FARFE: Face Recognition Feature Extraction Approach

Anshul Mishra, Arun Kumar Shukla

Abstract—In the modern era of computing, object recognition form a deeply entrenched and omnipresent component of intelligent social systems. With data and information accumulating in abundance, there is a crucial need for high security. Biometrics has now received more attention. Face biometrics, useful for a person's authentication is a simple and non-intrusive method that recognizes face in complex multidimensional visual model and develops a computational model for it. In this work we presented a novel Face Recognition feature selection system, FARFE, based on combination of Particle Swarm Optimization (PSO) and Oriented FAST Rotated Brief (ORB). The proposed PSO and ORB based feature selection system is utilized to search the feature space for the optimal feature subset where features are carefully selected according to a well-defined discrimination criterion. The classifier performance and the length of selected feature vector are considered for performance evaluation using MATLAB in ORL face database.

Keyword: Face Recognition, Feature selection, PSO, ORB, ORL Dataset, Computer Vision, SURF, SIFT

I. INTRODUCTION

Face recognition is the ability of categorize a set of images based on certain discriminatory features. Classification of the recognition patterns can be difficult problem and it is still very active field of research. Face recognition has long been a goal of computer vision, but only in recent years reliable automated face recognition has become a realistic target of biometrics research. New algorithms, and developments spurred by falling costs of cameras and by the increasing availability processing power have led to practical face recognition systems. A wide variety of systems require reliable personal recognition schemes to either confirm or determine the identity of an individual requesting their services. The purpose of such schemes is to ensure that the rendered services are accessed only by a legitimate user and not anyone else [1].

Face biometrics, useful for a person's authentication is a simple and non-intrusive method that recognizes face in complex multidimensional visual model and develops a computational model for it. A ubiquitous property of human perception is our ability to distinguish between different faces even when they look really similar and recognize hundreds of different individuals with almost no effort. Automated face recognition is an area within Computer Vision inspired by this ability. Facial recognition systems focus on extracting faces from static images and video sequences and deciding whether they belong to a database of known individuals [2]. Face recognition (FR) has emerged as one of the most extensively studied research topics that spans multiple disciplines such as pattern recognition, signal processing and computer vision. This is due to its numerous important applications in identity authentication, security access control, intelligent human-computer interaction, and automatic indexing of image and video databases [3]. Face is the index of mind. It is a complex multidimensional structure and needs a good computing technique for recognition. While using automatic system for face recognition, computers are easily confused by changes in illumination, variation in poses and change in angles of faces. A numerous techniques are being used for security and authentication purposes which includes areas in detective agencies and military purpose [4].

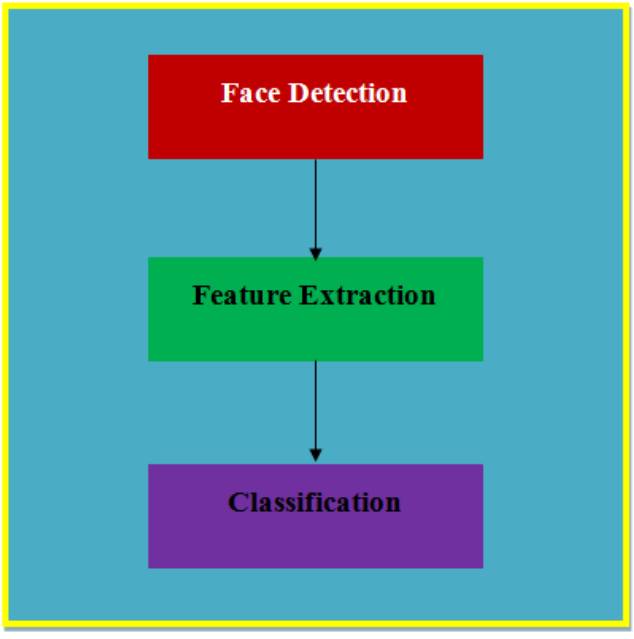

Figure 1: Face Recognition

The face detection and face extraction are carried out simultaneously. The complete process of face recognition can be shown in the Figure 1. The first step in face recognition system is to detect the face in an image. The main objective of face detection is to find whether there are any faces in the image or not. If the face is present, then it returns the location of the image and extent of the each face. Pre-processing is done to remove the noise and reliance on the precise registration.

