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Intelligent Surveillance System for Crime Prevention Using Deep Learning

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Abstract: *This project aims to develop a Criminal Face and Violence Detection System for Public Safety that utilizes computer vision and machine learning techniques to detect and recognize criminal faces and violence in real-time or from uploaded videos. The successful implementation of this system can significantly reduce the time and resources required for manual surveillance and improve the effectiveness of public safety measures.*

Keywords: Violence Detection, Face Recognition, Computer Vision, Deep Learning, Smart Surveillance System.

I. INTRODUCTION

Public safety is a paramount concern in any society, as the well-being and security of citizens in public spaces are vital for maintaining social stability. Regrettably, instances of criminal activity and violence have been increasing in recent years, necessitating the exploration of new strategies and technologies to bolster public safety. One such technology that has shown great promise is computer vision and machine learning. These systems can analyse vast amounts of visual data in real-time and identify patterns and anomalies indicative of criminal behaviour or violence. This project aims to leverage the capabilities of computer vision and machine learning to detect known criminal faces and violent behaviour in public places, providing real-time alerts and notifications to law enforcement and security personnel.

II. PROPOSED SYSTEM

The proposed system, Intelligent Surveillance System for Crime Prevention using Deep Learning, aims to enhance public safety by utilizing computer vision and machine learning algorithms. It offers live monitoring of public places, facial recognition for identifying criminal faces, violence detection algorithms, an alert system for notifying authorities, and scalability for deployment in various public settings. By leveraging these features, the system has the potential to detect potential threats in real-time, allowing authorities to respond swiftly and effectively, ultimately improving public safety and security.

III. METHODOLOGY

The proposed system utilizes a methodology consisting of several steps to detect criminal faces and violence in public places. It begins with data collection from cameras in public areas, followed by pre-processing to remove noise and irrelevant information. Key characteristics are extracted from the data, such as facial features and body language, which are used to train a machine learning model. The model is then tested on separate datasets to evaluate its performance. Once validated, the model is integrated into a real-world system connected to cameras and sensors for real-time detection. Continuous improvement is emphasized through user feedback and updates to enhance accuracy and performance over time. This comprehensive methodology aims to enhance public safety and security by detecting potential threats and preventing criminal activity in public places.

IV. SYSTEM ARCHITECTURE

The system architecture for this project comprises several layers, each with specific components and responsibilities. At the core, the architecture includes a Data Collection Layer responsible for capturing video data from input sources such

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as cameras or pre-recorded video files. The Data Preprocessing Layer prepares the video data for analysis by performing tasks like resizing, cropping, and colour correction. The Detection Layer incorporates modules for face detection and violence detection, which analyse the video data to identify potential threats. The Data Storage Layer facilitates data processing, storage, and retrieval, allowing for future analysis and retrieval of stored data. The Alerting Layer generates alerts when potential threats are detected, utilizing components like notification systems or automatic alarm triggers. Finally, the User Interface Layer provides a graphical interface for users to interact with the system, which may include a web-based dashboard or a mobile app. The system architecture can be customized to meet the specific requirements of the implementation environment.

