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# 3D Face Recognition System in Time Critical Security Applications

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**Abstract:** 3D face recognition has gained lot of attention due to improved sensors and advanced algorithms, deployment of this modality in biometrics systems is common now days. This paper presents the application of Region based 3D face recognition system. Region based face recognition system works by extracting 15 small regions from the frontal face; Modified face recognition algorithm along with hierarchical contour based registration technique is applied for finding similarity. We are operating this system in two modes namely the verification mode and the confirmation mode. The approaches employed is Distributed computing which gives more insight into the implementation of the system in time critical applications.

**Key words:** Biometrics · 3D Face Recognition · 2D Face Recognition · MFRA

## INTRODUCTION

The advancement in Computer technology and the need for better security applications brought biometrics into the main scenario. The term biometrics refers to the calculation of unique physical or behavioral characteristics for verifying personal identity. Face recognition is one of the most important research areas in computer vision and image processing. This technique is the least intrusive and most popular among biometric modalities. Face is considered as the most attractive biometrics due to its public acceptance. In Biometrics context the word recognition can be defined as the capability to perform identification and verification. In verification one biometric pattern is compared with another biometric pattern whereas in identification, one biometric pattern is compared with a set of biometric patterns.

Face recognition is considered as a difficult pattern recognition problem mainly due to inter class similarity and intra class variability. The intra class variability may be due to pose change, illumination, expressions, facial accessories and aging effect. Face recognition area is broadly classified as 2D face recognition and 3D face recognition. The major problem with 2D face recognition process is the change in pose, illumination and expression. As a result of this 2D face recognition system can be employed in limited applications.

In 3D face recognition the use of geometric depth information is having more relevance than color and texture; it is invariant to head angles, camera distance. Thus most of the limitations of 2D face recognition can be resolved by using 3D face recognition approaches, refer Table 1. 3D face recognition dominates mainly due to the advancement in 3D sensors.

The major application of face recognition in earlier days was in access control and video surveillance. This technology now plays a vital role in access and security, payments, criminal identification and health care. More over face recognition algorithms are implemented in video gaming and artist's uses facial recognition technology to project digital makeup on models.

Different algorithms are proposed to address the diverse aspects of face recognition technology, so here arise the need to analyze the effectiveness and efficiency of each algorithm. In this paper we are focusing on the effectiveness of region based 3D face recognition system powered by modified face recognition algorithm.

**Related Work and Overview:** A detailed survey of face recognition with its features was given in [1].

Gokberg *et al*. [2] discuss about the advancement in 3D face recognition technology, current research trends and open challenges. Five real world scenarios where 3D face recognition can be applied are highlighted in his work.

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Table 1: Strengths of 2D /3D Face recognition

| Features | 2D Face Recognition | 3D Face Recognition |
|---|---|---|
| Accuracy | | ✓ |
| Ease of use | ✓ | ✓ |
| Cost | ✓ | |
| Precision | | ✓ |
| Acceptance | ✓ | ✓ |

Akarun *et al*. [3] highlights on the 3D face recognition and its biometrics applications.

Chang *et al*. [4] makes use of a region based 3D face recognition approach by dividing the face into multiple sub regions. These regions are located in and around the nose.

Faltemier *et al*. [5] proposed a region based approach by dividing the face region into 28 sub region They reported a Rank one recognition rate of 97.2% and VR of 93.2% at an FAR of 0.1%. They further extend their work by taking the number of regions to 38.

Reji *et al*. [6] presented a region based approach by dividing the face region into 48 sub regions and reported a Rank one recognition rate of 97.1% and VR of 93.7% at FAR of 0.1%.

Zhong *et al*. [7] divides the frontal face into, the upper face region and the lower face region. The upper face region without the mouth is used for experimentation. K-means clustering is applied and results were obtained using nearest neighbor classifier.

Reji *et al*. [8] propose an algorithm for analyzing altered fingerprints along with its software implementation in java.

Lie *et al.* [9] presents a 3D face recognition approach relying on low level geometric features that are collected from the forehead, eyes and nose. These regions are relatively unchangeable in the presence of facial expressions.

