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Machine Learning-Based Face Recognition System with Personal Information Retrieval

Chaithra N, Dr. Ravish G K

Dept. of CSE, MCA Program, Visvesvaraya Technological University "Jnana Sangama", Belgavi, Karnataka, India

Assist. Professor, Dept. of CSE, MCA program, Visvesvaraya Technological University "Jnana Sangama", Belgavi, Karnataka, India

ABSTRACT: The full system for facial recognition-based dataset generation and authentication is introduced in this work. Flask, a web framework, and libraries for computer vision are used to build the system. Users can create datasets containing facial image examples, train a classifier, and carry out face detection and recognition with this tool. The main parts of the system use the LBPH algorithm for recognition and the Haar cascade classifier for face detection.

The system has a number of crucial components. First, a user-friendly Flask-developed web interface enables users to enter personal information like name, age, and address. For future use, this information is safely kept in a MySQL database. The system supports webcam-based real-time face detection by utilizing the OpenCV and PIL libraries. Then, for further processing, detected faces are cropped, scaled, and made into grayscale pictures.

A face recognition classifier is trained using the collected facial photos, which are saved in a specific directory. The training process uses the LBPH method, which assigns a special ID to each image. The outcome classifier is serialized and kept for later use.

Additionally, the system has face detection and authentication features. Faces in live video feeds are found and identified using the learned classifier. Bounding boxes are used to contain identified faces, and if a high-confidence match is made, the database is queried for pertinent user data, which is then displayed next to the recognized face. Faces that are unknown are otherwise marked as "UNKNOWN."

KEYWORDS: OpenCV; Facial recognition; Dataset generation; Authentication;

I. INTRODUCTION

Recent developments in facial recognition technology have revolutionized a number of industries, including security, access control, surveillance, and identity verification. The efficiency and precision of these applications have been greatly enhanced by the automatic detection and recognition of human faces in photos and videos.

The Facial Recognition-Based Dataset Generation and Authentication System presented in this study integrates state-of-the-art computer vision techniques with web development tools. In order to create datasets of facial image examples, train a classifier, and carry out real-time face detection and recognition, the system provides an intuitive user interface. The system produces reliable and accurate results by utilizing cutting-edge techniques like the LBPH algorithm and the Haar cascade classifier.

This system's main goal is to make the process of creating datasets for facial recognition models simpler. Manually gathering and identifying facial photos can be laborious and error-prone, especially as the demand for big and varied datasets increases. The solution streamlines the dataset production process, requiring less human work and assuring consistent data gathering by combining web-based data entry and automatic face detection.

By using the taught classifier, the system also makes authentication and identification duties easier. The system can identify people and obtain the data related to them from a database using real-time facial detection and recognition capabilities. For applications like access control systems, where quick and precise identification is crucial, this functionality has enormous promise.

II. LITERATURE REVIEW

- **Present System**

This comprehensive investigation provides an overview of facial recognition methods, covering feature extraction approaches, classifier development, and assessment metrics. It discusses many topics and provides information on contemporary algorithms [1].

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The primary focus of this review is on recent advances in face recognition algorithms, covering both conventional and deep learning-based systems. It discusses both problems and potential solutions. Face detection, element extraction, and recognition techniques are other topics [2].

This survey focuses on deep learning algorithms for face recognition. It discusses several deep architectures for identifying faces, loss functions, and data augmentation strategies. Additionally, biases in the dataset and other issues such as occlusion are investigated [3].

This research investigates several approaches for recognizing persons based on their appearance. It discusses feature extraction techniques, pattern recognition algorithms, and performance measurements. It also indicates issues and prospective research avenues [4].

The major topic of this survey is the issues with facial recognition and privacy technologies. It looks into privacy-preserving techniques including differential privacy, holomorphic encryption, and secure multiparty computing. There is additional discussion of the trade-offs between privacy and recognition precision [5].

• Proposed System

Real-Time Face Detection: Real-time video streams from a webcam are used by the system to identify faces using the Haar cascade classifier technique. The algorithm locates faces in the frames that were collected, allowing the system to concentrate just on facial regions for additional processing.

Dataset Generation and Storage: By saving the preprocessed face photos in a specified directory, the system creates a dataset of facial images. Each image has a distinct identifier that makes it easier to maintain and retrieve the collection.

Handling of Unknown Faces: If a detected face cannot be positively matched to any existing records with a high level of confidence, the system marks the face as "UNKNOWN." This makes it possible to identify potential intruders or brand-new users who haven't been added to the database.

