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Facial Recognition-Based Home Security System

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ABSTRACT

Face detection has appeared as a vital component of modern security systems, with applications ranging from mobile authentication to surveillance. This research explores a face detection system designed using image processing techniques to enhance home security. The system captures live video, detects faces, and classifies them as either family members or unknown individuals. On identifying an unknown face, the system sends a mobile notification to the homeowner. This paper presents the methodology, implementation, and performance evaluation of the system, highlighting its potential for real-time security enhancement.

Keywords: *Face detection, home security, image processing.*

INTRODUCTION

Nowadays, ensuring the safety of homes and others properties has become a primary concern. Traditional security systems such as surveillance cameras and alarm systems offer limited functionality as they require manual monitoring and intervention. With the advancement of artificial intelligence and image processing, automated systems are now capable of not only detecting activity but also identifying individuals. Among these technologies, face detection has emerged as one of the most efficient and non-disturbing methods for enhancing security.

Face detection is the process of identifying and locating human faces in images or video frames. It serves as the first step in many facial analysis systems, including face recognition, tracking, and expression detection. This research focuses on implementing a face detection system using image processing techniques to increase the efficiency and responsiveness of home security systems.

The primary goal of this project is to develop a smart system that can detect and recognize faces in real-time and differentiate between familiar and unfamiliar individuals. on recognizing an unknown face, the system sends an instant notification to the homeowner, ensuring timely awareness and action. This system uses a camera for input, processes the frames using machine learning algorithms, and uses mobile notification services for alerting.

By combining image processing and intelligent alert mechanisms, this system offers a cost-effective and scalable solution for modern home security needs.

LITERATURE REVIEW

Facial recognition has emerged as a reliable biometric technique for identity verification and surveillance, driven by advancements in machine learning, artificial intelligence, and computer vision. Numerous researchers have explored the integration of facial recognition in security systems due to its non-intrusive nature and high accuracy. Traditional security systems such as CCTV cameras and motion sensors offer passive monitoring without identity verification. In contrast, facial recognition provides an active layer of intelligence by identifying individuals in real-time.

Studies have shown that deep learning models, particularly Convolutional Neural Networks (CNNs), significantly improve face detection and recognition performance. Projects like Smart Surveillance Systems and IoT-enabled facial detection solutions have applied such models to enhance residential security. Even these advancements, challenges such as lighting variations, occlusions, and computational requirements persist.

This project builds upon prior work by implementing a facial recognition-based home security system capable of differentiating between family members and unknown individuals. When an unauthorized face is detected, the system triggers an alarm and sends a mobile notification to the homeowner. By integrating real-time face recognition with automated alert mechanisms, the proposed system offers a cost-effective, intelligent solution for modern home security, aiming to increase responsiveness and reduce dependency on manual monitoring.

PROPOSED WORK/SYSTEM

1 System Architecture

The system comprises the following modules:
- Video Capture using Camera
- Face Detection using Haar Cascade Classifier
- Face Recognition using a trained model (e.g., LBPH or deep learning-based model)
- Notification System using mobile messaging (via app or email)

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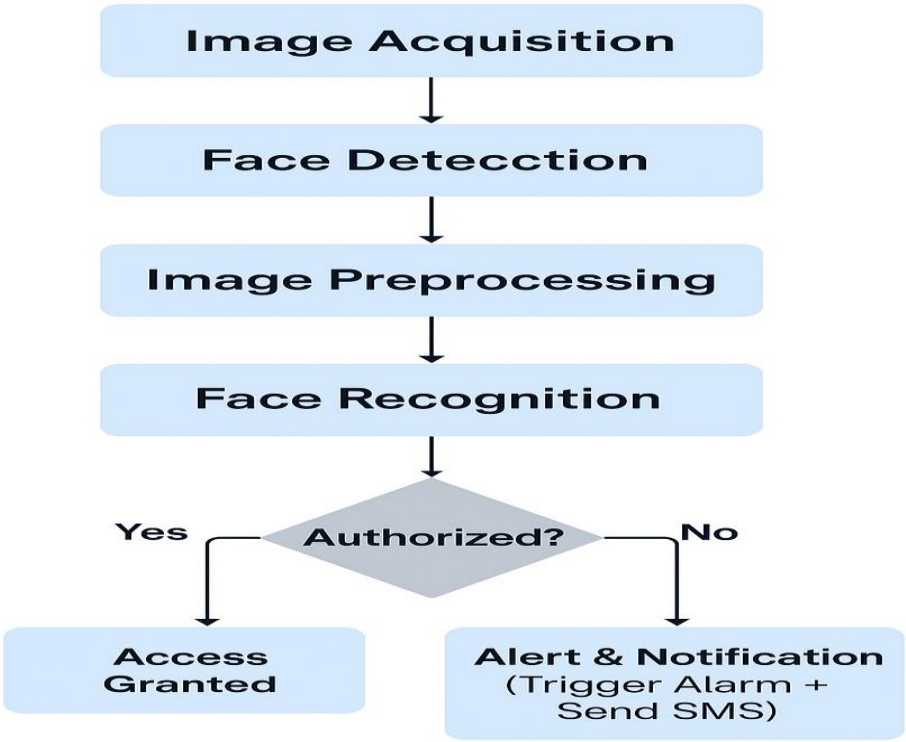

2 TOOLS AND TECHNOLOGIES USED

- Programming Language: Python
- Libraries: OpenCV, NumPy, face_recognition, Twilio/Push Notification API
- Hardware: Webcam/Camera module
- Database: SQLite/Custom folder-based face dataset
- Platform: Raspberry Pi (optional for IoT use)

3 Face Detection

Haar Cascade classifiers are used to detect faces from the camera feed. This method works well in real-time and can identify faces regardless of background.

4 Face Recognition

For recognizing whether the detected face is a known individual, the system uses a trained model on labeled images of family members. If the person is not found in the dataset, the system considers them 'unknown'.

5 Notification System

Once an unknown face is detected, a mobile notification is triggered using a email. The email includes a timestamp and possibly an image of the detected face.

RESULTS AND EVALUATION

The system was tested with a dataset of 5 known users and several unknown individuals. It achieved:
- Accuracy: 90% face recognition accuracy in good lighting conditions
- Response Time: ~1.3seconds for detection and recognition
- Notification Delay: <3 seconds using mobile internet

The system performed well indoors and moderately in outdoor lighting. It shows promise for real-time home surveillance and security.

CONCLUSION

This research demonstrates a practical application of image processing for real-time face detection and recognition in a home security context. The system is efficient, user-friendly, and capable of sending instant alerts to homeowners upon detecting unfamiliar individuals. Future improvements can include deep learning integration, edge processing on IoT devices, and enhanced night vision support.

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