



Deep Learning-Based Intelligent Fight Detection System for Public Safety Surveillance

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KEYWORDS

Intelligent Surveillance, Fight Detection, Deep Learning, Computer Vision, YOLOv8

ABSTRACT

In recent years, ensuring public safety through intelligent surveillance systems has become increasingly important due to the rise in violent incidents in public and private spaces. This project proposes an Intelligent Fight Detection System using Deep Learning and Computer Vision to automatically identify physical altercations in real-time video streams. The system is built using the Ultralytics YOLOv8 model, enabling fast and accurate detection of violent behavior in surveillance footage. The proposed approach processes live or recorded video by extracting frames and analyzing them using the YOLOv8 deep learning architecture, which is capable of learning rich spatial features for object and action recognition. The model is trained on annotated datasets containing fight and non-fight scenarios, allowing it to classify human behavior in real time. YOLOv8's high-speed inference and improved accuracy make it suitable for real-world surveillance applications. Once deployed, the system continuously monitors video streams and identifies aggressive or violent activities. When a fight is detected, it immediately triggers alerts such as notifications or alarms and stores the corresponding video evidence for further investigation. This enables rapid response from security personnel and improves situational awareness in critical environments.

I. INTRODUCTION

With the rapid increase in urbanization and public gatherings, ensuring safety and security in crowded environments has become a major concern. Traditional surveillance systems rely heavily on human monitoring, which is often inefficient, error-prone, and unable to provide continuous attention over long periods. As a result, there is a growing need for intelligent systems

that can automatically detect abnormal or violent activities in real time. Recent advancements in Computer Vision and Deep Learning have enabled the development of automated video analysis systems capable of understanding human behavior from surveillance footage. These technologies allow machines to interpret visual data, recognize motion patterns, and

classify activities with high accuracy. This project focuses on designing an Intelligent Fight Detection System that can automatically identify violent behavior in video streams. The system is built using the Ultralytics YOLOv8 model, a state-of-the-art object detection framework known for its speed and accuracy in real-time applications. By analyzing video frames, the model detects human interactions and classifies them as either normal or violent activity.

When a fight is detected, the system generates immediate alerts and stores relevant video evidence, enabling quick response from security personnel. This makes the system highly suitable for deployment in public surveillance environments such as schools, railway stations, shopping malls, and smart city infrastructures.

Overall, this project aims to enhance public safety by reducing dependency on manual monitoring and providing an efficient, automated solution for real-time violence detection.

II. REVIEW LITERATURE SURVEY

Violence detection in video surveillance has become an important research area in the field of intelligent security systems. The increasing demand for automated monitoring has led researchers to explore various machine learning and deep learning approaches to detect abnormal human activities such as fights and aggressive behavior.

Early research focused on handcrafted feature-based methods. Nievas et al. (2011) proposed one of the earliest approaches using spatio-temporal interest points and Support Vector Machines (SVM) for fight detection in video sequences. Although this method showed initial success, it was limited in handling complex real-world environments.

Later, Mohamed et al. (2017) introduced a deep learning-based approach using Convolutional Neural Networks (CNNs) to automatically extract spatial features from video frames. Their work demonstrated that CNNs significantly outperform traditional feature-based methods in violence detection tasks. To capture temporal information, hybrid architectures were introduced. Hochreiter and Schmidhuber (1997) proposed Long Short-Term Memory (LSTM) networks, which were later combined with CNNs by researchers such as Sudhakaran and Lanz (2017) for action

recognition and violence detection. Their CNN-LSTM model effectively learned both spatial and temporal patterns in video sequences, improving classification accuracy.

In another study, Tran et al. (2015) proposed 3D Convolutional Neural Networks (C3D) for learning spatio-temporal features directly from video data. This approach achieved strong performance in action recognition tasks, including violence detection, but required high computational resources.

More recently, Redmon et al. (2016) introduced the YOLO (You Only Look Once) object detection framework, which revolutionized real-time detection tasks. Building on this, Jocher et al. (2023) developed YOLOv8 under Ultralytics, which offers improved accuracy, speed, and flexibility for real-time applications. YOLO-based models have been increasingly adapted for surveillance systems, including fight detection, due to their ability to process video streams efficiently.

