

# Multi Distance Face Recognition of Eye Localization with Modified Gaussian Derivative Filter

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## Abstract

Face recognition at a distance (FRAD) is one of the most difficult types of face recognition applications, particularly at a distance. Due to the poor resolution of facial image, it is difficult to identify faces from a distance. Recently, while recording individuals, the camera view is broad and just a small portion of a person's face is visible in the image. To ensure that the facial image has a low resolution, which deteriorates both face detection and identification engines, the facial image is constantly at low resolution. As an immediate solution, employing a high-definition camera is considered as a simple and practical approach to improve the reliability of algorithm and perform well on low-resolution facial images. While facial detection will be somewhat decreased, a picture with higher quality will result in a slower face detection rate. The proposed work aims to recognize faces with good accuracy even at a distance. The eye localization works for the face and eye location in the face of a human being with varied sizes at multiple distances. This process is used to detect the face quickly with a comparatively high accuracy. The Gaussian derivative filter is used to reduce the feature size in the storage element, which improves the speed of the recognition ratio. Besides, the proposed work includes benchmark datasets to evaluate the recognition process. As a result, the proposed system has achieved a 93.24% average accuracy of face recognition.



**Keywords:** Face recognition, Gaussian derivative filter

## 1. Introduction

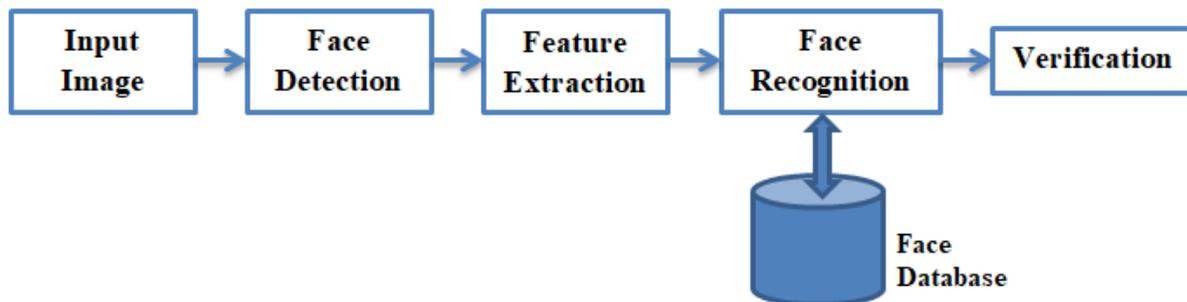
In the last several years, research has been conducted to know about the different ways to apply facial recognition software to pictures of blurred results in resolution. Super-resolution recovery technology detects the faces by utilizing facial recognition software that captures a low-resolution picture and recovers it into a high-resolution image. With regards to high-resolution recovery, the super-resolution recovery technique is better, but it falls short when it comes to face recognition. The accurate identification of terrorists and criminals on a watch list is critical for identifying such individuals in a monitoring environment [1-5]. Even though the overall performance of face recognition has improved, the primary challenges to attain high identification rates remain to be found in intrinsic (expression, age, etc.) and extrinsic (illumination, posture, etc.) changes. Another difficulty to be aware of is the poor image resolution problem, which is posed by facial recognition at a distance of over 5 meters. Facial recognition often fails in many surveillance systems if facial pictures have an inter-pupillary distance (or IPD) greater than 60 pixels in the image [6, 7]. Figure 1 shows the blurry effects due to image resolution.



**Figure 1.** Image Resolution by Blurry Effect

Biometric-based user identification systems such as, iris scanning, fingerprint recognition, and facial recognition have seen considerable improvements in biometric technology and are now widely used for access control due to their greater efficiency and security [8]. However, this method demands the use of specialized and costly equipment to acquire biometric information, for example, using fingerprints or an iris scanner. This research aims to develop a face recognition method that satisfies all the system criteria listed above for achieving a highly user-friendly access management system [9, 10].

The recognition methodology is only suitable for data that has already been compiled since it demands more learning data and processing time as the quantity of data increases at an unprecedented rate. Also, the research papers are exploring a process that harnesses the structural features via the use of face mapping and learning of two low-resolution pictures of the same face along with a high-resolution image [11, 12]. The utilization of structural features has the benefit of being simpler to calculate by making it preferable to the super-resolution recovery approach [13, 14]. Figure 2 shows the simplified block diagram of face recognition.



**Figure 2.** Simplified Block Diagram of Face Recognition

A model is presented by utilizing a Gaussian derivative filter and the LBP histogram to provide an accurate face representation regardless of changes in lighting and backgrounds. The

histogram intersection may be utilized as a scoring function for facial recognition [15, 16]. To test the effectiveness of the proposed approach, some tests have been carried out by using a database of benchmarks and footage from an indoor setting. The findings indicate that the suggested method attained realistic accuracy and it becomes simpler to deploy [17, 18].