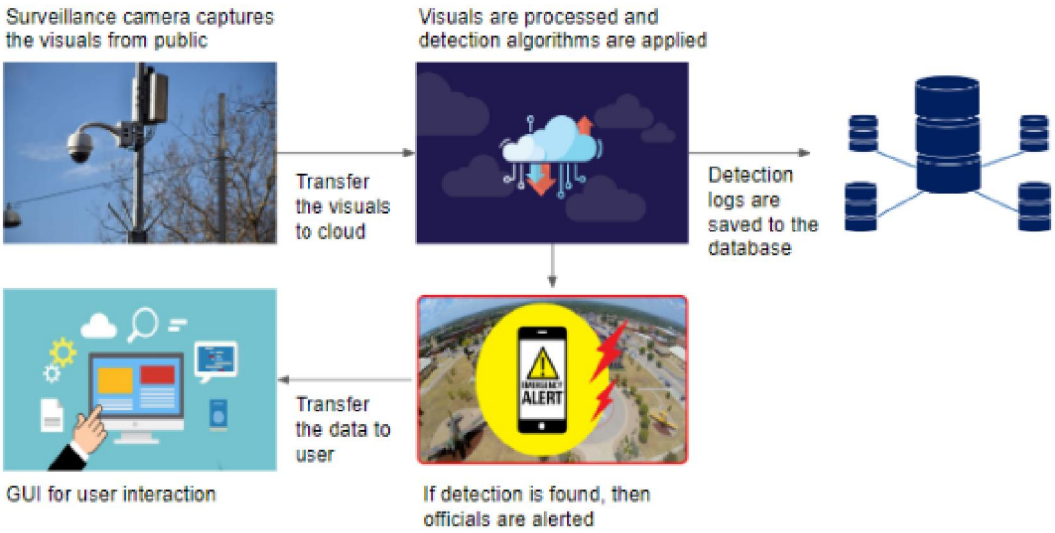

Fig. 1. System Architecture

V. ALGORITHMS IMPLEMENTED

Violence Detection Algorithm

MobileNetV2 is a lightweight convolutional neural network (CNN) architecture designed by Google for computer vision applications. It is particularly suitable for real-time applications like the Violence Detection System due to its efficiency on mobile and low-power devices. The architecture utilizes depth wise separable convolutions, separating spatial and channel-wise convolutions to reduce computational complexity and memory usage while maintaining accuracy. MobileNetV2 incorporates inverted residual blocks with skip connections to preserve high-level features and prevent information loss. During training, the model learns to recognize relevant features for violence detection by adjusting its parameters using a large dataset of labelled violent and non-violent images or videos.

Face Recognition Algorithm

The face recognition component of the system utilizes the face_recognition library in Python, which incorporates the FaceNet model, a convolutional neural network developed by Google. One notable feature of this model is its ability to support single-shot learning, allowing it to detect and recognize a person using just a single picture. By being trained on a vast dataset of face images, the FaceNet model can extract unique features and create distinct representations for everyone's face. During testing, the model accurately generates feature vectors for detected faces in an input image and compares them to a database of known faces. This single-shot learning capability enhances the efficiency and effectiveness of the system in recognizing individuals, even when faced with limited training data.

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VI. RESULT AND ANALYSIS

Dataset

The dataset used for training the system is sourced from Kaggle (www.kaggle.com), a widely recognized online platform for data scientists, machine learning practitioners, and researchers. Kaggle provides a diverse range of datasets, facilitates competitions, and promotes collaboration among its community members. The specific dataset utilized in this project, created by Mohamed Hussein, Mina Abd El-Massih, and Youssif Mohamed, comprises approximately 2000 videos capturing both violent situations (fights, assaults) and non-violent activities (walking, dancing, sports). These videos are sourced from various channels such as CCTV footage, surveillance cameras, and social media. The dataset serves as a valuable resource for training and evaluating machine learning models for violence detection in videos and for conducting research on the patterns and characteristics of real-life violent scenarios.

Training Results

To accommodate the limitations of computational resources, the dataset used for training the model was reduced to a total of 400 videos, with 200 videos each for violence and non-violence classes. Despite the smaller dataset size, the violence classifier model demonstrated promising performance, achieving an accuracy of 91.48% on the training set and 90.67% on the test set. These accuracy scores indicate that the model has successfully learned to generalize well to new, previously unseen data. During the training process, the model's loss function recorded values of 22.24% on the training set and 22.81% on the test set, demonstrating its ability to minimize errors and discrepancies.

