procedures which are used to measure the physical and behavioural traits of a person for identification and verification. A biometrics is an automated technique for recognizing an individual uniquely on the basis of physical or behavioral characteristics. Face recognition a promising and popular research field in the pattern recognition and computer vision. Face Recognition essentially scrutinize an individual in a digital image or video by analysing and correlating patterns. It is widely used in security systems like other biometrics such as eye iris or fingerprint recognition system. Face Recognition supports the security systems, surveillance, credit cards, passport, etc. Several techniques have been implied in last few years. Among all the contrasted and distinctive biometric schemes, face recognition may not be the most solid and productive, but one main point is that it doesn't pursue the test's collaboration subject to satisfy. Different biometrics like fingerprints, iris sweeps, and rhetoric recognition cannot perform this kind of recognizable proof. One of the dominant parts of face distinguishing proof is its vigour. In contrast with different biometrics, a face recognition framework would consent a passer to be recognized by just strolling forward to a reconnaissance camera. In this paper Hausdorff distance is used with SURF and SVM.

This paper is presented as follows: Section II review of literature related with research is presented. In section III methodology is discussed. In section IV the results obtained and parameters used are discussed and the paper is concluded with section V.

II. LITERATURE WORK

Face recognition is the promising field of research in biometrics. The research work that has been done in last few years is discussed in this section. Recognition by face biometrics gathers the interest of all researchers. Review of literature goes further search for data and involves the recognition and connection between literature and our research.

Ghinea, Kannan, *et al.* in [1] suggested a peculiar approach for faces recognition. Schur faces are introduced in this paper. It is a robust interpretation of conventional PCA. In this paper the authors use the Hausdroff distance for analyzing similarity or resemblance among distinct faces. Experiments were conducted on Yale and ORL face databases that shows the introduced approach is highly segregated and assuring accuracy for reorganization of face.

Ramadan and Abdel–Kader in [2] defines a peculiar algorithm for selection of features that is supported by PSO (Particle swarm optimization) technique. This algorithm is supported by coefficients derived from two techniques applied for extracting features: Discrete wavelet transform (DWT) and Discrete cosine transforms (DCT). PSO is an estimating model that supports the idea of synergetic behaviour influenced with the social demeanour of fish or bird behaviour. The suggested feature selection method supported by PSO is persisted to search component space for ideal facial components subset. Transformation is lured by a proficient function processed for enlarging the class separation. ORL face database is used. The length and the performance of the classifier of preferred facial component vectors are considered for performance estimation.

Dong Hui, Han Dian Yuan in [3] recommend SURF method to disclose and define the interest points and then match the interest positions by KD-tree closest position

searching criteria. The result obtained shows high time efficiency and excellent robustness. The characteristics of face are elicited by using SURF method. The usage of KD-tree searching method properly utilizes the efficacy for locating exact same position pairs. In this paper, matched images with distinct pivot edge were consummate.

Aneesh M U, *et al.* in [4] proposed a novel method by intelligent acceleration of particles called Accelerated Binary Particle Swarm Optimization (ABPSO). ABPSO is used for selecting features for obtaining extremely reduced feature and enhanced recognition rate. In this paper ABPSO performance is entrenched by measuring the no. of selected features on ORL and Cropped Yale B databases and recognition rate. Number of selected features and recognition rate results are gathered in tabulated form. This technique is appropriate for searching the feature space to have optimal feature subset. In this paper Experiments are performed on ORL and Cropped Yale B databases. In this algorithm produce enhanced results that depicts high recognition rate with selected features.

Thorat *et al.* in [5] focuses on 3-D facial and biometric facial recognition systems. The paper recommends the outlook of recognition system in India and also judge strength and weaknesses of face recognition system. Certain applications of face recognition technology are now more reliable, accurate and cost effective. Now's days face recognition system is used in ATM's, visa verification, driving license verification, and to identify the identity of duplicate voters, passport, in governments and private sectors, recognition of personnel in defence, in competitive and other exams.

Hamid M. Hasan *et al.* in [6] deals with using of Radon Transform (based on FFT slice theorm) followed by PCA and LDA techniques for Face Recognition. The data used are 2D Face Images from ORL Database. The directions along which the Radon transform is performed are selected using PSO. In this paper authors uses PCA technique for dimension reduction of data which is produced by Radon Transform and for minimizing the ratio between-class scatter and within–class scatter LDA technique is used which find set of basis vector for minimization.This method was verified on ROL data base using five different scenarios for training set selection. The best recognition rate was 97.5% when only 35 eigenvectors are used.

III. METHODOLOGY

Methodology is defined as the systematic, theoretical analysis of the approach applied to the research. Methodology that is followed in this research work is discussed in this section. Here, face recognition is done which is based on Hausdorff distance and for recognition and matching SVM and SURF is applied.