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The facial feature detection is the process to detect the presence and location of features, like nose, eyebrow, eyes, lips, nostrils, mouth, ears, etc. this is done with the assumptions that there is only a single face in an image. In the Face recognition process the input image is compared with the database. The input image is also called as probe and the database is called as gallery. Then it gives a match report and then the classification is done to identify the sub-population to which new observations belong [5].

II. BACKGROUND

A. *Particle Swarm Optimization (PSO)*

Particle Swarm Optimization is an algorithm capable of optimizing a non-linear and multidimensional problem which usually reaches good solutions efficiently while requiring minimal parameterization. The basic concept of the algorithm is to create a swarm of particles which move in the space around them (the problem space) searching for their goal, the place which best suits their needs given by a fitness function [6]. PSO shares many similarities with evolutionary computation techniques such as GA's. The system is initialized with a population of random solutions and searches for optima by updating generations. The search process utilizes a combination of deterministic and probabilistic rules that depend on information sharing among their population members to enhance their search processes

B. *Oriented FAST and Rotated BRIEF (ORB)*

ORB is basically a fusion of FAST keypoint detector and BRIEF descriptor with many modifications to enhance the performance. ORB [7] builds on the well-known FAST key point detector and the recently-developed BRIEF descriptor; for this reason we call it ORB (Oriented FAST and Rotated BRIEF). Both these techniques are attractive because of their good performance and low cost. ORB includes,

- ➔ The addition of a fast and accurate orientation component to FAST.
- ➔ The efficient computation of oriented BRIEF features.
- ➔ Analysis of variance and correlation of oriented BRIEF features.
- ➔ A learning method for de-correlating BRIEF features under rotational invariance, leading to better performance in nearest-neighbor applications.
- ➔ First it uses FAST to find key points, and then apply Harris corner measure to find top N points among them. It also use pyramid to produce multi-scale-features.

III. LITERATURE SURVEY

Some of the publications in this topic of research are briefly reviewed in the following.

In this, authors present a fusion approach to solve the non-rigid shape recovery problem, which takes advantage of both the appearance information and the local features, they have two major contributions. First, they propose a novel progressive finite Newton optimization scheme for the feature-based non-rigid surface detection problem, which is reduced to only solving a set of linear equations. The key is to formulate the non-rigid surface detection as an unconstrained quadratic optimization problem that has a closed-form solution for a given set of observations. Second, they proposed a deformable Lucas-Kanade algorithm that triangulates the template image into small patches and constrains, algorithm for both efficient and effective issues [8].

However, YUN FU introduced paper about Age estimation from facial images has promising applications in human-computer interaction, biometrics, visual surveillance, and electronic customer relationship management, etc. Most existing techniques and systems can only handle frontal or near frontal view age estimation due to the difficulties of (1) differentiating diverse variations from uncontrollable and personalized aging patterns on faces and (2) collecting a fairly large database covering the chronometrical image series for each individual in different views, the researcher proposed a robust framework to deal with multi view age estimation problem, also a large face database, with significant age, pose, gender, and identity variations, which should be followed by classification or regression algorithms [9].

Also Zheng, was written in the same topic and focused on the human action recognition problem and propose a new Curve-Distance approach based on the geometry modeling of video appearance manifold and the human action time series statistics on the geometry information, he present experimental results on the KTH database demonstrate the solution to be effective and promising [10].

Gao was proposed a novel high order local pattern descriptor, local derivative pattern (LDP), for face recognition. LDP is a general framework to encode directional pattern features based on local derivative variations. The nth-order LDP is proposed to encode the $(n-1)^{th}$ -order local derivative direction variations, which can capture more detailed information, they discover that the high-order LDP consistently performs much better than LBP for both face identification and face verification under various conditions. Next section will be on face recognition applications [11].

Authors propose to use binary strings as an efficient feature point descriptor, which we call BRIEF. They show that it is highly discriminative even when using relatively few bits and can be computed using simple intensity difference tests. Furthermore, the descriptor similarity can be evaluated using the Hamming distance, which is very efficient to compute, instead of the L2 norm as is usually done. As a result, BRIEF is very fast both to build and to match. Authors compare it against SURF and U-SURF on standard benchmarks and show that it yields a similar or better recognition performance, while running in a fraction of the time required by either [12].

IV. PROPOSED WORK

The given section provides the detailed understanding about the proposed face recognition system.

