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Real Time Face Detection and Recognition System

Dr. Vivek B. Kute, Takshashil Lohkare, Mohit Pathak, Ritesh Gajbhiye, Ayush Kale

Department of Computer Science, P. R. Pote Patil Institute of Engineering and Management, Amravati,
Maharashtra, India

ABSTRACT: Facial recognition systems use computer programs to analyze and identify human faces by capturing, detecting, and comparing facial images. These systems rely on recognition algorithms like Haar cascades, which detect facial features based on nodal points. The Haar cascade approach, a machine learning method, has proven effective in achieving accurate face recognition with lower error rates. Overall, facial recognition systems offer secure and efficient human identification through advanced technologies.

KEYWORDS: Face Recognition System, Haar Cascade, Real Time Face Recognition, LBPH, Face Detection.

I. INTRODUCTION

The era of information technology is rapidly transforming the way we conduct transactions, with everyday tasks increasingly shifting from traditional paper-based or face-to-face methods to electronic processes. This surge in electronic transactions has created a heightened demand for swift and accurate user identification and authentication. Access to buildings, bank accounts, and computer systems often relies on Personal Identification Numbers (PINs) for security. However, the use of PINs doesn't always guarantee the verification of the user's identity, especially when credit or ATM cards are lost or stolen, potentially leading to unauthorized access.

Despite warnings, individuals often choose easily guessable PINs or passwords, such as birthdays, phone numbers, or social security numbers. The rising instances of identity theft have underscored the necessity for more secure methods to confirm a person's true identity. Facerecognition technology emerges as a promising solution to this challenge, as a person's face is inherently linked to their identity, barring identical twins. Unlike PINs, faces are non-transferable. This technology enables systems to compare facial scans with records stored in centralized or local databases, or even on smart cards. Face recognition, essentially identifying a person from an image or video feed, mimics the human eye's ability to recognize individuals and finds diverse applications in the real world[1].

Various methods exist to implement face recognition technology, and a typical system involves a computer equipped with a camera module. The process begins with face detection using Haar cascade, followed by the extraction of specific information from the detected face. This extracted information is then compared to a known database to identify the person. In a specific system, a computer system, along with a camera module, is utilized for face detection through Haarcascade and recognition using the Local Binary Pattern Histogram (LBPH) algorithm. The overarching goal is to develop a cost-effective and reliable system applicable across a range of scenarios.

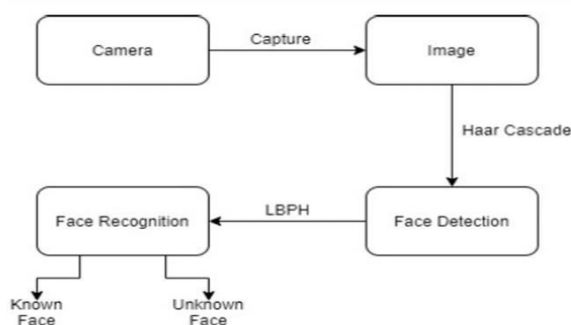


Fig 1: Generic Architecture of Face Recognition System

II. LITERATURE REVIEW

1. History: The world of face recognition has witnessed rapid growth and poses a significant challenge in the domains of computer vision and real-time applications. Over the years, numerous techniques have been devised to address the complexities of face recognition. This section provides an overview of various algorithms developed for this specific task. Face recognition, as a biometric technique, involves identifying a given face. In recent times, it has garnered considerable attention and sparked extensive research not only among engineers but also within the fields of neuroscience. The applications of face recognition extend to computer vision, communication, and automatic access control systems. An integral component of face recognition is face detection, a crucial step in the automated identification of faces. However, face detection is far from straightforward due to the diverse challenges posed by variations in image appearance, including different poses (frontal, non-frontal), occlusion, varying illuminating conditions, and facial expressions.

2. Related Work

A. Support Vector Machine (SVM):

In the field of machine learning, Support Vector Machines (SVM) emerge as a prominent algorithm, especially in addressing classification problems. This algorithm tackles the issue of data interference by utilizing a demarcating surface known as a hyperplane. The Support Vectors (SV) represent the data points closest to this hyperplane. Significantly, the accuracy of classification correlates positively with the distance of support vectors from the hyperplane. When it comes to attendance systems, SVM has been acknowledged and advocated as the optimal and most efficient algorithm for handling classification tasks.

