Decision Making: Applications in Management and Engineering

ISSN: 2560-6018, eISSN: 2620-0104

FACE RECOGNITION SYSTEM USING OPENCV

[1]Rajat Pathak*
MCA Scholar
Department of Computer Science & Engineering
Lingaya's Vidyapeeth
Faridabad, India
pathakrajat463@gmail.com

[2]Dr. Tapsi Nagpal
Department of Computer Science & Engineering
Lingaya's Vidyapeeth
Faridabad, India
dr.tapsi@lingayasvidyapeeth.edu.in

Abstract

The facial recognition system has emerged as one of the most advanced technologies in Image processing. It captures objects from the background in live video streams taken from camera sensors. In other words, it is an application that analyzes and identifies objects from fixed images or video frames. Facial recognition capabilities encompass extraction and identification algorithms that automatically detect human faces when an individual is in front of the camera, recognizing them. The Viola-Jones Algorithm for face detection are used in which it identifies human faces using the Haar Classifier.

The pros and cons of the facial recognition system are examined in this section. Section 3 outlines the project's functional and non-functional requirements and evaluates its feasibility. The development approach we used to create the application, along with the tools and technologies employed, are also discussed.

Keywords: Face Recognition, AdaBoost, Cascade Haar Classifier, Principal Component Analysis (PCA).

INTRODUCTION

Facial recognition systems have quickly become a fundamental aspect of today's technology, transforming how we engage with both digital and physical environments. This advanced technology utilizes sophisticated algorithms and machine learning techniques to detect and authenticate human faces from images and video recordings. By analyzing distinctive facial features, these systems deliver exceptional accuracy and efficiency in various applications, including security, surveillance, personal device authentication, and social networking. As the need for seamless and secure identification methods increases, facial recognition technology remains at the cutting edge, offering improved security, convenience, and user experience across multiple domains.

This system is particularly designed for recognizing frontal human faces. Various face recognition algorithms have been developed, each with its unique strengths. Facial recognition has emerged as a significant area of interest in recent years, with its natural ability to be justified and applied to real-life scenarios.

Various face recognition algorithms have been developed, each with its unique strengths. Facial recognition has emerged as a significant area of interest in recent years, with its natural ability to be justified and applied to real-life scenarios.

The first approach is a local face recognition system, which uses specific facial features to identify a person's face. In contrast, the second approach, a global face recognition system, considers the entire face for recognition. These two methods have been integrated using various algorithms, allowing them to complement each other in the recognition process.

I. LITERATURE REVIEW

The main motive of this paper is to explore the solutions shared by other authors, while also addressing any shortcomings in their systems and proposing improved solutions. By using this algorithm, student attendance is automatically marked by cameras while capturing the images of the students in the class. The Framework is simple, by mounting two cameras on the classroom walls [1].

The first one is for capturing the image student in the class and the second camera is sensor camera is used to getting the seat of a student inside the class and the camera capturing will click the image of the student. Then the system compares the picture taking from a camera capturing images and the faces shown in the database done much time to perfect the attendance [2].

The Face recognition system is used to capture the images of the user simultaneously and captured 300 images continuously and then available in the database. The captured image can later be retrieved from the database to check the clicked image of the user and the user available in the front of the camera is same or not. If both are not same then it will reflect the error or unknown user [3].

In earliest automatic facial identification techniques was presented. The Key points, such as the placement of the eyes, nose, and cognizance, were utilized to create a point vector, which also included the distance and angle between the points. This section provides a summary of the Fundamental techniques used in the face recognition system, which mostly relate to the frontal face of living things. contained some of the most basic work on geometric identification of faces [4].

The Eigenfaces system, which was explained in, approached face identification holistically. A bracket becomes unsolvable because the axes with the most friction do not invariably carry any discrimination data at each. The eigen vectors are arranged in descending order to reflect various degrees of face variation [5].

