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Smart Surveillance using Arcface & Motion Analysis with Alert System

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***Abstract*—**This paper presents an intelligent smart surveillance system that integrates motion analysis and deep learning-based facial recognition for real-time security monitoring. Traditional CCTV systems rely heavily on human observation, leading to inefficiency and missed threats. The proposed system utilizes Gaussian Mixture Model (GMM) for anomaly detection, object tracking for movement analysis, and ArcFace for robust facial recognition under challenging conditions such as occlusion and low illumination. The system generates real-time alerts for suspicious activities and unknown individuals. This approach significantly enhances detection accuracy, reduces false alarms, and minimizes human intervention, making it suitable for modern surveillance applications**.**

***Keywords*:**

Smart Surveillance, ArcFace, GMM, Motion Analysis, Object Tracking, AI Security, Facial Recognition

I. INTRODUCTION

With the rapid growth of urbanization and increasing security concerns, surveillance systems have become essential in public and private environments such as banks, malls, and transportation hubs. Traditional CCTV systems require continuous human monitoring, which is time-consuming and prone to human error.

Modern advancements in Artificial Intelligence (AI) and Computer Vision enable automated video analysis, allowing systems to detect abnormal behavior and identify individuals in real time. This paper proposesa smart surveillance system that combines motion anomaly detection and ArcFace- based facial recognition to enhance security efficiency and accuracy.

II. OBJECTIVES

The main objectives of the proposed system are:

- To develop an automated surveillance system without human dependency
- To detect abnormal or suspicious activities in real time
- Toimplementaccuratefacial recognition using ArcFace
- To reduce false alarms in complex environments

To generateinstant alertsforsecurity personnel

III. EXISTING SYSTEM

Most existing surveillance systems use:

- Background subtraction
- Basic motion detection

- Rule-based monitoring

Limitations:

- High false alarm rates
- Poor performance in low-light conditions
- Difficulty handling occlusion and crowd scenarios
- Requires continuous human monitoring

These limitations highlight the need for an intelligent automated system.

IV. PROPOSED SYSTEM

The proposed system introduces an AI-based hybrid surveillance model integrating:

- Motion detection using GMM
- Object tracking and blob analysis
- Face recognition using ArcFace
- Real-time alert system Working Flow:

1. Capture CCTV video
2. Preprocess frames
3. Detect motion using GMM
4. Track objects
5. Recognize faces
6. Generate alerts

V. LITERATURE SURVEY

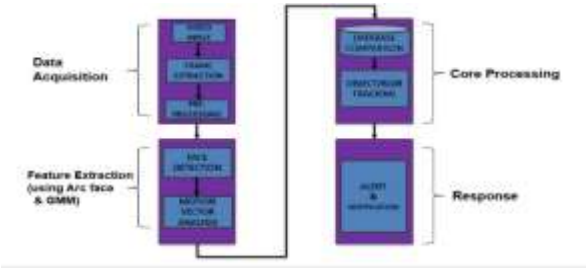
Recent research in surveillance systems focuses on:

- Deep learning for behavior detection
- Multimodal video analysis
- Real-time object detection However, many systems lack:
- Real-time adaptability
- Efficient handling of occlusion
- Integrated facial recognition with anomaly detection

The proposed system addresses these gaps using ArcFace and GMM**.**

SYSTEM ARCHITECTURE

The proposed smart surveillance system is composed of several interconnected modules that work together to ensure efficient monitoring, detection, and alert generation. Each module is designed to perform a specific function within the



system.

- **Input-Module:**

This module is responsible for capturing real-time video streams from CCTV cameras. It continuously acquires video data and converts it into frames for further processing. The quality and consistency of input data play a crucial role in the overall system performance.

- **Processing-Module:**

The processing module performs motion detection and object tracking using techniques such as Gaussian Mixture Model (GMM). It analyzes frame sequences to identify moving objects and detect abnormal activities, forming the core analytical component of the system.

- **Recognition-Module:**

This module focuses on identifying individuals using ArcFace-based facial recognition. It extracts facial features, generates embeddings, and compares them with stored data to accurately recognize known persons or detect unknown individuals.

- **Alert-Module:**

The alert module generates real-timenotificationswhensuspiciousactivities or unidentified persons are detected. Alerts can be sent to security personnel, enabling immediate response and preventive action.

- **Database-Module:**

- **D. Face Detection and Recognition**

Faces are detected using deep learning
techniques and converted into embeddings. ArcFace is used to compare facial features with stored data, ensuring accurate recognition even in difficult conditions.
This module stores important information such as user data, facial

records, and event logs. It ensures efficient data management and supports quick retrieval for analysis and verification purposes.