B. Principal Component Analysis (PCA): Human recognition with the help of PCA was done by Turk and Pentland. The recognition technique, called Eigen face technique, defines an area which reduces the depth of the authentic data space. This reduced knowledge area is used for recognition. [3]

C. Genetic Algorithms:

A significant obstacle in face recognition lies in the intricate process of feature selection, constituting a broader optimization challenge within machine learning. The objective is to refine the dataset by eliminating unnecessary features—such as irrelevant, noisy, or redundant data—to enhance both efficiency and accuracy. Approaches employing genetic algorithms have been introduced to tackle this challenge, providing optimized search strategies for effective feature selection. Particularly valuable in real-time applications, these methods have been combined with techniques like Principal Component Analysis and Discrete Cosine Transform, resulting in notable success with face detection accuracy reaching up to 99%. [3, 6]

D. Deep Learning and CNNs:

In the field of deep learning and convolutional neural networks (CNNs), these sophisticated models have proven effective, particularly in the domain of face recognition. Traditionally, entire images were input into the network for tasks such as feature selection, extraction, and training. However, this process was intricate and time-consuming. A novel approach, proposed by Gupta, Priya, et al, involves presenting only the extracted facial features to the deep neural network, bypassing the need for raw pixel inputs. Despite its simplified nature, this method achieves an impressive accuracy of 97.05% and utilizes a neural network with four dense layers [2].

Additionally, the region-based CNN (RCNN), an extension of CNNs, has been employed for face detection. Sun, Xudong, et al have enhanced the existing RCNN method by incorporating strategies like feature concatenation, hard negative mining, and multi-scale training. While its efficiency and scalability are yet to be thoroughly addressed, this method showcases cutting-edge performance when evaluated on the Face Detection Dataset and Benchmark (FDDDB).

E. Local Binary Pattern Histogram (LBPH):

The Local Binary Pattern Histogram (LBPH) is a straightforward yet efficient algorithm for pixel labeling in images. This labeling is accomplished through a technique called thresholding, a basic form of image segmentation that transforms a grayscale or color image into a binary format, effectively distinguishing between the background and foreground.

LBPH involves four key parameters:

Radius: This parameter determines the size of the circular pattern formed around the central pixel. Number of

Neighbours: It specifies the sample points used to construct a circular binary pattern.

Grid X and Grid Y: These parameters denote the number of cells in the horizontal and vertical directions, respectively.

The algorithm operates by dividing the input image into pixel windows, with each window transformed into a matrix. The matrix is populated with intensity values from the pixels in that region. The central value in each matrix serves as the threshold. Subsequently, binary values are assigned to neighboring pixels based on this threshold. If a neighboring value exceeds the threshold, it is set to 1; otherwise, if it is below the threshold, it is set to 0. This process effectively captures local patterns in the image, providing a useful representation for further analysis [3, 8].

F. Viola Jones (VJ) algorithm:

The Viola-Jones (VJ) algorithm, devised by Paul Viola and Michael Jones, excels in detecting frontal faces but is less effective for profiles, upward, or downward-facing faces. This real-time algorithm initially identifies the face in a grayscale image and then pinpoints its location on the corresponding colored image [4].

Viola and Jones introduced simple rectangular features, essentially parts of an image obtained by subtracting one portion from another. Their method adopts a machine learning-based approach, where they select a set of uncomplicated features that they amalgamate into an efficient and scalable classifier.

Their significant contribution lies in devising a rapid way to calculate these features and utilize them for facial classification.

To address the challenge of slow pixel calculations in images, they introduced the concept of an integral image. Instead of computing sums for large pixel groups in an image, they efficiently calculate all features within a given sub-window, such as 24 by 24-pixel regions. They evaluate all possible combinations of 2, 3, and 4 rectangle features within these regions to determine the most effective feature for face detection. This innovative approach significantly enhances the algorithm's speed and accuracy [4, 9].

