ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2014

A Novel Idea for Age Invariant Face Recognition

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ABSTRACT: Biometric identification is the technique of automatically identifying or verifying an individual by a physical characteristic or personal trait. The term "automatically" means the biometric identification system must identify or verify a human characteristic or trait quickly with little or no intervention from the user. A face recognition system is non-invasive means it allow user to be identified by simply walking past a camera. Human beings often recognize one another by unique facial characteristics. Automatic facial recognition also uses certain facial characteristics that are unique in nature. Facial recognition is the most successful form of human surveillance.

The basic idea of this work focuses on the updation of corpus (database) by using a method based on feature extraction which is combined with minimization algorithm for searching process. This approach may be applied to other databases in which the data items varies with time such as human signature and other behavioural activities. The proposed idea first extracts features from the face images. These extracted features are stored in database during training period. Later on this database is used for identification. At the time of identification certain fitness function is calculated, if the value of fitness function decreases below a threshold value then the database is updated with features extracted from new image that is being identified. As in proposed idea the corpus is updated during recognition phase, it is expected to gives high acceptance rate as compared to static matching of face images. The application of this project range from static matching of controlled format photographs such as passports, credit cards, photo ID's, drivers licenses, and mug shots to real time matching of surveillance video images.

KEYWORDS: AFR, Biometric, Age invariant, corpus, learning, database optimization

I. INTRODUCTION

Face recognition is one of the most important biometric which seems to be a good compromise between actuality and social reception and balances security and privacy well. Also it has a variety of potential applications in information security, law enforcement, and access controls [1]. More efforts have been devoted to face recognition because of the availability of commodity cameras and deployment opportunities in many security scenarios. However, face recognition is susceptible to a variety of factors encountered in practice, such as pose and lighting variations, expression variations, age variations, and facial occlusions. Fig. 1 and Fig. 2 show examples of the pose and lighting variations and occlusion. Local feature based recognition has been proposed to overcome the global variations from pose and lighting changes[5]. The use of multiple frames with temporal coherence in a video and 3D face models have also been proposed to improve the recognition rate.

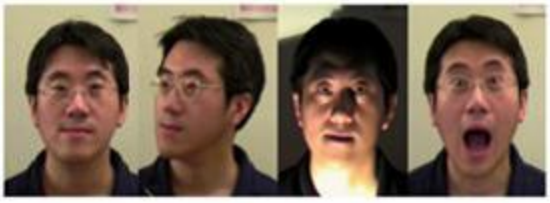

Figure 1: Example of images showing pose, lighting and expression variation.

DOI: 10.15680/IJIRSET.2014.0308073

ISSN: 2319-8753

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Pose Variation: Pose variation is one of the major sources of performance degradation in face recognition. The face is a 3D object that appears different depending on which direction the face is imaged. Thus, it is possible that images taken at two different viewpoints of the same subject (intra-user variation) may appear more different than two images taken from the same view point for two different subjects (inter-user variation).

Lighting Variation: It has been shown that the difference in face images of the same person due to severe lighting variation can be more significant than the difference in face images of different persons. Since the face is a 3D object, different lighting sources can generate various illumination conditions and shadings. There have been studies to develop invariant facial features that are robust against lighting variations, and to learn and compensate for the lighting variations using prior knowledge of lighting sources based on training data. These methods provide visually enhanced face images after lighting normalization and show improved recognition accuracy of up to 100%.

Figure 2: Example of images showing occlusion.

Occlusion: Face images often appear occluded by other objects or by the face itself (i.e., self-occlusion), especially in surveillance videos. Most of the commercial face recognition engines reject an input image when the eyes cannot be detected. Local feature based methods are proposed to overcome the occlusion problem.

Expression: Facial expression is an internal variation that causes large intra-class variation. There are some local feature based approaches and 3D model based approaches designed to handle the expression problem. On the other hand, the recognition of facial expressions is an active research area in human computer interaction and communications.