A single layer of an artificial neural network (ANN) was utilized for face identification, showcasing its adaptability in essential face recognition systems. For the face verification method, a dual layer of WISARD was used within the neural network. An alternative method for facial recognition includes graph matching, where algorithms can be developed for recognizing both faces and objects by optimizing a matching function. The accuracy of face recognition are 96 percent precise because it consistently delivers the image from the database [6].

The geometrical face arrangement provides sufficient data to assist face identification and recognition systems. This is one of the most prevalent methods for locating and recognizing faces. This system seemed to generate favorable outcomes. This technique can also employ many face templates from different perspectives to portray a single face [7].

The photos in this database are almost completely uniform in terms of emotion and occlusion, with a concentration on lodging features that are resistant to illumination. While surmising that dataset is too big for the experiments I do in this document. For preliminary testing, utilize the AT&T Face database [8].

II. PROPOSED SYSTEM

The proposed system methods are used to implement an efficient approach for Face Detection and cannot be changed with the qualities like color, hairstyle, or facial expressions. This is attained by using the technique of Viola-Jones algorithm, PCA. The process flow of the proposed methodology... is as shown in Figure 1.

The methodology utilizes the database as its standard image database, which comprises 1521 grayscale images with a resolution of 384x286 pixels, all showing the frontal view of the faces of 23 different individuals. The test set includes a wide range of illumination, backgrounds, and face sizes, accurately reflecting real-world conditions.

3.1 Methodology

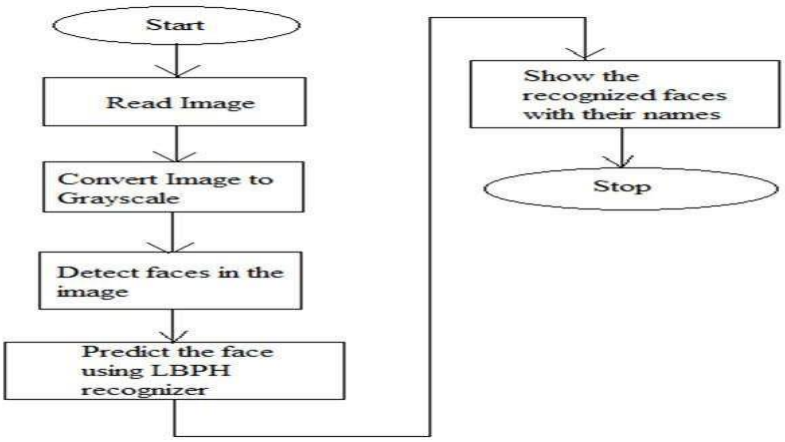


Fig 1. Steps involved in methodology

3.1.1 PRE-PROCESSING: It is a method in which the extraction of facial region from an image if done. The normalization techniques are used to check all the images are in the same format of not, and help to reduces the variations due to pose and size differences.

3.1.2 FACE DETECTION: After the preprocessing method. The Integral Image algorithm is used to calculate the pixel sum making it cost-effective. It requires only four additions to calculate the sum of a rectangular area in the original image, regardless of the rectangle's size.

3.1.3 FEATURE EXTRACTION: It is a technique which is used to extract the features of image which can be done by the method PCA (Principal component analysis). PCA is a method employed to extract features from a cropped and resized facial image. It serves as a tool in predictive and explanatory data analysis, facilitating the transformation of higher-dimensional data into a lower-dimensional format.

3.1.5 FACE TAGGING: In this method, the output from the representation to assign a name to the image of the person to identify that the image of the person is correct or not. Since the data is in binary form, this stage also involves converting the expression into a specific value and matching it to a person’s name in the list. However, if the image does not match the output, it will reflect the error:” Unknown.”

3.2 Types of error in Model:

Errors in face recognition systems can stem from various sources, ranging from technical limitations to environmental factors. Here are some common types of errors in face recognition systems as shown in Table 1:

Error Type	Values
False Positives	1
False Negatives	2
Illumination Variations	3
Pose Variations	4
Facial Expression Variations	5
Obstructed Faces	6
Quality of Images	7
Race and Ethnicity Biases	8
Aging	9
Environmental Factors	10

Table 1. Error in Model

3.3 Accuracy:

The Accuracy rate of a facial recognition refers to how reliably the system can correctly identify individuals from a set of images or video frames. It is usually designed to overcome the output of recognized the faces accurately out of the total number of faces processed by the system. The accuracy rate must be 96%.

