WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Review of Vision-Based Weapon Detection and Human Tracking

Pratik Kamble[1], Aditya Jadhav[2], Gayatri Bagal[3], Monali Jamdade[4], Prof. Nita Dimble[5]

[1 2 3 4 5] Department of AIML Engineering, Navsahyadri Education Society's Group of Institute Faculty of Engineering, Pune, Maharashtra, India

A B S T R A C T:

A review of deep learning-based weapon detection and human tracking systems is presented in this work. The suggested system integrates the DeepSORT algorithm for object tracking with the state-of-the-art object identification model YOLOv8 to identify guns and other weapons. Following a thorough testing and assessment process, YOLOv8 was determined to provide better accuracy and performance than competing models like YOLOv5 and YOLOv11. This device may be used for real-time monitoring because it is also designed to identify firearms using a regular webcam. Together with future plans for this technology, this article offers a thorough summary of the study, goals, methods, and current state of the art.

Keywords: Weapon Detection, Person Tracking, Public Safety Deep Learning, YOLOv8, DeepSORT, Transfer Learning.

Introduction

As public safety concerns in locations like airports, schools, and shopping malls grow, there is an urgent need for sophisticated surveillance systems that can detect threats and track individuals in real time. Since human error, fatigue, and poor reaction times are frequent shortcomings of traditional surveillance approaches that rely on human operators, automated solutions are essential for improving security and situational awareness. This study explores the development of an automated weapon identification and person tracking system that provides a reliable, real-time solution using deep learning techniques. To continually monitor individuals carrying recognized weapons, the proposed system uses YOLOv8 for weapon identification and DeepSORT for person tracking.

A cutting-edge object identification model, YOLOv8, demonstrated better accuracy in recognizing firearms than models like YOLOv5, YOLOv7, and experimental versions like YOLOv11, YOLOv8. DeepSORT reduces identity shifts and maintains consistent tracking between frames by handling occlusions, cluttered sceneries, and dynamic motions using its combination of motion and appearance-based tracking. This study describes the objectives, challenges, and methods associated with developing a dependable, real-time surveillance system that can be applied in a range of environments, including dimly lit spaces and intricate, crowded regions.

Additionally, the solution enhances accessibility and deployability for both public and private security applications by optimizing YOLOv8 and DeepSORT to function effectively with common cameras. By providing security personnel with real-time information, the system facilitates proactive threat detection and faster response times.

Methodology

This section delves into the core modules of the system, including data collection, the weapon detection model using YOLOv8, and person tracking via DeepSORT.

1.1. Data Collection and Preprocessing

Data collection is crucial to ensure the robustness and accuracy of the weapon detection model. For this study, a dataset of thousands of photos of various weapons, including firearms and knives, was compiled from public databases such as the Custom and Roboflow datasets, as well as specialist collections for security research. The dataset comprises a wide range of scenarios and lighting circumstances to ensure that the model operates effectively in a variety of settings, from well-lit places to poor visibility situations. Each image was meticulously pre-processed, scaled, and labeled to determine the precise location of weaponry within frames. To improve the model's generalization abilities, data augmentation techniques such as rotation, scaling, flipping, and brightness modifications were used. These strategies serve to imitate real-world settings and improve the model's robustness, ensuring accurate detection even in crowded and complex scenes.

1.2. Weapon Detection Model using YOLOv8

The weapon detection module uses the YOLOv8 model, which was chosen after considerable testing with several architectures. YOLOv8's design enables high-speed processing and accurate detection, which is important for real-time surveillance. Earlier variants using models such as YOLOv5, YOLOv7, and even an experimental YOLOv11 version were tested, but none were as accurate and efficient as YOLOv8. This model was fine-tuned using transfer learning on a particular dataset, dramatically improving detection precision for a variety of weapon kinds.

A crucial characteristic of YOLOv8 is its capacity to deal with complicated backgrounds and congested situations, where false positives are common. The model's remarkable accuracy in detecting even small or partially obscured firearms makes it especially useful for public-space applications that require quick, dependable identification. Furthermore, the system is configured to interact with ordinary cameras, allowing adaptability for both indoor and outdoor scenarios. By exploiting YOLOv8's real-time detection strengths and merging them with live video feeds, the model has demonstrated its ability to provide accurate weapon identification in a variety of circumstances, establishing its utility for increased surveillance.

Another advantage of utilizing YOLOv8 is its modular and extendable architecture, which facilitates integration with other systems such as object tracking algorithms and alert production techniques. In this research, YOLOv8 is combined with a lightweight tracking module to track the movement of people carrying detectable weapons across video frames. This not only enables constant observation, but also helps to generate behavioral analytics for security staff. The integration facilitates scalability, allowing the system to be deployed in a variety of settings, including schools, transportation hubs, and public events, without requiring large computational resources.