**Proposed System:** Our region based 3D face recognition system is having two modes of operation, the Verification mode and Confirmation mode. This face recognition system is implemented as two programs using IDL as the language. The whole system is tested in a distributed environment with parallel processing. Architecture of our proposed face recognition system is shown in figure 4. We can apply this system mainly for criminal identification purpose.

In our approach we are having three databases namely test database, trained and probe database. Test database is having a collection of criminal's data. Trained database is used for storing sub regions; this will act as gallery while comparing with the image under scrutiny. Probe database is temporarily storing the image under scrutiny. Implementation of this approach starts with the execution of program 1. The algorithmic approach in this program is for automatic detection of nose tip and sub region generation.

Steps in program 1:

- Input the image.
- Smooth the image
- Automatic detection of nose tip.
- Sub region generation
- Alignment of sub region to trained database.

Output obtained from program 1is highlighted in Figure 1, 2.

These steps are repeated for all the face images in the test database.

The next phase of this system is implemented in program 2. The major algorithmic approach in this program is the Modified Face Recognition algorithm and the Hierarchical contour based image registration. When a new face arrives we need to check whether it is having any similarity with the images in test database.

Steps in program 2:

- Input the image under scrutiny.
- Copy it into probe database.
- Apply MFRA.
- Calculate the rank based similarity score.
- Report match or not.
- Move to the next mode if required.

- Apply Hierarchical contour based image registration
- Match confirmed / No Match

- Stop.

The similarity measure is calculated and is compared against a threshold value. If the similarity score is greater than or equal to threshold a match is obtained otherwise no match, refer figure 3.At some cases the similarity score is just less than the specified threshold value. This situation adds some fuzziness to the system. In this case the second phase of MFRA called confirmation phase comes to play. Rank based score is taken; hierarchical contour based image registration is applied to find a match with the image in scrutiny and the most matched image from the test database.