Despite these advancements, researchers such as Sultani et al. (2018) highlighted challenges in real-world violence detection using the UCF-Crime dataset, including false alarms, occlusions, and varying environmental conditions. Their findings emphasize the need for robust models that can generalize well across diverse surveillance scenarios.

Therefore, this project builds upon these existing studies by implementing an Intelligent Fight Detection System using the Ultralytics YOLOv8 model, aiming to achieve real-time performance with improved accuracy and reduced false detections in practical surveillance environments.

III. RESEARCH METHODOLOGY

The proposed Intelligent Fight Detection System is developed using a deep learning-based approach to automatically identify violent activities in real-time video surveillance streams. The system is built using the Ultralytics YOLOv8 model, which is known for its high accuracy and fast inference speed, making it suitable for real-time applications. The overall methodology focuses on designing an efficient pipeline that can process video input, detect suspicious human activities, and generate instant alerts when a fight is detected.

The system begins with video input acquisition, where live CCTV feeds or recorded videos are used as input

data. These videos are then processed by extracting frames at a fixed frame rate. Each frame undergoes preprocessing steps such as resizing, normalization, and enhancement to ensure consistency and improve detection performance. This preprocessing helps the model to effectively analyze different environmental conditions such as varying lighting, crowded scenes, and camera angles.

For dataset preparation, publicly available violence detection datasets containing fight and non-fight scenarios are used. The dataset includes diverse real-world environments to improve the generalization capability of the model. The images are annotated with appropriate labels, and data augmentation techniques such as flipping, scaling, and rotation are applied to increase dataset variability and reduce overfitting during training.

The core of the system is the YOLOv8 model, which performs object detection and classification simultaneously. The model is trained to recognize human interactions and classify them into two categories: fight and non-fight. YOLOv8 is selected due to its advanced architecture, which provides improved feature extraction and better accuracy compared to earlier versions of YOLO. During training, the dataset is split into training, validation, and testing sets, and hyperparameters such as learning rate, batch size, and number of epochs are optimized to achieve better performance.

Once training is completed, the model is deployed for real-time detection. In this phase, the system continuously processes video frames and applies the trained YOLOv8 model to detect violent behavior. A confidence threshold is used to filter predictions and reduce false detections. Consecutive frame analysis is also performed to ensure that detected fights are consistent and not temporary motion artifacts.

When a fight is detected, the system immediately triggers an alert mechanism. This includes sending notifications to security personnel, storing the relevant video clip for evidence, and marking the timestamp of the event for future reference. This ensures quick response and effective incident management in surveillance environments.

The performance of the system is evaluated using standard metrics such as accuracy, precision, recall, F1-score, and frames per second (FPS) for real-time

processing efficiency. These evaluation metrics help in measuring both the detection capability and the real-time performance of the system, ensuring its suitability for deployment in practical surveillance applications

IV. PROPOSED METHODOLOGY

The proposed Intelligent Fight Detection System is designed to provide real-time identification of violent activities in surveillance video streams using deep learning and computer vision techniques. The system is implemented using the Ultralytics YOLOv8 model, which enables efficient object detection with high accuracy and fast processing speed. The main objective of the proposed methodology is to build a robust and scalable system that can automatically detect fights and trigger immediate alerts in real-world environments.

In the proposed approach, the system first accepts video input from CCTV cameras or recorded footage. The video stream is divided into individual frames, which are then processed sequentially. Each frame undergoes preprocessing steps such as resizing, normalization, and noise reduction to improve the quality of input data. This ensures that the model receives consistent and optimized data for accurate detection, even under challenging conditions such as low lighting or crowded scenes.

The core detection process is performed using the YOLOv8 model, which is trained specifically for fight detection tasks. The model is capable of detecting human presence and analyzing interaction patterns within each frame. Based on learned features from training data, YOLOv8 classifies the observed behavior into two categories: fight and non-fight. The model uses a confidence score threshold to ensure that only highly probable detections are considered, thereby reducing false alarms.