Firstly the image is selected from the database or from anywhere possible and given as input. Then pre-processing is performed. After that facial features are extracted by using hausdroff distance. For classifying the features obtained, Support Vector Machine classifier is used. After classification the matching is performed by using SURF feature and experiments are performed for analyzing the efficiency of proposed approach. The flowchart of methodology is shown in figure 1 below;

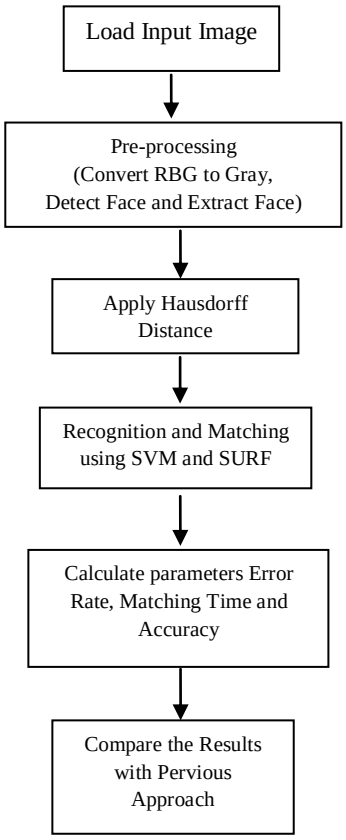

Fig 1: Flowchart of Methodology

In methodology followed, following steps are involved.
Step 1: Firstly a code is developed for the loading of face image from the database i.e loading the face image value in the workspace of the Matlab.

Step 2: Next step is to develop a code for applying Pre-processing Techniques to the loaded image. Code is developed to generate the formula for pre-processing like rgb to gray, image to binary, detect face and extract face in the Matlab.

Step 3: After that a code is developed for the calculating the Hausdorff Distance in the Matlab. In this step code is developed for the feature extraction technique to extract the face feature.

Step 4: Develop a code for the recognition of the loaded face image by using SVM classifier and for matching SURF Technique is used.

Step 5: Lastly develop a code to analyze result using parameters like Error Rate, Matching Time and Accuracy and compare with previous approach.

Hausdorff Distance:
In mathematics this distance is also called Pompeiu–Hausdorff distance. Hausdorff distance determines how far two subsets are from each other. The Hausdorff distance is

named after Felix Hausdorff. Generally, the two sets are near in Hausdorff distance if each point of one or the other set is near to some point of the other set. This is the protracted distance that can be contrived to travel by an antagonist who elects a point in one of the two subsets. Particularly, this distance is the maximum distances from a point in one set to the nearest point in the other set.

RECOGNITION:
Recognition is the process of identifying someone from the previously obtained knowledge. This is achieved by extracting face feature and then compare these extracted feature to the database for determining that which image matches the closest to it. In this research work recognition is performed by using support vector machine (SVM) classifier.

Support Vector Machine (SVM):
In 1992, Vapnik illustrated a classification scheme named SVM classifier. In bioinformatics and other applications this classifier is generally applied by virtue of its many characteristics such as high precision, and can process high dimensional data like gene expression. In case of non-linear classification, kernel trick is used for classifying support vectors. A kernel trick implies the data gathered through dot products. In this case, kernel function estimates the dot product in conceivably high dimensional space of facial components. Support Vector Machines classifier has consummate incredibly in machine learning and classification. Classification is acquired by understanding a linear or non-linear partition surface in the information space. The sample of SVM in bioinformatics are protein Structure and arrangement either DNA or protein. It stacks the set with the closest combine of focuses from inverse classes like the Direct SVM calculation.

SVM Algorithm
1. Identify a violating point in the dataset.
2. If there is a Violator point is identified in the dataset then it will be greedily added to the candidate set.
3. It may take place if adjoining of the contaminate point as a Support Vector might be impeded by other candidate Support Vectors that are already present in the set.
4. Steps are repeated if the points are contaminate eliminated.

MATCHING:
Speed up Robust Features (SURF)
SURF algorithm is a feature point extraction algorithm. It is purposed by Bay H, Tuytelaars T, Gool L V in 2006. SURF algorithm works in two parts:
- Feature Point Detection.
- Feature Invariant Point Descriptor.

SURF (Speeded Up Robust Features) algorithm is the quickened adaptation of SIFT (Scale-Invariant Feature Transform), having a more noteworthy advancement continuously. SURF is utilized for object acknowledgment and target following. SURF descriptors are utilized to create instructive component vectors. One of the fundamental points of interest of SURF is that it rapidly processes unmistakable descriptors. SURF descriptors are invariant to some basic picture changes like picture pivot, perspective, change in scale, light illumination. Surf is utilized as a part of different frameworks for performing coordinating operation. It is a hearty nearby component finder and is great at taking care of pictures with revolution and obscuring. Various Experiments demonstrates that SIFT is three times slower than SURF. It approximates the plans which are already proposed as for uniqueness, repeatability, and power but then can be registered and contrasted much quicker as looked at and other coordinating strategies.