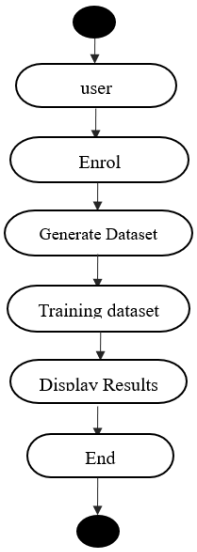

Fig 1. Activity Diagram

Step 1: The user enters their personal data, such as name, age, and address, into the web interface. The input is verified by the system, and its completeness is examined. The system moves on to the following stage if the data is accurate. Otherwise, the user is prompted for all the information and an error message is presented.

Step 2: Real-time video frames are captured by the system from the webcam. The system employs face detection utilizing the Haar cascade classifier for each frame. When a face is found, the image is cropped, scaled, and made grayscale. The preprocessed face image is saved as part of the dataset in a specified directory.

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Step 3: The system trains the LBPH facial recognition classifier using the generated dataset. The classifier picks up on the face characteristics and relates them to distinctive identifiers. The classifier is serialized and stored for later use after training is finished.

Step 4: The technology records webcam live video broadcasts. The Haar cascade classifier is used by the system to do face detection for each frame. The system uses the learned LBPH classifier for recognition if a face is found. If a match is identified with enough certainty, the system obtains the database's record for the related user. The screen shows the detected face as well as pertinent user data. If the identified face does not match any data already in existence, it is marked as "UNKNOWN."

Step 5: Until the user ends real-time facial detection and authentication, the system keeps going. The user has the option to end the current session or start a new one.

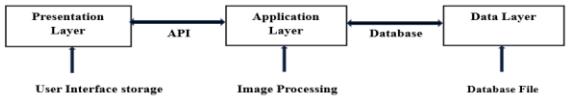

Fig 2. Three-Tier Architecture

1. **Presentation Layer**
   - This tier stands in for the system's presentation layer or user interface.
   - It contains the Flask web framework, which offers a simple interface for gathering user data and showing the outcomes.
   - Users can enter their personal information on the online interface, such as name, age, and address.
   - Additionally, it shows the results of real-time face identification and authentication, including identified faces and user data related to them.

2. **Application Layer**
   - This tier acts as the system's processing and logic layer.
   - It manages the face recognition classifier's training, dataset development, facial picture processing, and business logic.
   - Face detection utilizing the Haar cascade classifier, face cropping and preprocessing, the LBPH face recognition method, and dataset administration are some of the elements in this tier.
   - To gather user inputs, analyze facial images, and deliver the required outputs, the application tier communicates with the presentation tier.

3. **Data Layer**
   - The system's layer for managing and storing data is represented by this tier.
   - It has a MySQL database where the generated dataset and user data are kept.
   - The generated facial images are linked to user information in the database, including name, age, and address.
   - During the dataset generation, training, and authentication procedures, the data tier collaborates with the application layer to store and retrieve user information.

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III. RESULT AND DISCUSSION

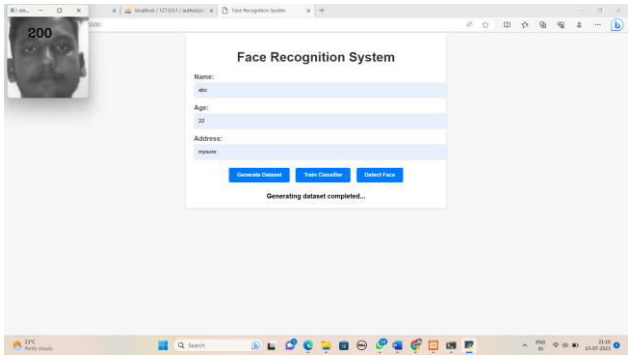

Fig 3. Dataset Generation

The /generate_dataset(Fig 3) endpoint uses the Haar Cascade classifier to recognize faces in webcam photos. It stores the identified facial areas as grayscale pictures in a local directory with an incremental file name, along with a unique ID, name, age, and address entered via a form. The procedure is repeated until 200 photos are recorded or the user pushes the Enter (return key). The collected facial photos and user data are saved in a MySQL database table called my_table.