Algorithm 1: The Original Viola-Jones Algorithm. Input: A grayscale image, a scaling factor (s) and scanning factor (p)

Output: The location and size of a detected face size = detector.size

while size ≤ image.height AND size ≤ image.width
do

Step 5: Face is recognized by green rectangle. Step 6: Save that captured face with the name into the Database.

Finally, the user can login into the system using face for i from 0 to image.width-size in increments of p do

for j from 0 to image.height-size in

increments of p do

if runCascade(subwindow of image of size size located at (i,j)) then

Add (s,i,j) to detection list size = RoundUp (size * s) return average of detections

VJ was trained in Wider Face dataset and evaluates the algorithm on different settings [10].

Proposed System

The proposed system is the real time face recognition system based on PCA. The proposed system utilizes the Eigen face method is information reduction for the images. This proposed system can easily be implemented, and its based on Emguvcv coding. The resources that are required to implement these are easily available as open sources. This application supports the modern trends of face detection and recognition technology and easily accessible, so more security of this system. The main aim of the research work is providing security to Peoples.

Step1: Scan the input image for face detection. Step2: Capture image from video/image inputs. Step3: using Viola-Jones algorithm for its efficiency over other face detection algorithms. Step4: Do Feature Extraction based on the extraction process Using Eigenvector selection (it can be transformed into the reduced set of features).

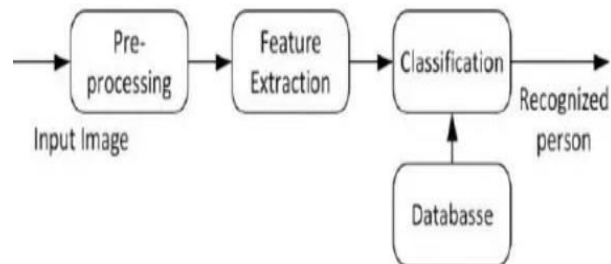


Figure: Proposed System

III. SYSTEM IMPLEMENTATION

A. Software:

1. Operating System: A suitable operating system must be installed on the computer, such as Windows, Linux, or macOS.
2. Integrated Development Environment (IDE): An IDE such as PyCharm, Jupyter Notebook, or Visual Studio Code is needed to develop and run the project.
3. Libraries: Several software libraries are required to implement the project, including OpenCV, Tkinter, and NumPy[14].

B. Hardware:

1. Camera: A camera or video source is required to capture the real-time video stream. This can be a webcam or a mobile device with a camera.
2. Processor: The processor should be powerful enough to handle the real-time video stream and the face recognition algorithm. A multicore CPU or a dedicated GPU can significantly improve performance.
3. Memory: Sufficient RAM is needed to store the video stream and intermediate data generated by the algorithm.
4. Storage: Adequate storage space is required to store the project files and any training data or models that are used.

C. Implementation Details:

Implementation specifics for real-time face recognition encompass the utilization of diverse modules, image processing methodologies, and algorithms for critical tasks such as feature extraction, training, and image recognition. These details outline the comprehensive approach taken to achieve efficient and accurate face recognition in real-time scenarios.

1. Data Collection Module:

The initial phase of the face recognition system involves the Data Collection Module, which is specifically tailored to accumulate a diverse set of images for each individual targeted for recognition. This module orchestrates the capture of multiple images, strategically incorporating varying lighting conditions, angles, and facial expressions. The intention is to construct a comprehensive dataset that encapsulates the subtle nuances of facial features under different circumstances. Each of these images is methodically labeled, associating them with the corresponding person's name or ID for clarity and organization. This meticulously curated dataset forms the foundational resource for subsequent stages of the face recognition process, contributing to the system's adaptability and accuracy in real-world scenarios[15].