- Quality of Training Data: The accuracy of a face recognition system heavily depends on the quality and diversity of the dataset used to train it. A more extensive and representative dataset generally leads to better accuracy.
- Algorithm Performance: The effectiveness of the face recognition algorithm itself plays a crucial role. Different algorithms may perform differently under various conditions and datasets.
- Environmental Factors: Factors such as lighting conditions, pose variations, facial expressions, and occlusions can significantly impact the accuracy of face recognition systems.

III. RESULTS & EVALUATION

By using this technique, computer is commanded to recognize the visual element by relying on Vast databases and identifying emerging patterns that allowing them to understand images.

The Facial Recognition method used the KLT algorithm and PCA(Principal

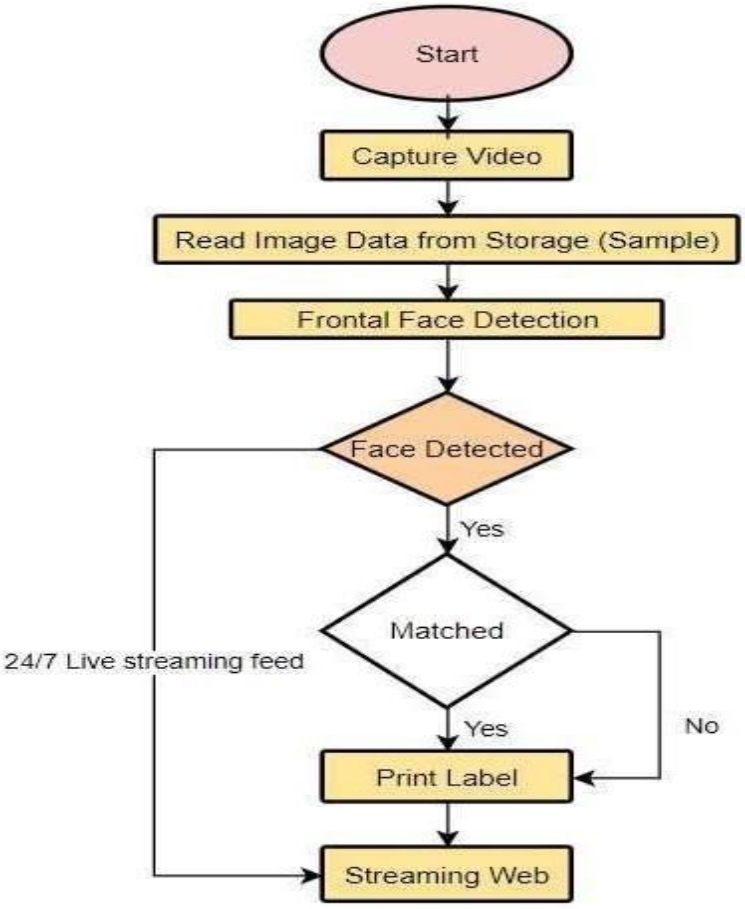
Fig 2. Proposed System Flow Chart

Component Analysis and recognition of element plays a crucial role in a wide range of applications. The accuracy rate of the application is high for identifying the desired person. In the backend a database is created where the images get stored. Each face has their own feature which may not be present in the original image.

Consider an image from the Bio ID-Face-Database by applying the Viola-Jones algorithm to the image, an identified face image is obtained with a bounding box around the detected face. Allowing for the calculation of Haar features and extraction of all relevant features.

The features acquired by the Viola-Jones algorithm are shown as nodes, which are interconnected to

Each other to make a shape. The connections ensure that all nodes are linked with each other and the lines connecting them are labeled with reference numbers. (fig 2).



Here is a screenshot of GUI of the Face Recognition System (fig 3).