Age Variation: The effect of aging on face recognition performance has not been substantially studied. There are a number of reasons that explain the lack of studies on aging effects:

(i) Pose and lighting variations are more critical factors degrading face recognition performance.
(ii) Template update1 can be used as an easy work-around for aging variation.
(iii) There has been no public domain database for studying aging until recently.

Aging related changes on the face appear in a number of different ways:

(i) Wrinkles and speckles,
(ii) weight loss and gain, and
(iii) change in shape of face primitives (e.g., sagged eyes, cheeks, or mouth).

All these aging related variations degrade face recognition performance. These variations could be learned and artificially introduced or removed in a face image to improve face recognition performance. Even though it is possible to update the template images as the subject ages, template updating is not always possible in cases of missing child, screening, and multiple enrolment problems where subjects are either not available or purposely trying to hide their identity. Therefore, facial aging has become an important research problem in face recognition.

II. RELATED WORK

From literature it is found that human face recognition is an ongoing area of research since last five decades. Most of the work has been carried out by using statistical features, geometrical features, color, facial expression, pose and aging. Most of the face recognition studies that have addressed the aging problem are focused on age estimation or age simulation. Designing an appropriate feature representation and an effective matching framework for age invariant face recognition still remains an open problem. The algorithms used by many researchers for face recognition are PCA,

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LDA, Eigenspace-based adaptive(EP), Elastic bunch graph matching, 3-D morphable model, kernal method and so on. It is also found that the most of the work which was focused on aging, used the PCA algorithm.

The aging pattern of an individual depends on a variety of different factors that are difficult to model in a computational framework. But humans are quite good at matching faces across age progression[7]. This may mean that irrespective of the exact manner in which a person ages, there is a coherency in the way facial appearance changes with age. This motivates us to capture and utilize this coherency to recognize age-separated faces. Specifically, we analyse the coherency of the drifts in various facial features to verify whether two age-separated images belong to the same individual or not. We use approach to match the facial features across two images in order to evaluate the displacement. Since facial features are not specific to human faces, it does not always locate all the facial features. Also appearance changes like weight gain/loss will affect the facial features. For different image pairs, different number of features at different locations may be extracted. Moreover, since the displacement of features depend on the underlying facial muscle structure, this information may be used to obtain a better measure of drift coherency. Also, measures to capture textural variations with aging may be useful for matching age-separated images in adults.

III. GENETIC ALGORITHM

A genetic algorithm[10] is a heuristic technique used to solve optimization problems. Optimization problems attempt to find the best solution for a given problem that has several parameters with associated constraints. The most basic tools for solving optimization problems are complete enumeration of all possible choices, calculus, and linear optimization techniques using the simplex algorithm. The steps that are performed in Genetic Algorithm for optimization of database are as follows.

1. **Create Initial Population -** The GA selects an initial chromosome population of a specified size randomly. In other words, it fills in the input variables randomly with acceptable values. A full set of input variables is a chromosome, and it makes as many of these as you specify. For example, if the user has requested 20 population members in the problem definition, they are created by assigning random values to genes, based on the range set when the genes were defined. This provides an initial group of 20 population members for generation 0.

2. **Decode the Chromosome -** The GA then evaluates the 'fitness' of each chromosome by finding out how well it meets the fitness function. That is, how optimal an answer does this set of input values produce?

3. **Order the Chromosomes -** At the beginning of each generation, the population members are evaluated and then ordered according to their fitness.

4. **Choose Which Chromosomes will Mate -** In order for crossover to occur, we must pair two population members so that genes can be exchanged. Mate selection is carried out using evolutionary principles. That is, members with the best fitness are given a higher likelihood of mating, which increases the chances of superior offspring. Mate selection is accomplished by using a "graduated" roulette wheel.

5. **Perform Crossover -** Once a member of the population and its mate have been chosen, it must be determined which genes will be exchanged. This is done by randomly selecting two "cut points" in the string of genes. Genes in between the two cut points will be swapped between the population member and its selected mate.