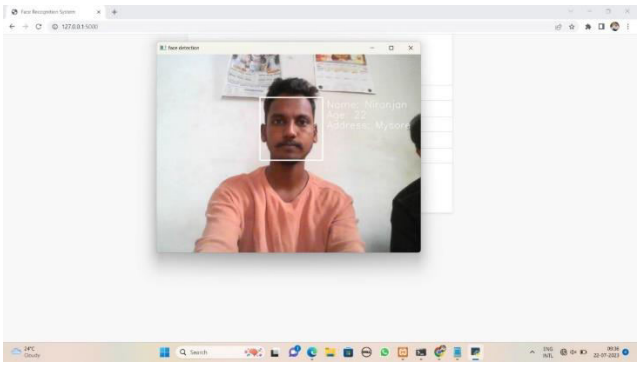

Fig 4. Detect the Authorized Person

By comparing the detected face to the training dataset, the recognizer guesses its identity. If the confidence level exceeds a particular threshold the face is considered allowed. Based on the identified person's ID, it then obtains(Fig 4) the person's information from the MySQL database.

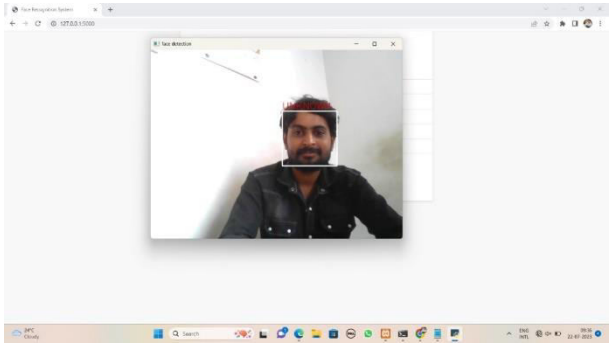

Fig 5. Find Unknown Person

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To recognize faces in the webcam video, the algorithm uses a trained classifier. When a face is spotted, the system determines whether the face falls inside a predefined Region of Interest (ROI) in order to focus on a specific region for identification. The trained classifier is then used by the code to predict the identity of the discovered face. If the prediction's confidence level falls below a particular threshold the person is classified as unknown. In such circumstances, the code(Fig 5) shows "UNKNOWN" on the bounding box of the identified face, indicating that the person's identity is not recognized.

IV. LIMITATIONS

1. **Sensitivity to Environmental circumstances:** The system's performance may be impacted by several environmental circumstances, including the amount of light, the caliber of the camera, and the angle of capture. Reduced accuracy and reliability of face detection and recognition may be the result of less-than-ideal circumstances.
2. **Dependency on Face Detection Algorithm:** The Haar cascade classifier is used by the system to identify faces. Despite being widely used and efficient, this algorithm may have trouble identifying faces in some situations, such as occlusion, partial face views, or alterations in facial appearance.
3. **Performance Considerations**: Computational resources are needed for real-time face detection and recognition. The hardware's processing capacity, the amount of the dataset, and the difficulty of the facial recognition algorithm may all have an impact on the system's performance. To ensure a seamless and effective system operation, these variables should be taken into consideration.
4. **Limitations in User Information Retrieval:** The system uses the recognized face to retrieve user information from a database. However, the system might not offer any additional details about the person if it comes across a face that is not registered or exists in the database. The system's capacity to provide thorough user identification and verification may be constrained by this constraint.

V. FUTURE SCOPE AND IMPROVEMENTS

1. **Improved Face Detection Methods:** Investigate and incorporate more sophisticated face detection methods, such as those based on deep learning (for example, convolutional neural networks), to increase the precision and robustness of face recognition, especially in difficult situations like occlusion or pose variations.
2. **Improved Face Recognition Algorithms:** Research and implement cutting-edge face recognition algorithms, such as Siamese networks or ArcFace, that perform better in terms of accuracy, speed, and handling variances in facial appearance.
3. **Scalability and Distributed Deployment:** Look at strategies for expanding the system's capacity to support several concurrent users and distributing the processing load among several servers. To enhance efficiency and meet growing user expectations, this may entail developing distributed computing frameworks or investigating cloud-based solutions.
4. **Real-World Testing and Evaluation:** Put the system through a lot of real-world testing and evaluation in a variety of settings and circumstances. This involves evaluating the system's performance under various lighting circumstances, with a variety of demographics, and while being deployed in actual situations.

VI. CONCLUSION

Finally, the Facial Recognition-Based Dataset Generation and Authentication System provides a comprehensive and effective answer to facial recognition problems. The system accelerates the procedure for capturing and identifying faces by integrating dataset generation, face detection, recognition, and database maintenance under a single framework. While there are still certain restrictions, such as those related to environmental sensitivity and dataset variety, further developments may improve face detection methods, increase dataset diversity, and address privacy issues. Overall, this approach shows potential for use in identity verification, monitoring, and access control, helping to enhance face recognition technology.

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