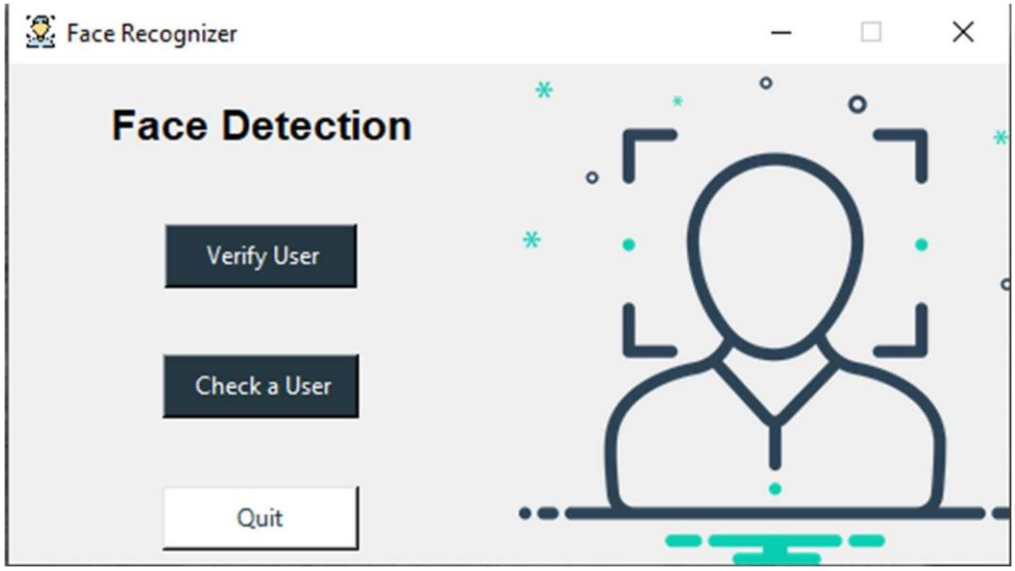


Fig 3. Gui for Face Recognition System

Now this is an overview of how to predict the values.

Step 1: The first is to capture facial images or videos using cameras or sensors.

Step 2: Now the second step Image processing. Enhance and normalize the captured images to improve the quality.

Step 3: The third step is the face detection. Using the algorithm like Haar cascades, viola-jones.

Step 4: The fourth step is facing alignment. Rotate the face to standard position for feature extraction.

Step 5: The fifth step is the face normalization.

Step 6: Six step to feature extraction.

Step 7: Seventh step is to encoded into a mathematical representation suitable for comparison and classification.

Step 8: Eighth step is the database query. This database contains the encoded features of known individuals along with their corresponding identities.

Step 9: Ninth step is to predict the captured image.

Step 10: Now this is the final step where post-processing steps may be applied to refine the prediction, such as consensus-based decision-making or temporal smoothing to improve the stability of predictions over time.

Here are some observations in the table given below for your reference that are calculated and compare the images and Predicted by the two different Algorithms used inthis model. (Fig 3).

Table 2. Tested Output Results

	Face features of Images Vs Different angles						
	1	2	3	4	5	6	7
1	883	355	522	521	654	567	579
2	861	382	522	523	653	571	589
3	1922	369	529	511	649	637	645
4	1925	353	511	598	632	617	612
5	1119	418	694	611	719	638	653
6	1942	384	554	542	711	584	587
7	1911	361	559	545	665	699	611
8	1957	341	513	516	655	618	616
9	1191	325	448	465	631	629	631
10	1981	332	517	526	657	611	625
11	1942	319	471	488	625	578	691
12	1996	363	516	511	659	575	583
13	1933	244	491	419	541	612	618
14	1931	391	438	442	612	621	637
15	1867	359	511	598	631	551	547

The Table 2 shows the Tested Output Results

Here are some graphs to show the Reduction errors in model. (graph 1 and 2)