6. **Store Offspring -** Each member of the original population will be given a chance to mate according to the "roulette" selection outlined above. This will result in a new population which is the same size as the original population.

7. **Mutate Selected Chromosomes -** After the new population has been created, randomly selected members of the population will undergo mutation based on the settings made by the user. For a random mutation, the GA randomly selects the population members to undergo mutation according to a specified mutation probability. The GA then randomly selects the genes which will be mutated according to the specified probability. Next, each gene selected will

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calculated, it is either added to or subtracted from the original gene. The new value of the gene is checked to make sure that it does not go outside the specified range.

8. **Replace parts of population with superior mutations and superior prior generation members –** The fitness for each member will be recalculated after all the genes have been mutated. The population members are then ordered according to their fitness. The best members of the old population may be added to the new population in some algorithms, unless the best members of the old population are not as good as the worst members of the new population. A genetic algorithm that keeps one or more of the best members from each generation is said to incorporate "elitism". This keeps the best members of the population from getting worse from one generation to the next, and insures that the fitness of the best member can only improve or stay the same. It also gives the "elite", highest-fitness individuals further opportunities to produce offspring in subsequent generations.

9. **Create new generation -** Once this has been done, the population is ready to create another generation. The population will cycle through generations until the Exit Condition is met.

IV. METHODOLOGY

The proposed model consists of two major stages of processing the image. The two phases are verification phase and updation phase. Verification phase is some what existing technology where the image are acquired from a live camera or taken from some other source. After acquiring the image pre-processing is done for removal of noise. This pre-processed image are then used by feature extraction phase followed by a verification phase. These phases will be discussed in next section. The updation phase is the key of proposed model where the database are periodically updated on the basis of existing information and current information using genetic algorithm. Figure 3 shows the basic block diagram of proposed methodology of age invariant face recognition. The whole diagram is divided into two blocks. The verification block situated at right side and the updation block on the left side.