## **2. Organization of the Research**

The rest of the research paper is organized as follows: section 3 discusses about the past research works in face recognition at distance. Section 4 delivers the proposed framework to solve face recognition at a multi-distance problem. Section 5 describes the results obtained through the proposed architecture. The conclusion and future task of the proposed work have been given in the final section.

## **3. Preliminaries**

Cascaded multitask frameworks are designed to identify and align faces in unconstrained environments were developed by Zhang et al. Using a cascaded architecture with three layers of deep convolutional networks, this research work has developed a method that integrates detection and alignment to forecast both face and radical positions from a long distance [19].

FaceNet, created by Schroff et al. is a unified system that uses convolutional neural networks to learn embedding for each picture by combining this information with the Euclidean norm of distance from the face. To do face verification, recognition, and clustering, it is highly required to threshold the image, perform k-NN classification, and perform k-means clustering on the dataset [20].

Chen et al. have suggested a fast and accurate CNN face verification model that is developed by using Mobile FaceNets. Using just one million parameters, the suggested technique

may be implemented [21]. The authors, Saraf et al., created an automated stand-alone door access control system, which has used facial recognition and constructed a Raspberry Pi microcomputer with internet connection via a USB modem along with a battery power source [22].

Boka et al. integrated a software and hardware system to perform access monitoring, which was built on a Raspberry Pi with two portable cameras, the neural compute system, and two hardware PCs. Also, FaceNet has been used to find face from the animation of human walk [23]. A primary-component-based facial recognition method that is optimized for real-life applications was suggested by Bakshi et al. using an integrated camera and MATLAB, the suggested system is built on an Arduino Uno microcontroller [24].

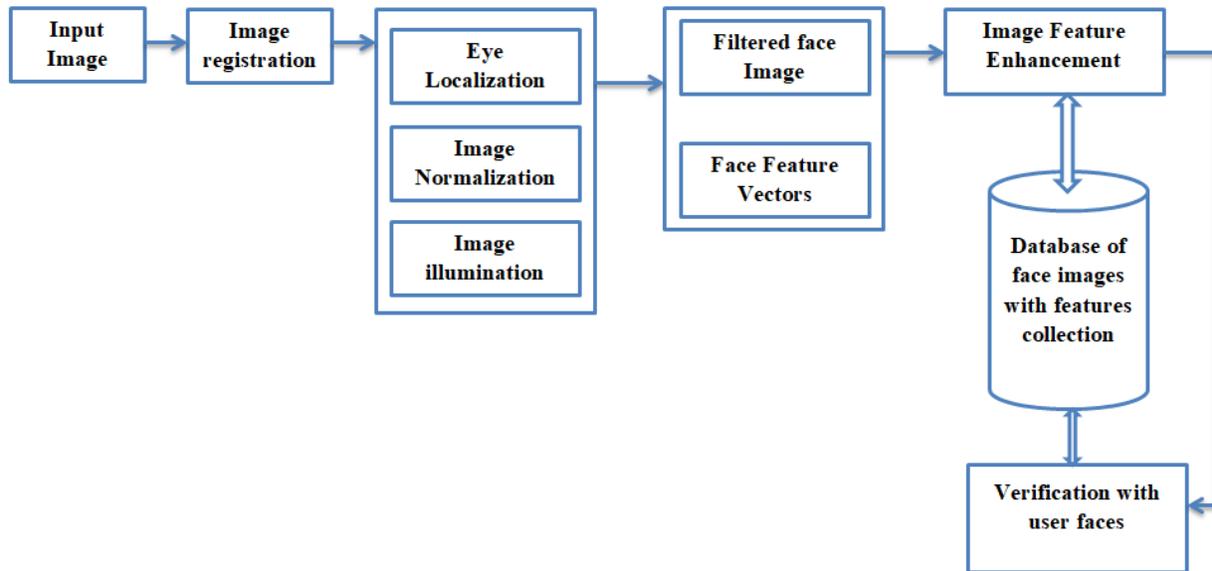
In the paper published by Sagar et al., a smart locking system is described to utilize ambient light to choose the face detection and identification method. To supplement facial detection and identification, they used basic principal component analysis, linear discriminant analysis, and other variants [25].

In an attempt to use Raspberry Pi and the cloud for face recognition, Sajjad et al. designed a system by using a bag of words for the extraction of oriented features from FAST and BRIEF data obtained from the identified face. Besides, it can be done with the support vector machine for identification [26].