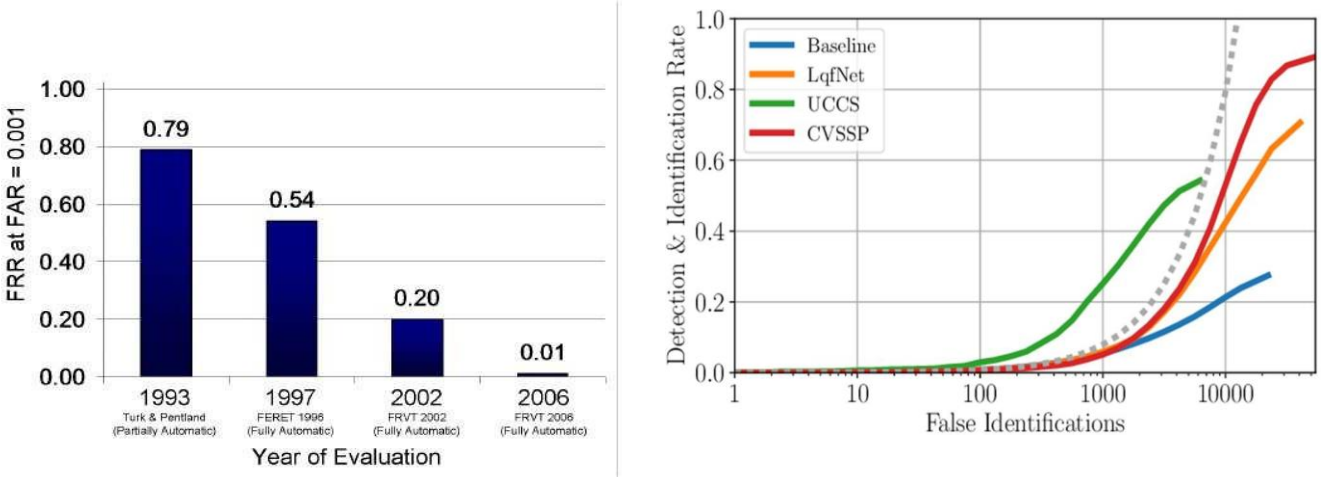


Fig 4. Reduction in Errors

IV. FUTURE SCOPE

The future scope of face recognition systems is vast and exciting. With the rapid advancement of AI and machine learning, facial recognition technology is expected to become more accurate, efficient, and widespread. Here are some potential future developments:

1. **Increased use in security and surveillance:** Face recognition systems will be used more extensively in security and surveillance applications, such as border control, law enforcement, and public safety.
2. **Improved accuracy and speed:** Advances in AI and machine learning will lead to more accurate and faster face recognition systems, enabling real-time identification and authentication.
3. **Wider adoption in industries:** Face recognition technology will be adopted in various industries, such as healthcare, finance, and retail, for authentication, identification, and customer experience enhancement.
4. **Enhanced privacy and security:** As concerns about privacy and security grow, face recognition systems will need to incorporate robust security measures and privacy protections to ensure responsible use.
5. **Hybrid approaches:** The approach is hybridized, combining traditional face recognition methods with new techniques, such as 3D modeling and liveness detection, to improve accuracy and prevent spoofing attacks.

V. CONCLUSION

By examine all the techniques which is used in this paper regarding face recognition system is working fine. The face recognition system is the method which is used to identified the unknown person by capturing their images and crosscheck it with the database image. The PCA and other algorithm are also used in this technique. The future work will focus on enhancing the algorithm's recognition capabilities. In the current system, only 30-degree angle variations are recognized, which needs to be improved.

Face recognition technology is Expanding quickly and becoming more common in everyday life. Face Recognition Systems works on determining human faces. This paper explores the concept of facial recognition, which is a biometric identification technology that utilizes facial features. It captures images of a person's face with a camera and identifies them through a series of processes. Additionally, the paper includes an illustration to explain the workflow of a face recognition system. Finally, it discusses the application of face recognition technology in four key fields, with a primary focus on the financial sector.

Therefore, this paper proves that face recognition systems are increasingly favored in various aspects of life. The working experience of the face recognition system meet the user's expectation though certain problems still need to be resolved. The technology holds promise for achieving even higher levels of accuracy and robustness.