Table 1: ORB Algorithm for ORL Datasets

Input: ORL Face Dataset **Output:** Reduced Redundancy, Features
Process:

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1: Load ORL Data set
2: Apply Oriented FAST and Rotated Brief, i.e. ORB
3: for ORB , do some estimation
4: Find Intensity of Centroids
5: Find Corner Points of the Images
6: Compute Orientation and Rotation
7: Get Features and divide into 3 different sets
i. Training Set
ii. Evaluation Set
iii. Testing Set
8: do classification of different Faces
9: ***End process***

Table 2: ORB + PSO Algorithm for Training Datasets

Input: ORL Face Dataset
Output: Reduced Redundancy, Feature Selection

Process:
1: Load ORL Data set
2: Apply ORB
3: Get Features and divide into 3 different sets
i. Training Set
ii. Evaluation Set
iii. Testing Set
4: Apply PSO Algorithm on above all 3 datasets
5: Calculate Fitness Function of all datasets

$$F = \sqrt{\sum_{i=1}^{L} (M_i - M_0)'(M_i - M_0)}$$

$M_0 = means\ of\ corresponding\ classes$
$M_i = grand\ mean\ in\ the\ feature\ space$
$F = class\ scatter\ fitness\ function$

6: Find Maximum and Minimum value of all 3 datasets
i. Training Set – Maximum and Minimum
ii. Evaluation Set – Maximum and Minimum
iii. Testing Set – Maximum and Minimum
7: Apply PSO function
Input:
$X = Swarm$
$F = Swarm\ Fitness$
FE_max=Maximum number of function Evaluation (Iteration)
$Fun = Function\ Specifire$
$err = Admissible\ error$
$LB = Lower\ bound$
$UB = Upper\ bound$
opt_f=Global optimum for function
Retrieved optimized function features of faces
8: do classification of different faces
9: End process

Here we listed algorithmic structure of the proposed face recognition system. In table 1 demonstrate the ORB analysis of for extracting the feature of an image. We apply ORB algorithm. For demonstrate this, we need to calculate different constraints. After that we get features and divide into three different dataset by estimated of ORB algorithm for evaluating classification of different images. Next table contain combination of ORB with particle swarm intelligence algorithm in which we take different input parameters for functioning of PSO Algorithm. In the last different images return optimized function feature for process of classification.

V. RESULT ANALYSIS

This section provides the analysis of obtained results and performance of the system implemented for face recognition.

A. Precision

Precision rate (%) is defined by the ratio of the numbers of correct recognition to total numbers of recognition for each person face. Precision is the fraction of the detected images that square measure relevant to the user's wants. It is additionally referred to as reliability or repeatability and is that the degree to that recurrent measurement beneath unchanged conditions shows an equivalent result. Equation (1) represents them.

$$Precision = \frac{Number\ of\ True\ Positive}{Number\ of\ all\ Detected\ Pattern}$$

In binary classification, precision is additionally known as positive predictive value. It is represented in Equation (2).

$$Precision = \frac{TP}{TP + FP}$$

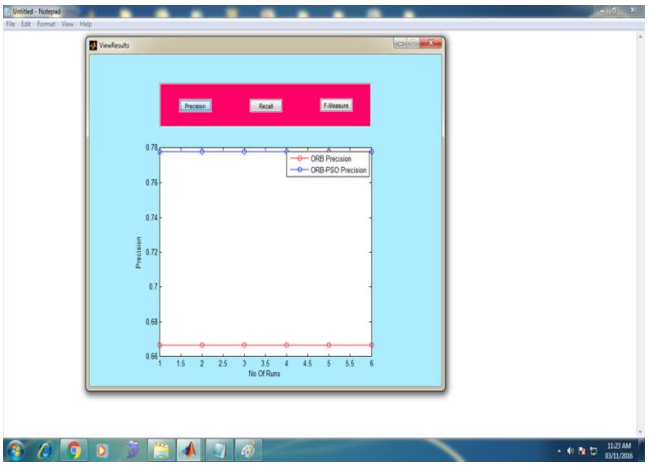

Figure 2: Precision rates (%) Comparison of traditional and proposed

The figure 2 shows the performance of base ORB and proposed PSO based ORB face recognition techniques. According to the obtained results of precision rate of both the systems are comparable as shown in figure. But the comparative performance of the proposed model is much accurate for face recognition as compared to traditional recognition. Thus the method is much adoptable for face recognition.