#### **4. Proposed Framework**

This section contains a face detection and eye localization procedure that aligns facial images and prioritises their appearance for easy identification before performing further facial image processing such as facial normalisation and lighting normalisation [27]. Figure 3 shows proposed framework for this research article. Besides the proposed framework includes eye

localization and Gaussian derivative filters procedure for performing face detection and recognition at a distance as follows;



**Figure 3.** Proposed Framework

#### 4.1 Eye Localization Procedure

The major process that constitutes facial image alignment involves face recognition and eye localization. Eye detection is eliminated by just detecting the face area of the input picture. For eye localization, the decreased ROI is used to track the exact eye locations. Face recognition is performed by using localized eye locations to align facial pictures. Face and eye recognition at a distance without further user participation, which is required to offer easy-to-use access control [28-31]. Faces and eyes of various sizes should be able to be detected from a distance spanning from when faces are small at long distances to when faces are big at short distances.

## 4.2 Gaussian Derivative Filter Procedure

Once the face and eyes have been identified in the input picture, the facial area of the image is normalized to a set size depending on the location of the eyes that have been identified. The picture is rotated so that the eyes are horizontal and for a rotated face, this causes the nose to point upward. A self-quotient image (SQI) is used to counteract the effects of complex lighting changes and backdrops on face pictures before they are utilized in the final processing stage. One picture has the same quotient form as another, and therefore, one may generate a new image by dividing one by the other [32-34].

### 4.2.1 Spatial Histogram

To improve the representation capacity of the spatial histogram, the Gabor-LBP histogram framework was updated to include elements from the spatial histogram.

#### Modification:

Eight first-order and eight second-order Gaussian derivative filters were substituted for forty Gabor wavelet filters in the face representation framework since the filter parameters are easier to modify and higher recognition performance has been proven with a lower number of filters.

### Second Order Filter

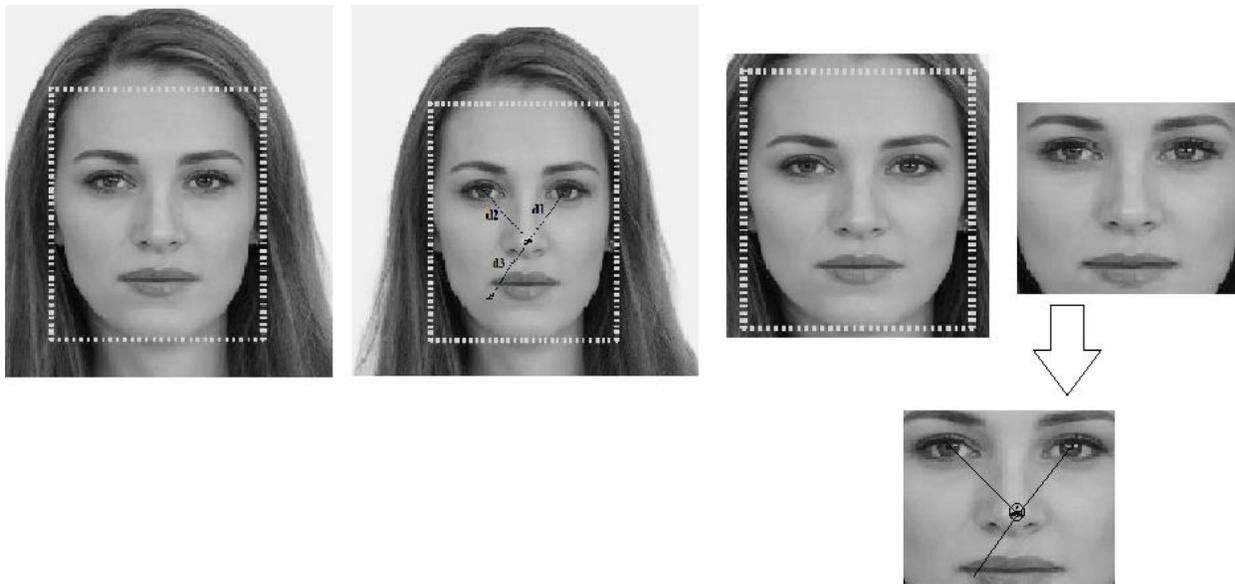
To get the first-order and second-order Gaussian derivative filters for a facial image description, first, obtain the first-order and second-order Gaussian filters for a generic face image. An equation of the form  $G(x, y)$  is stated as:

$$G(x, y) = e^{\left(-\frac{x^2}{2\sigma_x^2} - \frac{y^2}{2\sigma_y^2}\right)}$$

Where  $\sigma_x$  &  $\sigma_y$  standard deviation parameter

## 5. Results & Discussion

To obtain high-quality facial images, this research work suggests a framework that is comprised of a good image capture device of output image for obtaining better experimental results. Figure 4 shows a user-friendly interface. It also makes use of an active resolution reader, which is coupled with a proximity sensor. The proposed Gaussian derivative filter is used to retrieve the clear images from the original image. Once the user has been approved by the remote controller, the signal to open the gate is sent by the remote controller [35]. The given pictures are shown at different angles and from multiple distances. Figure 4 shows our scale setting at various distances. It shows the distances  $d_1$  and  $d_2$  as eye localization from the nose point. This will help to extract the special features from the original image for various distances.