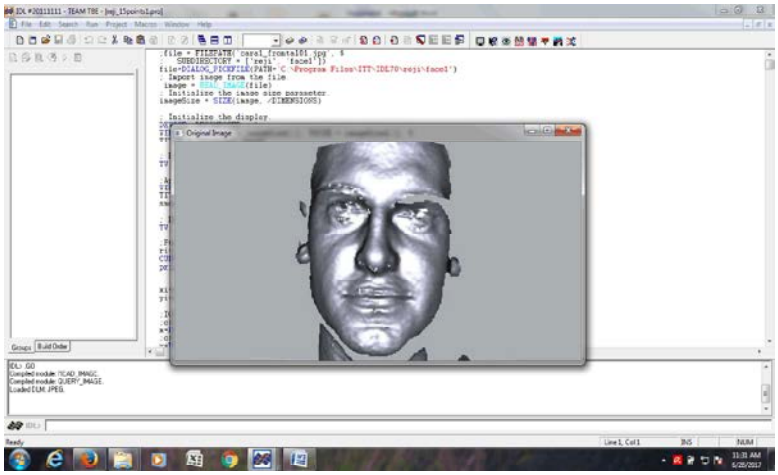

Fig. 1: Program 1- Test image

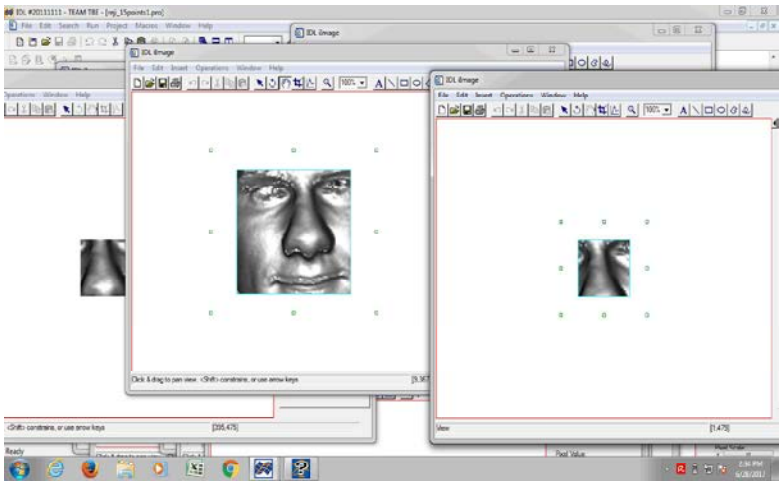

Fig. 2: Program 1- Sub Region generation

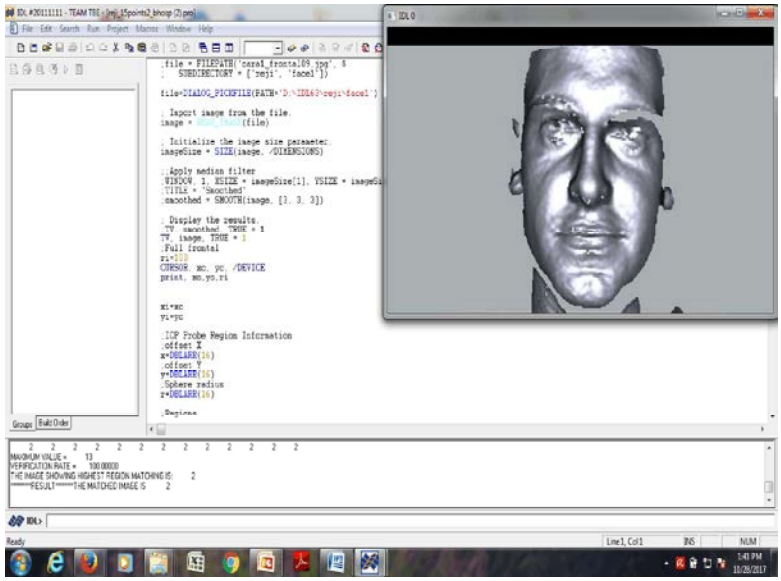

Fig. 3: Program 2- Matched Image

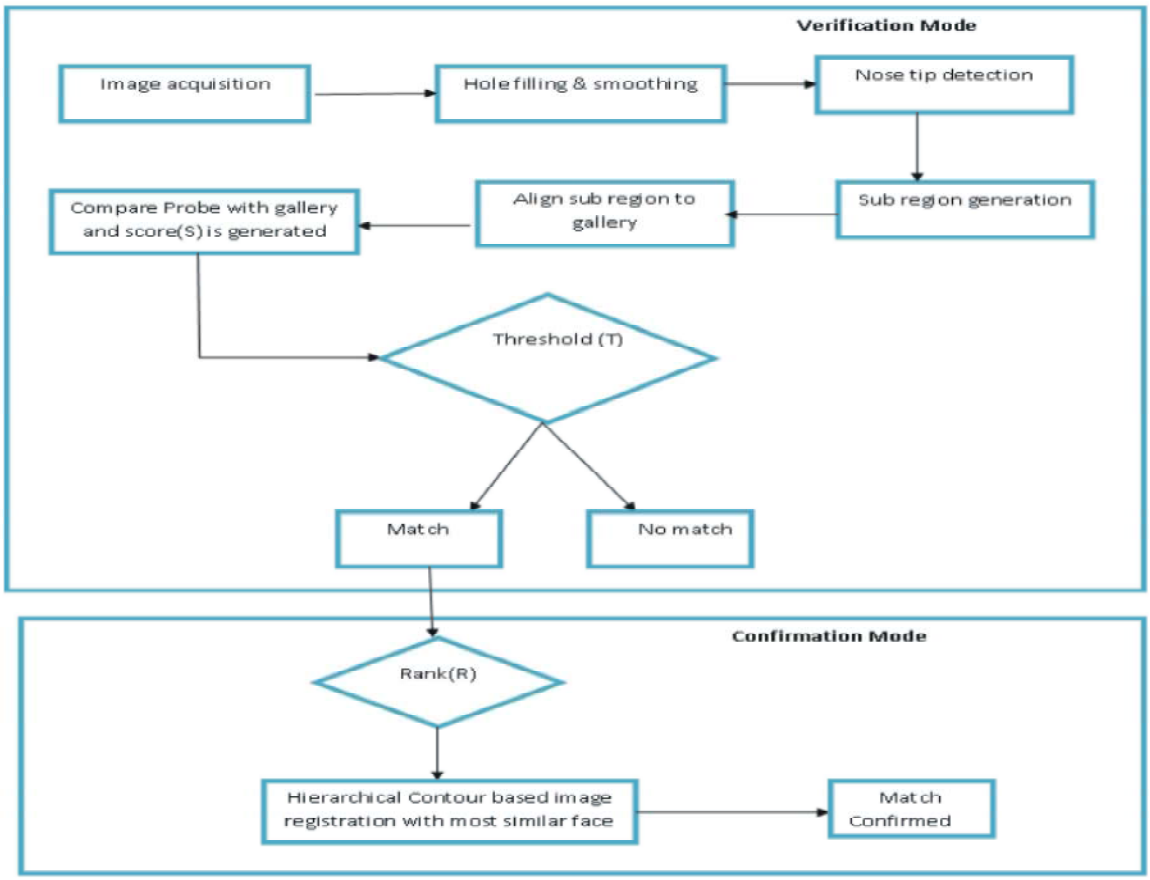


Fig. 4: Architecture diagram

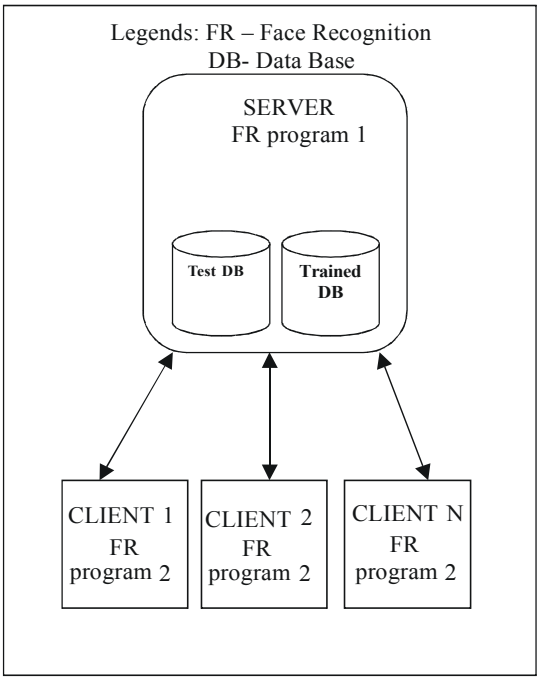


Fig. 5: Implementation of FR system

Table 2: Running time in Client

| Phase | Steps | Time(ms) |
|---|---|---|
| Verification Mode | Data Preprocessing | 4, 540 |
| | Matching | 1, 940 |
| Confirmation Mode | Registration | 5, 120 |

Table 3: Running time in Server

| Phase | Steps | Time(ms) |
|---|---|---|
| Verification Mode | Data Preprocessing | 2, 070 |
| | Matching | 645 |
| Confirmation Mode | Registration | 2, 150 |

**System Level Implementation:** Region based 3D face recognition frame work is implemented and tested in a Distributed computing approach. Distributed computing is conceptually closer to parallel computing. Program 1 is loaded on the server with multiple cores. The test database and the trained database are stored on the server. The program 2 is loaded on client machine. When a new image under scrutiny is obtained the client machine store the image temporarily on the probe database. The MFRA algorithm compares the image from the client with trained database in the server. The system level implementation is shown in Figure 5.

Table 2, 3 shows the running time of the region based face recognition system in verification mode and confirmation mode. In case of a client from Preprocessing to hierarchical image registration technique the process takes less than 12 Seconds on a 2.40 GHz Intel Core i3 Processor with 4 GB of memory. This suggests that a feasible execution time may be achieved for use at critical security applications.

## CONCLUSION

The region based 3D face recognition approach is applied on Bosphorus 3d datasets and achieved a VR of 95.3% at FAR of 0.1%. In the identification scenario, rank one recognition rate of 99 .3% is achieved. We are now experimenting the approach in a third party dataset also. Our system can be implemented in time critical areas such as Airport checkpoints, ATM and can be used in building other security scenario. We can speed up the face recognition system further by optimizing the IDL code.

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