Screenshot: Sample Dataset

2. Pre-processing Module: The pre-processing module should apply the following operations to prepare the images for feature extraction:

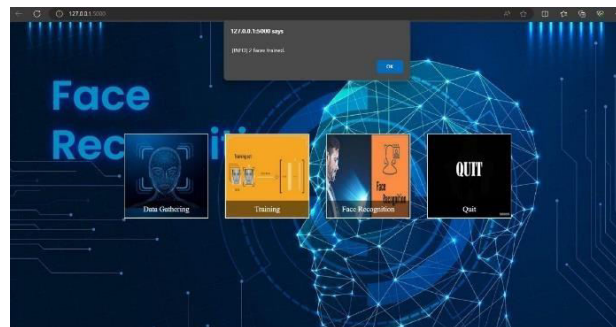
- i. Convert the coloured image to grayscale
- ii. Perform face detection using Haar cascades to detect faces in the input image
- iii. Align the detected faces to a common reference frame
- iv. Normalize the face images to a common size and intensity range

3. Feature Extraction Module:

In the Feature Extraction Module, the focus is on extracting distinctive features from preprocessed face images through the application of the LBPH algorithm. The LBPH methodology involves breaking down the face image into a grid of smaller regions and generating a binary pattern for each of these regions. These binary patterns are then combined into a unified feature vector, effectively encapsulating the unique characteristics of the entire face in a condensed representation.

4. Training Module:

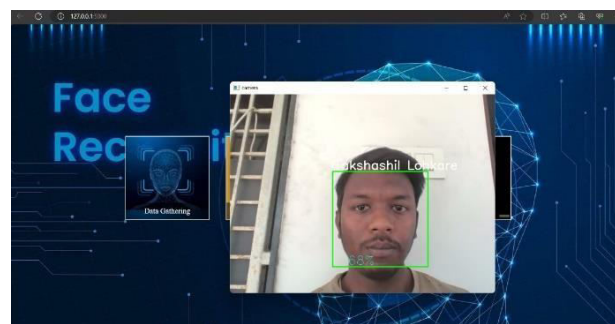
Within the Training Module, the data accumulated during the earlier data collection phase undergoes a crucial learning process. This involves associating each set of collected data with the respective identifiers provided by the data manager. To facilitate this learning, the Haar Cascade algorithm is deployed, allowing the system to discern and understand the distinctive facial features linked to each provided ID. As a result of this training process, the acquired knowledge is systematically saved in a .yml file. This file serves as a repository of the trained model, equipped with the capacity to effectively recognize and identify faces based on the acquired learning. This trained model becomes an essential component for subsequent face recognition tasks within the system.



Screenshot 3.2: Training Dataset

5. Recognition Module: The recognition module should perform the following operations:

- i. Capture video frames from a camera
- ii. Convert each video frame to grayscale
- iii. Perform face detection using Haar cascades to detect faces in the video frame
- iv. Align the detected faces to a common reference frame
- v. Extract LBPH features from each aligned face
- vi. Use the trained machine learning model to predict the identity of each face based on its feature vector
- vii. Display the predicted identity on the video stream or store the results for further processing.



Screenshot 3.3: Result of Real Time Face Recognition System

6. Performance Evaluation Module: The performance evaluation module should evaluate the performance of the face recognition system using various metrics, such as accuracy, precision, recall, and F1-score. This module can use a separate test set of face images that were not used in the training phase and it shows as unknown result.

III. RESULT ANALYSIS

The findings reveal the real-time face recognition system's effectiveness in promptly and accurately detecting faces using Haar features, Cascade Classifier, and LBPH, achieving an impressive accuracy rate of 95%. This heightened accuracy suggests the machine learning model's adeptness in identifying faces even amidst challenging lighting and varied poses. However, inherent limitations surface, primarily stemming from the system's reliance on pre-defined features for recognition. This constraint raises concerns about recognizing faces absent from the training dataset or displaying significant variations. To address this, the exploration of deep learning algorithms is suggested, allowing the system to learn features directly from data and adapt to new faces and variations.

IV. ADVANTAGES & LIMITATIONS

A. Advantages:

1. Face recognition systems offer numerous advantages, primarily centered around their convenience and social acceptability. The simplicity of having one's picture taken is all that is required for the system to function.
2. The ease of use is a notable advantage of face recognition, and in many instances, it can be executed without the individual being aware of the process.
3. Face recognition stands out as one of the most cost-effective biometric solutions available, and its affordability is expected to further decrease over time.
4. The system proves exceptionally beneficial in time-saving scenarios, especially in places like airports or banks where swift identification is crucial, demonstrating its practicality in various high-paced environments.