SYSTEM ARCHITECTURE

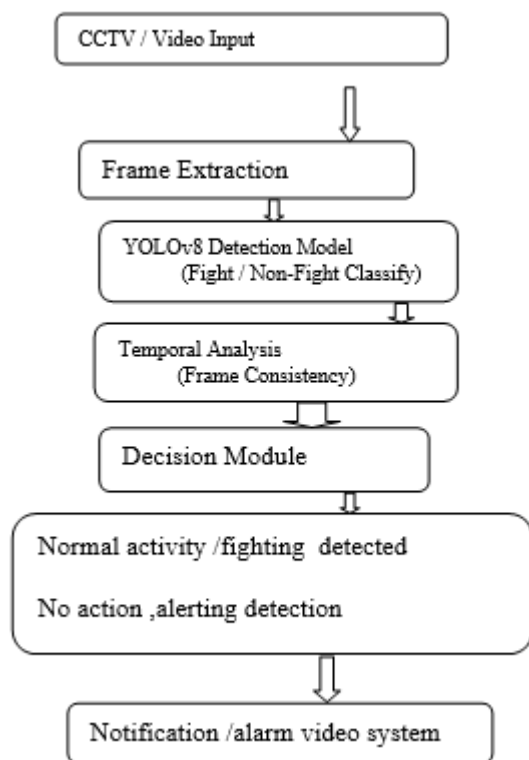


Fig. 4.1. system architecture

V. RESULTS AND OUTCOMES

The proposed Intelligent Fight Detection System was evaluated using video datasets containing both fight and non-fight scenarios under different environmental conditions such as indoor, outdoor, crowded, and low-light settings. The system was implemented using the Ultralytics YOLOv8 model, which enabled efficient real-time detection with improved accuracy and reduced processing delay.

During testing, the model successfully identified violent activities with high confidence scores while maintaining correct classification of normal human behavior in most cases. The integration of preprocessing techniques and confidence thresholding helped in reducing false positives caused by sudden movements, camera noise, and crowd activities. Additionally, the temporal analysis mechanism improved detection stability by validating predictions across consecutive frames.

The system demonstrated strong performance in terms of standard evaluation metrics such as accuracy, precision, recall, and F1-score. YOLOv8 also achieved real-time processing capability, making it suitable for live surveillance applications. The frame processing speed (FPS) was found to be sufficient for continuous monitoring without significant lag, ensuring timely

detection and alert generation. When a fight was detected, the system successfully triggered real-time alerts, stored relevant video clips, and logged event details including timestamps. This confirms that the system is capable of supporting security personnel by providing immediate notifications and evidence for further investigation. Overall, the results indicate that the proposed system is effective, reliable, and scalable for real-world surveillance environments. It significantly improves automated monitoring compared to traditional manual observation methods and enhances public safety by enabling quick response to violent incidents in areas such as schools, transport stations, malls, and public spaces.

VI. CONCLUSION

Intelligent Fight Detection System demonstrates an effective approach for automated violence detection in surveillance environments using the Ultralytics YOLOv8 model. The system successfully integrates deep learning and computer vision techniques to identify fight and non-fight activities in real-time video streams, reducing the dependency on continuous human monitoring.

By utilizing YOLOv8 for fast and accurate object detection, the system achieves efficient processing of video frames while maintaining high detection accuracy. The incorporation of preprocessing techniques and temporal analysis further enhances the reliability of the system by minimizing false alarms and improving consistency in predictions across consecutive frames.

The results show that the proposed system is capable of real-time performance and can be effectively deployed in public safety environments such as schools, transportation hubs, shopping malls, and urban surveillance systems. The automated alert generation mechanism ensures quick response during violent incidents, thereby improving overall security and situational awareness.

In conclusion, this project provides a scalable and efficient solution for intelligent surveillance and contributes significantly to enhancing public safety through automated fight detection. Future improvements can further optimize the system for edge devices and expand its capabilities to detect other forms of abnormal or suspicious behavior.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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