Also, SURF depends on totals of 2D Haar wavelet equations and makes an effective utilization of integral images. This uses a whole number rough guess to the determinant of Hessian blob detector; which can be figured to a great degree rapidly with an integral picture (3 number operations). This uses the whole of the Haar wavelet reaction around the purpose of hobby. These can be registered with the integral's guide image. SURF utilized as a part of this way to deal with concentrate applicable elements and descriptors from images. This methodology is favoured over its ancestor because of its concise descriptor length i.e. 64 skimming point values. In SURF, a descriptor vector of length 64 is built utilizing a histogram of inclination introductions in the nearby neighbourhood encompassing every key point.

IV. EXPERIMENTAL RESULTS

This section contains two parts parameters used and results:

Parameters Used:
There are some parameters which were useful validating the approach. In our implementation error rate, matching time and accuracy is estimated.

MSE: MSE is the cumulative squared error between the confining and the original image. Mean square error is considerably a signal fidelity measure. The purpose of a signal fidelity measure is to compare two signals. Consistently, it is pretended that one of the signals is bright, while other signal is distorted or corrupted by errors. The MSE is given by formula:

$$MSE = \frac{1}{M * N} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [f(x,y) - F(x,y)]$$

Where, *M*x*N* is the size of image, f(x,y) is the original image and F(x,y) is the reconstructed image.

PSNR: PSNR is most commonly used to measure the quality of image confining. The signal in this case is the original data, and the noise is the error introduced by confining. When comparing confining, PSNR is a human perception of reconstruction quality. The PSNR is calculated based on color texture based image segmentation. The PSNR range between [0, 1], the higher is better. PSNR calculate by using formula:-

$$PSNR = 20\log10\ (255/\sqrt{MSE})$$

PSNR is most commonly used to measure the quality of alteration. The signal in this case is the original data, and the noise is the error introduced by confining. Although a higher

PSNR generally indicates that the alteration is of higher quality, in some cases it may not.

Error Rate: Error rate is delineated as the rate at which errors occur in a transmission system. Bit error rate can be calculated by using formula:

$$Bit\ Error\ Rate, BER = \frac{Number\ of\ errors}{Total\ number\ of\ bits\ sent}$$

If there is high signal to noise ratio, then there will be very small bit error rate, possibly having no notable effect on the entire system.

Results:

The main objective of the research was to recognize and detect face with Hausdorff distance and SURF and SVM. The results obtained for validation of the proposed work with different parameter like Error rate, matching time and accuracy is discussed and compared with the previous work. In figure 2 and 3 comparison of error rate is shown between previous and proposed approach. The value obtained of Error rate should be less as lower the value, means less no. of errors present. Lesser the errors, more better is the approach.

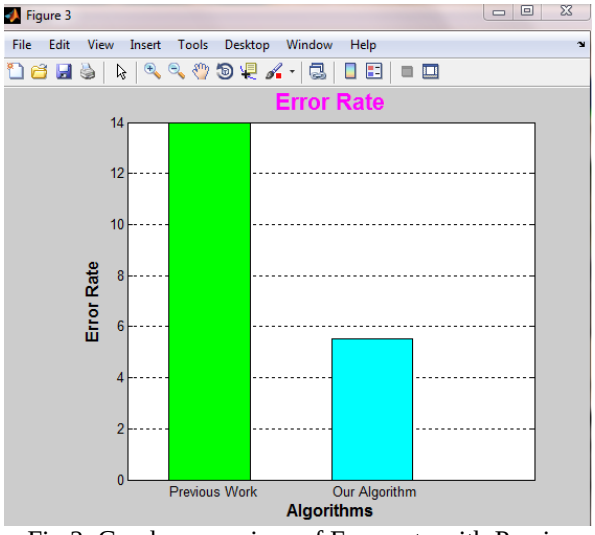

Fig 2: Graph comparison of Error rate with Previous and proposed algorithm

In figure 2 and 3 the graphical comparison and value obtained of error rate for both previous and proposed algorithm is shown.

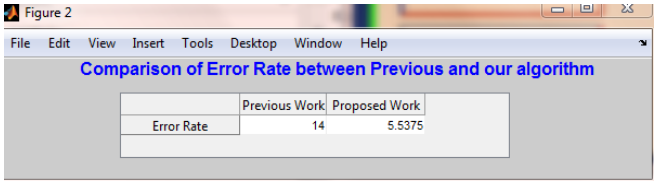

Fig 3: Comparison of error rate with Previous and proposed algorithm

When we compared these results with the results shown in previous work, we found that the error rate value in prospected work is less (5.53) as compared with previous work.