VI. MODULE DESCRIPTION

A. Video Preprocessing

This module captures CCTV video streams and converts them into frames. Noise reduction and normalization techniques are applied to improve image quality. The processed frames are prepared for motion detection.

B. Motion Detection using GMM

The Gaussian Mixture Model separates foreground from background by modeling pixel distributions. It detects moving objects and identifies abnormal motion patterns while adapting to environmental changes.

C. Object Tracking and Blob Analysis

This module tracks moving objects across frames using blob detection. It analyzes object size, position, and movement patterns, helping to detect suspicious behavior in crowded environments.E. Database Management

Stores:

- Known face data
- Event logs
- Alert records

It supports fast retrieval and system analysis

F. Alert Generation System

This module generates real-time alerts when:

- Suspicious activity is detected
- Unknown person is identified

Alerts are sent to security personnel for immediate action.

VII. ALGORITHM AND METHOD DESCRIPTION

A. ArcFace Algorithm

Step 1: Capture face image from video Step 2: Preprocess image (resize, normalize)
Step 3: Detect facial landmarks Step 4: Extract feature embeddings Step 5: Normalize embeddings Step 6: Apply angular margin loss Step 7: Compare with database
Step 8: Compute cosine similarity
Step 9: Identify person or mark unknown

B. Gaussian Mixture Model (GMM)

Step 1: Input video frames
Step 2: Initialize Gaussian distributions Step 3: Model background pixels
Step 4: Detect foreground objects Step 5: Update model dynamically Step 6: Identify abnormal motion Step 7: Perform blob analysis
Step 8: Track object movement Step 9: Detect anomalies
Step 10: Send results to alert system

VIII. IMPLEMENTATION TOOLS AND TECHNOLOGIES

A. Software Requirements

- OS: Windows
- Frontend: HTML, CSS, JavaScript
- Backend: Python
- Database: MySQL
- IDE: PyCharm

B. Hardware Requirements

The system was tested on hardware with the following minimum specifications:

- Processor: Intel 2.6 GHz
- RAM: 4 GB

- Storage: 160 GB

IX. RESULTS AND DISCUSSION

The proposed smart surveillance system was evaluated under different real-world conditions to analyze its effectiveness and performance. The testing included challenging environments such as low lighting, crowded areas, and occlusion scenarios.

In **low lighting conditions**, the system was able to detect motion and recognize faceswith good accuracy due to the robustness of the ArcFace algorithm. In **crowded environments**, the object tracking mechanism successfully distinguished multiple individuals and maintained consistent tracking without significant errors. During **occlusion scenarios**, where faces or objects were partially hidden, the system still managed to identify individuals with acceptable accuracy, demonstrating its reliability.

Results:

- Improved detection accuracy compared to traditional surveillance systems
- Significant reduction in false positives through intelligent motion analysis
- Real-time processing with minimal delay in detection and alert generation
- Efficient face recognition even under challenging conditions

Overall, the proposed system provides better reliability, faster response time, and higher accuracy than conventional methods. These improvements make it highly suitable for modern surveillance applications such as public security, smart cities, and restricted area monitoring.

X. CONCLUSION

The proposed smart surveillance system integrates motion analysis and ArcFace- based facial recognition to provide an efficient, accurate, and automated security solution. By combining intelligent motion detection with advanced face recognition techniques, the system is capable of identifying suspicious activities and individuals in real time.

The implementation of this system significantly enhances detection accuracy while reducing false alarms and minimizing the need for continuous human monitoring. Its ability to operate effectively under challenging conditions such as low lighting, crowd density, and partial occlusion further improves its practical applicability.

Moreover, the real-time alert generation mechanism ensures quick response to potential threats, making the system highly reliable for security-critical environments. Compared to traditional surveillance methods, the proposed approach offers improved efficiency, faster response time, and better adaptability.

Overall, this system represents a significant advancement in smart surveillanceFuture work will focus on extendingthe system to support more diverse disease datasets, improving modelaggregation strategies, and evaluating performance on real-world distributed healthcare infrastructure.technology and demonstrates strong potential for real-world deployment in areas such as public safety, smart cities, and secure infrastructure monitoring

REFERENCES

[1] Ma, T., et al., “Abnormal behavior analysis…,” 2024

[2] Wastupranata, L., et al., “Deep learning for abnormal behavior detection,” 2024

[3] Nwakeze, O., et al., “Enhancing risk management…,” 2025

[4] Jinnuo, Z., et al., “Behavioral analysis using deep learning,” 2025

[5] Nadar, A., et al., “Network data analytics…,” 2024