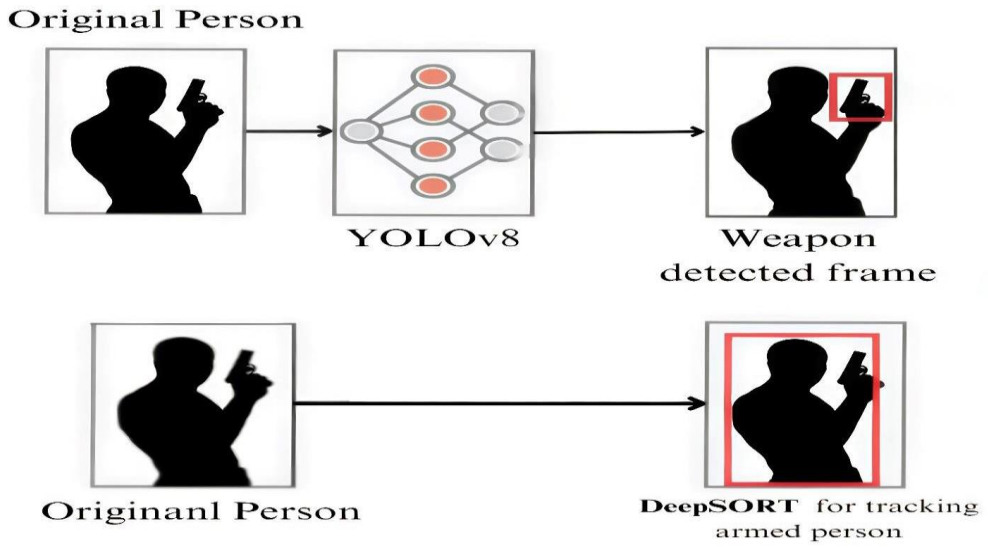
1.3. Person Tracking DeepSORT

There are various methods for monitoring people in security surveillance, and DeepSORT is one of the most effective systems for real-time multi-object tracking. Because traditional tracking approaches solely use mobility data, they are susceptible to identity theft, especially in populated areas. DeepSORT improves tracking by merging motion and appearance information, allowing for more reliable identification of people even when they briefly leave the frame or change route.

Once a potential threat, such as a weapon, is recognized, tracking specific individuals becomes critical in security applications. YOLOv8 successfully recognizes firearms in images and videos by surrounding them in precise bounding boxes. Tracing the person who is carrying the weapon, on the other hand, ensures continuing surveillance and helps security experts take appropriate action. Weapon detection is insufficient. DeepSORT does this by connecting the detected weapon with a single individual and preserving their identity over numerous frames. Even in complex settings, the technology ensures that the suspect is not lost by dealing with occlusions, rapid movements, and other people in the area. DeepSORT reduces false tracking mistakes significantly when compared to other simple tracking systems due to its ability to adapt to differences in appearance and movement patterns.

In order to enable prompt and well-informed actions, this guarantees that security personnel receive real-time alerts on questionable locations. The device improves situational awareness by utilizing sophisticated tracking algorithms, which makes monitoring more effective and proactive. In addition to keeping an eye on suspects, tracking offers useful movement data that enable security professionals foresee possible threats and take action before a situation gets out of hand.

System Diagram



The system uses YOLOv8 for weapon detection and DeepSORT for person tracking. It identifies weapons in images/videos, draws bounding boxes, and tracks the person carrying the detected weapon in real time.

Result

The system effectively detects weapons and tracks them in real-time. Results:

A. Weapon Detection :

The system detects a variety of weapons, such as knives, guns, and other types of guns in real-time by using YOLOv8, a cutting-edge deep learning model. The model minimizes false positives and false negatives while achieving high detection accuracy by utilizing a rich dataset that includes a variety of weapon kinds, lighting situations, and occlusions. Using precise bounding boxes, it locates firearms with accuracy while processing pictures and video feeds in an efficient manner. Cutting-edge feature extraction methods improve detection accuracy, guaranteeing that guns are recognized even in difficult situations including crowded backdrops, partial occlusions, dim lighting, and different object sizes. The system is very useful for security applications in surveillance, law enforcement, and public safety monitoring since it continually adjusts to new threats by fine-tuning and retraining on updated datasets.

Fig. 4.1 Weapon Detection

Challenges and Future Work

Although there have been issues with YOLOv8 and DeepSORT integration, the system continues to experience hurdles due to environmental variability. Lighting conditions, occlusions, and the presence of non-standard weapon appearances can all affect detection accuracy. Future research attempts to solve these challenges by combining multimodal data, such as temperature and acoustic inputs, to improve detection accuracy in tough environments.

Furthermore, refining the system for edge device deployment could reduce latency and power consumption, making it ideal for use on security cameras and other systems with limited resources. Another area for improvement is decreasing the model's computing load, which would allow for faster processing without sacrificing accuracy. These improvements could enhance the system's scalability and effectiveness, especially in densely populated areas with limited_resources.

Conclusion

This review presents, a robust approach to weapon detection and person tracking by integrating YOLOv8 and B. The use of YOLOv8 offers high detection accuracy and speed, making it ideal for real-time surveillance applications. The model's compatibility with webcam based detection adds to its flexibility, allowing deployment in various environments. Combined with the DeepSORT, this system provides a seamless solution for monitoring individuals carrying weapons and continuous tracking down the person till person appears in the frame.

REFERENCES :

1. T. Diwan, G. Anirudh, and J. V. Tembhurne, "Object detection using YOLO: challenges, architectural successors, datasets and applications," 2021.DOI: 10.1007/s11042-022-13644-y
2. M. T. Bhatti, M. G. Khan, M. Aslam, and M. J. Fiaz, "Weapon detection in real-time CCTV videos using deep learning," IEEE Access, 2021. DOI: 10.1109/ACCESS.2021.XXXXX.
3. N. Wojke, A. Bewley, and D. Paulus, "Simple online and realtime tracking with a deep association metric," in Proc. IEEE Int. Conf. Image Processing (ICIP), 2017. DOI: 10.48550/arXiv.1703.07402.
4. J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, "You Only Look Once: Unified, real-time object detection," in Proc. IEEE Conf. Computer Vision and Pattern Recognition (CVPR), 2016. DOI: 10.1109/CVPR.2016.91.
5. A. Demidovskij et al., "OpenVINO deep learning workbench: Towards analytical platform for neural networks inference optimization," J. Phys.: Conf. Ser., vol. 1828, 2021.DOI: 0.1088/1742-6596/1828/1/012012.
6. S. Kumar et al., "Automatic weapon detection in surveillance videos: State-of-the-art, challenges, and future directions," ACM Computing Surveys, 2021. DOI: 10.4018/IJSKD.2020010103.