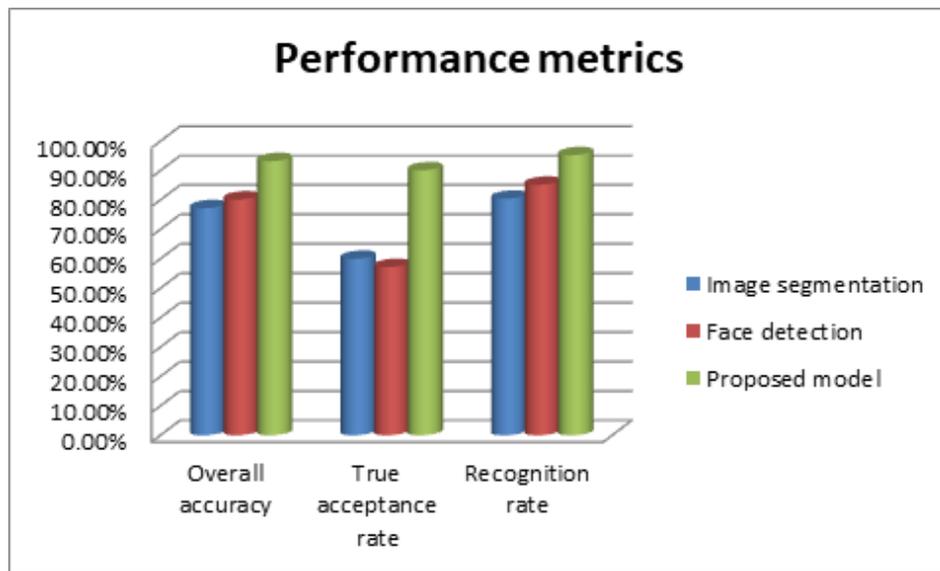


**Figure 4.** Obtained Results at Different Scale

Experiments using benchmark datasets were carried out to assess the overall performance of the proposed method in face recognition applications. The dataset comprises 55 individuals, each of whom had 20 pictures. The performance metrics are accuracy, true acceptance rate and recognition rate. The proposed model is performing well and it has been proven with all the performance metrics, which are shown in Table 1. It contains the computed performance metrics and numerical value of the proposed model.

**Table 1.** Computed Performance Metrics

S.No	Model	Overall Accuracy	True Acceptance Rate	Total Execution time	Recognition Rate
1	Pure Image Segmentation process	77.2%	60%	81.4ms	80.43%
2	Face detection without extra features	80.14%	57.2%	180ms	85.2%
3	Proposed hybrid recognition method	93.24%	90.11%	255ms	95.24%



**Figure 5.** Overall Performance Measures

All of the facial images were shot under a variety of circumstances, including the varying lighting conditions, changes in posture, and face image resolution. Only ten pictures per participant were selected for use as gallery images with the other images, which are being used as probing images. Figure 5 shows the obtained performance metrics.

The proposed benchmark dataset is one of the most frequently used benchmark datasets, which consists of 295 individuals with an average of eight pictures per subject and is one of the largest benchmark datasets available. For each subject, four pictures were chosen as gallery images, while the remaining images were used as probing images. In this experiment, the eye localization and derivative filter with the histogram intersection similarity metric were combined with the histogram intersection similarity measure.

## 6. Conclusion

This research article has described the design and implementation of multi-distance face recognition by using a combination of eye localization and the Gaussian derivative filter technique, as well as our suggested system based on human face recognition at a distance by using RFID technology to offer a user-friendly interface with a secured access system. This method may be used in a variety of stand-alone access control systems that use human facial recognition to grant or deny access to individuals. The limitations of the proposed architecture are as follows:

- (1) Object detection with static cameras only allow objects to be detected within a short distance.
- (2) Another intrinsic restriction of state-of-the-art facial recognition is that it can only identify a face when it is closer to the frontal position. We want to pursue an

alternative technique of calibration for static and dynamic measurements with self-quotient images [36].

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