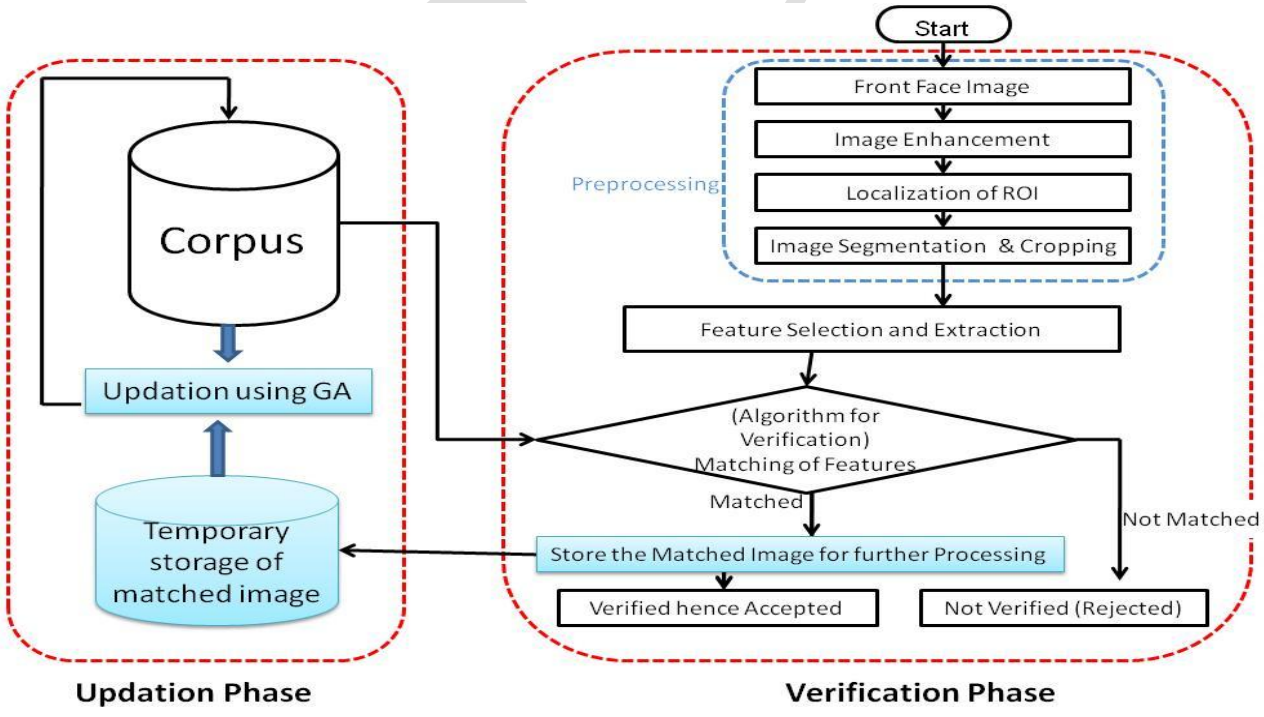

Figure 3: flow diagram showing the proposed methodology.

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A. **VERIFICATION PHASE:** Let's discuss the verification phase first. In The current scenario a trained database is used for verification purpose. It starts with acquiring a front face image from a live video. This module will continuously monitor the live video for any human face and will get a still image as soon a front face appears. This still image is then pre-processed i.e. image enhancement, localization of region of interest, image segmentation and cropping.

After pre-processing features are extracted from the given image. This work is going to be implemented using Elastic Graph Bunch Mapping technique therefore in feature extraction phase the landmark points are identified automatically. Gabor jets are used to represent the landmark jet information in the EBGM algorithm. A Gabor jet is produced by convolving the landmark location with a collection of Gabor masks. Therefore, the Gabor jet will contain a good description of the local frequency information around the landmark. The structure of Gabor wavelets allow this information to be heavily weighted in the area immediately surrounding the landmark, while still covering enough of the image to get a good description of the landmark. Gabor jets act as feature vectors that describe the landmark from which the jet was taken. Landmark similarity is based only on the Gabor jets taken from the two landmarks. The Gabor jets are based on a variety of Gabor masks and contain an accurate description of the landmark. Therefore, the similarity of jets is a best indicator of the similarity of the landmarks.

As a final step these extracted features in the form of Gabor jet are matched with the features already stored in corpus. On successful matching the image is verified or it is rejected. If the face is verified on successful matching then the current information are stored in the database and are associated with the matched information for further processing.

B. **UPDATION PHASE:** The complexity of this phase is much higher than the verification phase. It is basically responsible for time to time updation of database so to replace the unused outdated data with fresh information. This phase will came into existence periodically like at night or once in a weak, or even once in a year which depends on the frequency of verification of a single user. In this updation phase the concept of genetic algorithm has been adapted. As already discussed the images which are verified successfully are stored in a temporary database. These stored images are clubbed with associated data from corpus and then genetic algorithm is applied to optimize the corpus for better acceptance ration. In general the acceptance ratio reduces with time as face of human changes over time. The proposed idea is basically to maintain and increase (in certain cases) the acceptance ratio. Figure 4 describes the detail of updation phase where genetic algorithm is applied for optimizing the corpus.

A genetic algorithm is a heuristic technique used to solve optimization problems. Optimization problems attempt to find the best solution(s) for a given problem that has several parameters (goals or resources) with associated constraints. In the proposed idea following steps of genetic algorithms are used:

✓ **Start** Generate random population of n chromosomes (suitable solutions for the problem). In this phase the features of an object are selected from both database i.e. the corpus and the temporary database. Each object will have a number of Gabor sets already stored in corpus as well as some new sets will also be available in temporary data base.

✓ **Fitness** Evaluate the fitness f(x) of each chromosome x in the population. In the proposed model the fitness number will be directly proportional to number of times the set is used for verification purpose. The fitness number will be high for a set which is used more frequently as compared to other sets for the same object.

Repeat until a threshold value is obtained

✓ **Selection** Select two parent chromosomes from a population according to their fitness (the better fitness, the bigger chance to be selected).