VI. RECALL

The Recall rate (%) is defined by the ratio of the numbers of correct face recognition to total number of input faces for each person. Recall is the proportion of positive cases that were properly identified. It is the fraction of relevant images that are successfully detected. It is additionally referred to as true positive rate. Recall is calculated using Equation (3).

$$Recall = \frac{Number\ of\ True\ Positive}{Number\ of\ Relevant\ Patterns}$$

In binary classification, recall is commonly referred to as sensitivity. It is denoted in Equation (4).

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$$Recall = \frac{TP}{TP + FN}$$

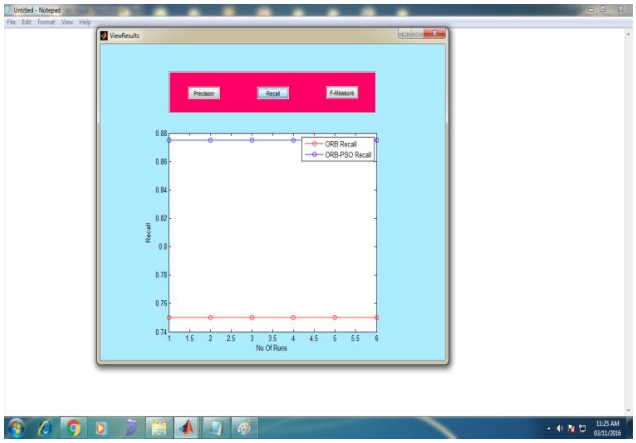

Figure 3: Recall rates (%) Comparison of traditional and proposed

The Recall rate for the proposed system is given the figure 3. In this diagram shows the performance of face recognition using ORB and PSO based method. In order to represent the performance of the system X axis shows the number of runs and the Y axis contains the recall rate of the input patterns. According to the obtained performance of system the face recognition for the recall is higher as compared to traditional classifier.

VII. F-MEASURE

F-measure is additionally referred to as F-Score or F1-measure. It combines the exactness and recall. It computes the average of the precision and recall. A conventional F-measure is the harmonic mean of precision and recall. This score is used to give a summary of the PR curve. It will be denoted as in Equation (5):

$$F - measure = \frac{2 * Precision * Recall}{Precision + Recall}$$

In binary classification it is denoted as in Equation (6):

$$F - measure = \frac{2 * TP}{(2 * TP + FP + FN)}$$

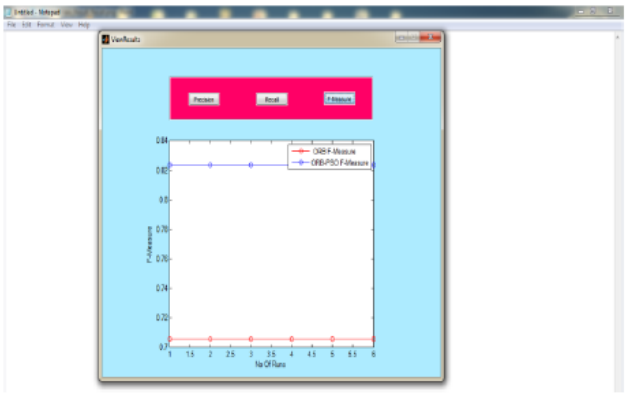

Figure 4: F-measure Comparison of traditional and proposed

The performance of the system in terms of ORB face recognition and ORB+PSO face recognition is given using figure 4. The above figure represents the F-measure of the system. In this x axis contains number of runs and y axis shows f-measure rate for both proposed and tradition. Thus the proposed model ORB+PSO Face recognition is adoptable with the high f-measure rate during the analysis of the face

VIII. CONCLUSION

Humans have a capability to recognize a wide range of familiar and novel objects with little effort even though they may vary in attributes like form, color, texture, etc. Typically, objects are recognized in many different places, from many different vantage points, of different sizes and sometimes, they may even be partially obstructed from view point. Face recognition is a challenging problem in the field of image processing and computer vision. Because of lots of application in different fields the face recognition has received great attention. Optimal feature selection (FS) is to find the minimal subset of features from original feature set that can represent the whole dataset. In this presented work, a novel PSO and ORB based Face Recognition feature Extraction, *FARFE* is proposed. These techniques are frequently used in the new generation for optimizing the experience of human life.

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