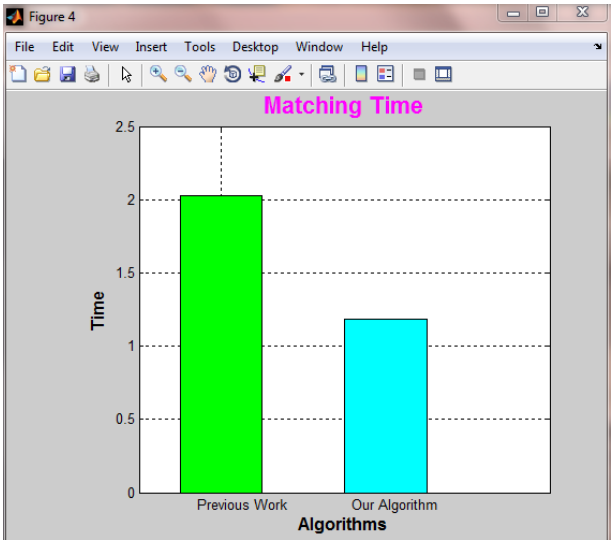

Fig 4: Graph comparison between Previous and proposed algorithm Matching Time

In figure shown (fig 4 and 5) shows the comparison of matching time among previous and proposed scheme.

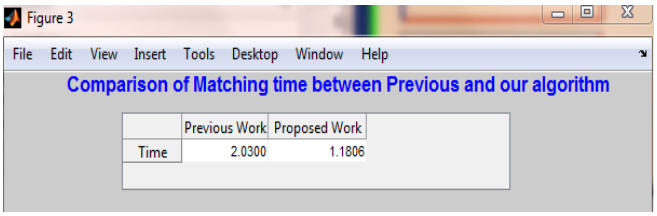

Fig 5: comparison between Previous and proposed algorithm Matching Time

When we compared these results with the results shown in previous work, we found that the value of matching time in previous work is more as compared to proposed work. This states that our approach is fast as it takes less time for performing matching.

Figure 6 and 7 shows the comparison of average accuracy between previous approach (SURF+SVM) and proposed approach (Hausdorff distance + SURF + SVM).

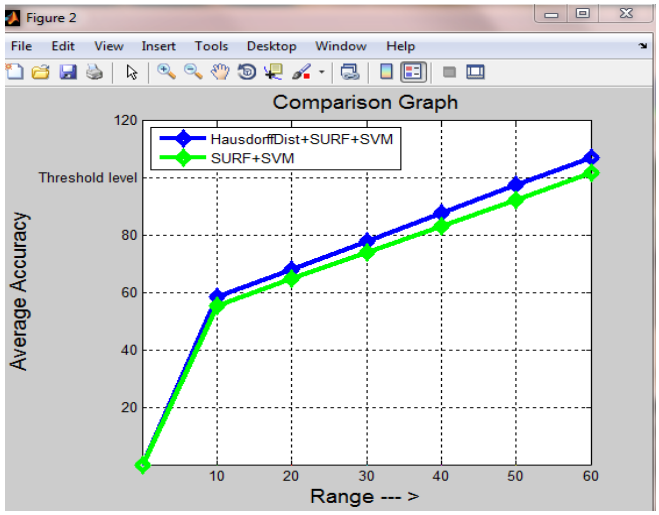

Fig 6: Graph comparison of Average Accuracy with Previous and proposed algorithm

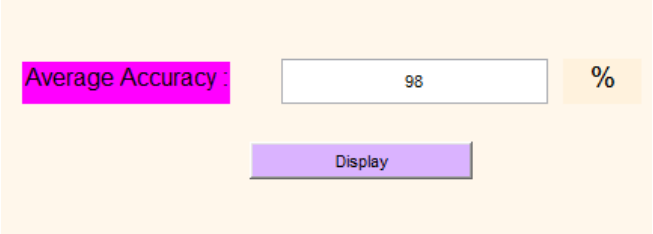

Fig 7: Comparison of Average Accuracy with Previous and proposed algorithm

When the results obtained is compared with the results shown in previous work, it is found that the proposed approach gives 98 percent of average accuracy which is high in comparison to previous technique.
The experimental results obtained validate that the prospected technique is more competent and decisive.

V. CONCLUSION AND FUTURE SCOPE

In this paper, we propose an efficient approach for recognition and detection of face using Hausdorff distance with SURF and SVM. This approach utilized for accomplishing better Error Rate, matching time and average accuracy result. The research work is limited to acquire face recognition from single image. The work can be extended on different images at the same time. More and different parameters can be considered in future. Additionally, new algorithms can be applied for the improvement in detecting face and minimizing the execution time. Furthermore the algorithm proposed in this paper can be implemented and realized on various tools.

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