✓ **Crossover** Crossover the parents to form new offsprings (children). If no crossover was performed, offspring is the exact copy of parents. This step is not required in the proposed model.

✓ **Mutation** Mutate new offspring at selected position(s) in chromosome. The Gabor set will be changed by calculating the average displacement of all selected sets.

✓ **Accepting** Generate new population by placing new offsprings. The new mutated Gabor set will replace the existing Gabor sets whose fitness value is lowest for a particular object.

✓ Return the best solution in current population. Current corpus data will be replaced with new data sets obtained after performing the above iteration.

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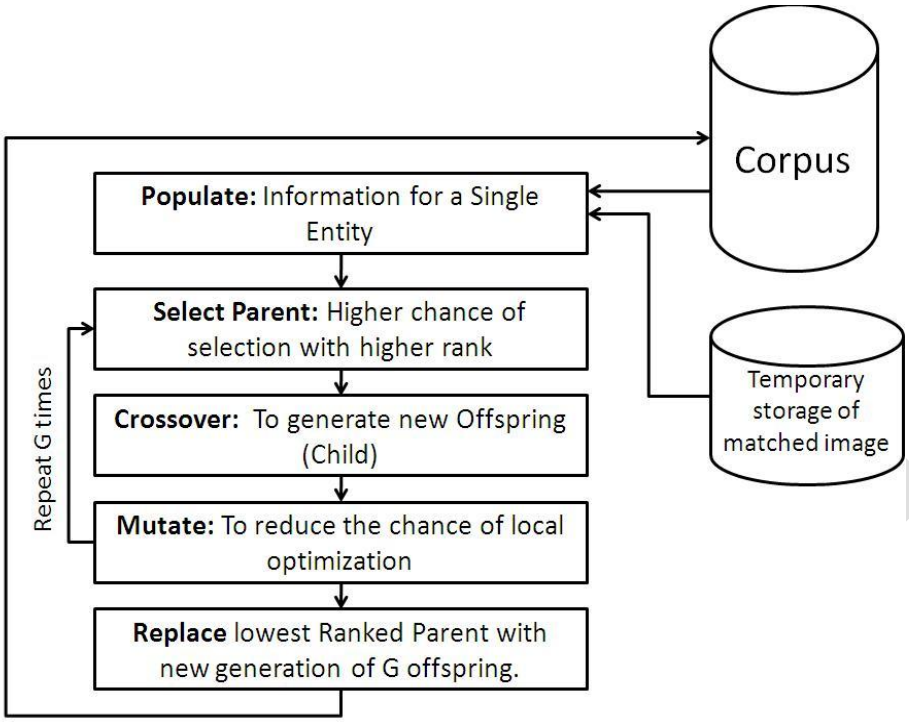

FIGURE 4: DETAIL EXPLANATION OF UPDATION PHASE

V. CONCLUSIONS

Face recognition is a challenging problem in the field of image analysis and computer vision that has received a great deal of attention over the last few years because of its many applications in various domains. Research has been conducted vigorously in this area for the past five decades or so, and though huge progress has been made, encouraging results have been obtained and current face recognition systems have reached a certain degree of maturity when operating under constrained conditions; however, they are far from achieving the ideal of being able to perform adequately in all the various situations that are commonly encountered by applications utilizing these techniques in practical life.

In the proposed work sufficiently optimized data-base for human face images will be obtained, that will be able to recognize a person effectively irrespective of age. Proposed algorithm will use optimized database at any stage of age therefore it gives acceptable results. As this algorithm will optimize the database periodically the complexity of algorithm will not affect the existing algorithm during verification process. In the proposed work, a thorough mathematical analysis will be performed for the recognition of face from front face feature extraction and a well optimized database. In order to achieve the target of age invariant face recognition this model with Genetic Algorithm will surely increase the acceptance ratio. This algorithm can be extended to other systems in which objects vary with time like signature in banking application.

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ISSN: 2319-8753

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