REFERENCES

[1] Deshpande, N. T., & Ravishankar, S. (2017). Face Detection and Recognition using Viola-Jones algorithm and Fusion of PCA and ANN. Advances in Computational Sciences and Technology, 10(5), 1173- 1189

[2] Shivam Singh, Prof. S. Grace line Jasmine, 2019, Face Recognition System, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 08, Issue 05 (May 2019), 2278-0181

[3] S. Kherchaoui and A. Houacine, "Face Detection Based on A Model of Skin Color with Constraints and Template Matching," in Proc. 2010 International Conference on Machine and Web Intelligence, Algiers, Algeria, pp. 469 - 472.

[4] Shubhobrata Bhattacharya, Shubhobrata Bhattacharya, Shubhobrata Bhattacharya, Shubhobrata Bhattacharya, Shubhobrata "A Face Recognition Based Attendance System for Classroom Environment." "Smart Attendance Monitoring System (SAMS): A Face Recognition Based Attendance System for Classroom Environment." The 18th International Conference on Advanced Learning Technologies (IEEE) will be held in 2018. (ICALT).

[5] Xiang-Yu Li and Zhen-Xian Lin, Xiang-Yu Li and Zhen-Xian Lin, Xiang-Yu Li and Zhen-Xian Lin, X "Face recognition using a quick PCA algorithm and the HOG algorithm." The Euro-China Conference on Intelligent Data Analysis and Applications is a collaboration between Europe and China. Cham. Springer.

[6] Zhi Deng, et al. “Application and exploration of face recognition technology in urban traffic field.” Digital Technology.

[7] Stan Z, Li, and Anil K. Jain, “Handbook of Face Recognition”, Chapter 1, Page 12, ISBN 0-387-40595-X

[8] Asit Kumar Datta, Madhura Datta, Pradipta Kumar Banerjee, “Face Detection and Recognition: Theory and Practice”, CRC Press, 2016, Chapter 1, pages 4, 5 & 12

[9] Asit Kumar Datta, Madhura Datta, Pradipta Kumar Banerjee, “Face Detection and Recognition: Theory and Practice”, CRC Press, 2016, Chapter 2, pages 20 & 22-25

[10] Asit Kumar Datta, Madhura Datta, Pradipta Kumar Banerjee, “Face Detection and Recognition: Theory and Practice”, CRC Press, 2016, Chapter 7, pg. 133

[11] Brahmbhatt, Samarth, “Practical OpenCV”, Apress, (2013), Chapter 1, page 6 Motion Detection Using OpenCV”, 2022, Volume 9, Issue 2, pages 55/ pages 6.

[12] http://www.face-rec.org

[13] Shemi P M, Ali M A, A Principal Component Analysis Method for Recognition of Human Faces: Eigenfaces Approach, International Journal of Electronics Communication and Computer Technology (IJECCT) Volume 2 Issue 3 (May 2012).

[14]. M. Turk, A. Pentland: Face Recognition using Eigenfaces, Conference on Computer Vision and Pattern Recognition, 3 – 6 June 1991, Maui, HI, USA, pp. 586 – 591.

[15]. Prof. Y. Vijaya Lata, Chandra Kiran Bharadwaj Tungathurthi, H. Ram Mohan Rao, Dr. A. Govardhan, Dr. L. P. Reddy, Facial Recognition using Eigenfaces by PCA, Department of

Computer Science and Engineering, Gokaraju Rangaraju Institute of Engg&Tech, Jawaharlal Nehru Tech. University.

[16]. Parvinder S. Sandhu, Iqbal deep Kaur, Amit Verma, Samriti Jindal, Inderpreet Kaur, Shilpi Kumari, Face Recognition Using Eigen face Coefficients and Principal Component Analysis, International Journal on Electrical and Electronics Engineering 3:8 2009.

[17] S. Tan, X. Sun, W. Chan, L. Qu, and L. Shao, "Robust Face Recognition with Kernelized Locality-Sensitive Group Sparsity Representation," IEEE Trans. on Image Process., vol. 26, no. 10, pp. 4661–4668, Oct. 2017, Doi: 10.1109/TIP.2017.2716180.