B. Limitations:

1. Face recognition systems face a challenge in distinguishing between identical twins, as the inherent similarities in facial features can lead to confusion.
2. When an individual is positioned at a considerable distance from the camera, the system may encounter difficulty in accurately recognizing that person, highlighting a limitation in its performance under specific spatial conditions.

V. CONCLUSION

The study's exploration of various face recognition techniques highlights the Haar Cascade Classifier as highly efficient, with the Local Binary Pattern Histogram (LBPH) algorithm demonstrating superior accuracy exceeding 85%. Investing in high-quality hardware, especially cameras, is recommended to enhance system accuracy, particularly in capturing facial features from a distance and in low-light conditions. The "Real-Time Face Recognition System" developed in this study offers heightened accuracy and efficiency compared to existing alternatives, positioning it as a compelling solution for diverse applications, promising enhanced accuracy and computational efficiency in real-time face recognition.

REFERENCES

1. Wang, S.Z. Li and Y. Wang. Face recognition under varying lighting conditions using self quotient image. In IEEE International Conference on Automatic Face and Gesture Recognition (AFGR), pages 819-824. 2004.
2. Dr. Priya Gupta, Nidhi Saxena, Meetika Sharma, Jagriti Tripathi. Deep Neural Network for Human Face Recognition. © 2018 Published by MECS Publisher. Selection and/or peer review under responsibility of the Research Association of Modern Education and Computer Science.
3. Sanchit Dass, Mohammed Sadrulhuda Quadri, Navaz Pasha, "Real Time Face Recognition using Raspberry Pi", International Journal of Computer Applications, vol 176, pp. 0975 – 8887 2020
4. Raktim Nath, Kaberi Kakoty, Dibya Jyoti Bora, "Face Detection and Recognition Using Machine Learning" UGC Care Journal vol 43, ISSN: 2249-6661 2020
5. Insaf Adjabi, Abdeldjalil Quahabi, Amir Benzaoui, Abdelmalik Taleb-Ahmed, "Past, Present and Future of Face Recognition: A Review", MDPI 2020
6. Dr. S. B. Thorat, S. K. Nayak, Jyoti P. Dandale, "Facial Recognition Technology: An analysis with Scope In



- India", International Journal of Computer Science and Information Security, Vol 8 ISSN: 19475500 2010
7. Abhishek Jha, Monika Hooda, "Class Room Attendance System Using Facial Recognition System", The International Journal of Mathematics, Science, Technology and Management, vol 2 ISSN:2319-8125 2014
 8. Yassin Kortli, Maher Jridi, Ayman Al Falou, Mohamed Atri, "Face Recognition System: A Survey" MDPI 2020
 9. M. Smith, S. Millar, "The Ethical Application of Biometric Facial Recognition Technology", AI & Society vol 37, 167-175 2022
 10. Jana Alghamdi, Renad Alharthi, Raneem Alghamdi, Wafaa Alsubaie, Rawan Alsubaie, Dana Alqahtani, Rawan Alramadan, Leena Alqarni, Reem Alshammari, A Survey On Face Recognition Algorithms, 3rd International Conference on Computer Application and Information Security.
 11. sightcorp, "face detection- what is facedetection?," 2019. [Online]. Available: <https://sightcorp.com/knowledge-base/face-detection/>
 12. Ismail, Nurulhuda, Idayu, Mas, Md Sabri, Mas Idayu. : Review of existing algorithms for face detection and recognition.. pp. 1-39 (2009).
 13. Owusu E, Abdulai J-D, Zhan Y.: Face detection based on multilayer feed-forward neural network and Haar features. Softw Pract Exper. pp.1-10 (2018). <https://doi.org/10.1002/spe.2646>.
 14. opencv team, "opencv.org," 2019. [Online]. Available: <https://opencv.org/about/>.
 15. Adusumalli, H., Kalyani, D., Sri, R. K., Pratapreja, M., & Rao, P. P. (2021, February). Face Mask Detection Using OpenCV. In 2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV) (pp. 1304-1309). IEEE.
 16. Sriratana, W., Mukma, S., Tammarugwattana, N., & Sirisantamrid, K. (2018, July). Application of the OpenCV-Python for Personal Identifier Statement. In 2018 International Conference on Engineering, Applied Sciences, and Technology (ICEAST) (pp. 1-4). IEEE



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