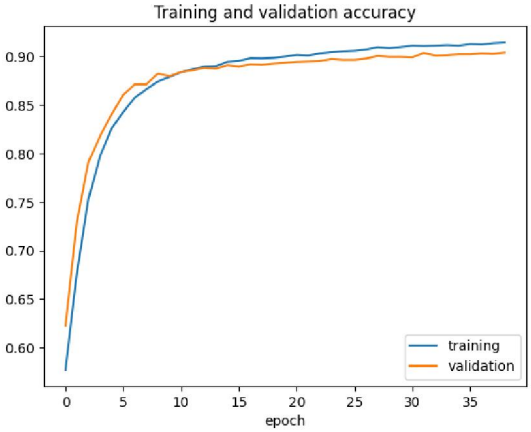

Fig. 2. Accuracy Curve of the Violence Detection model

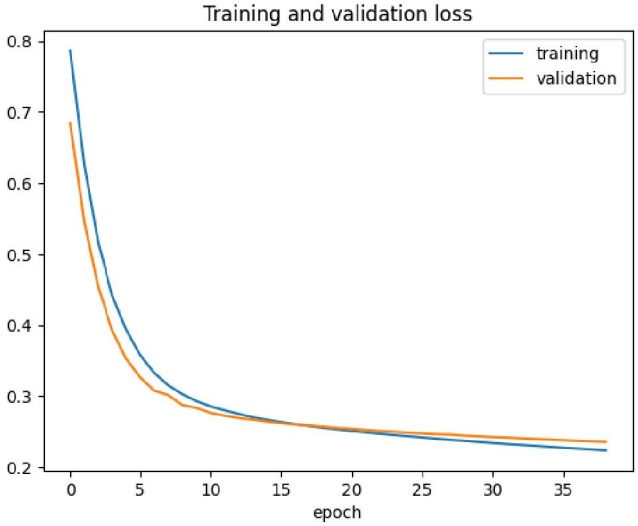

Fig. 3. Loss Curve of the Violence Detection model

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Sample Outputs

Fig. 4. Sample output for face recognition

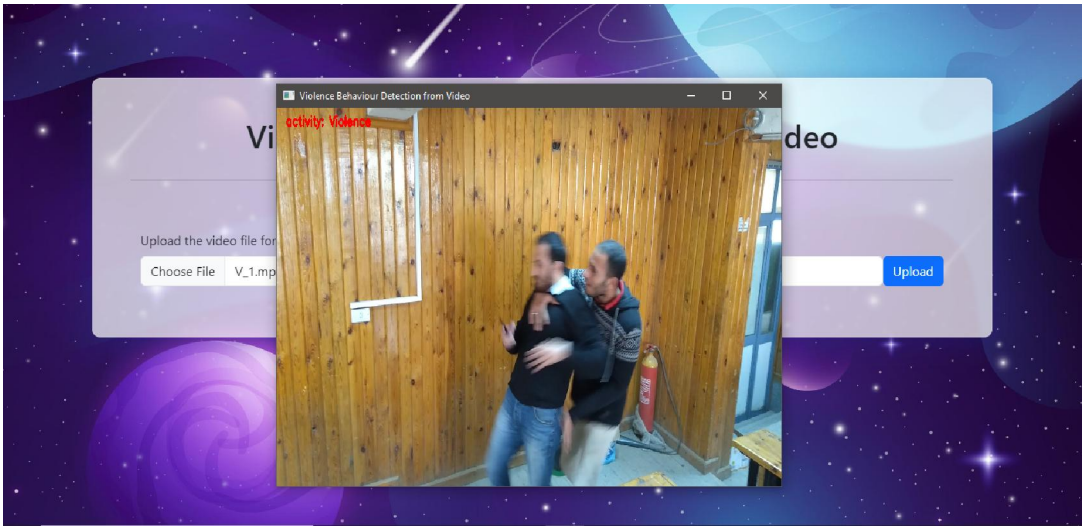

Fig. 5. Sample output for violence detection

VII. CONCLUSION

In conclusion, the proposed Intelligent Surveillance System for Crime Prevention using Deep Learning holds immense potential for enhancing public safety and security. By leveraging advanced machine learning techniques and computer vision algorithms, the system can accurately detect criminal faces and violent behaviour in real-time or through uploaded videos. However, there are several areas for future improvement, such as enhancing accuracy through advanced machine learning techniques, incorporating real-time tracking and integration with existing surveillance systems, and developing a mobile application for efficient alert management. The successful implementation of this system has the potential to significantly reduce manual surveillance efforts, improve public safety measures, and ultimately contribute to the reduction of crime rates.

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