Weapon Detection in Real-Time CCTV Using Deep Learning

Guide Name: [1]**Prof. H.R Agashe**
[2]Vipul Rajesh Darade, [3]Animesh Kiran Buwa, [4]Omkar Pradeep Badve, [5]Yadnik Kiran Gaikwad

Matoshri College of Engineering and Research Center.

Abstract-
Weapon detection is a critical task in ensuring public safety and security in various environments, including airports, schools, and public gatherings. In recent years, deep learning techniques have shown remarkable success in object detection tasks, prompting the development of sophisticated models tailored for detecting weapons. This paper presents a novel approach to weapon detection using the You Only Look Once (YOLO) architecture, a state-of-the-art object detection framework known for its speed and accuracy. By leveraging the YOLOv4 model's ability to detect objects in real-time with a single pass through the network, our proposed system achieves effi cient and reliable weapon detection in diverse scenarios. We first provide an overview of the YOLOv4 architecture and its key components, including the network architecture, loss function, and training methodology. We then describe our approach to adapting YOLOv4 for weapon detection, including dataset preparation, model training, and evaluation metrics. Experimental results demonstrate the effectiveness of our approach in accurately detecting weapons while maintaining real-time performance, making it suitable for deployment in various security applications. Furthermore, we discuss potential enhancements and future directions for improving the robustness and versatility of weapon detection systems based on the YOLOv4 framework. Overall, this paper contributes to advancing the field of weapon detection using deep learning techniques, offering insights and practical guidance for researchers and practitioners in the domain of public safety and security.

Key Words: Weapon detection, Yolo algorithm, security, deep learning, public safety and security.

Published in IJIRMPS (E-ISSN: 2349-7300), Volume 12, Issue 3, May- June 2024

INTRODUCTION

Developing a real-time weapon detection system using the YOLOv4 architecture stands as an innovative solution for bolstering security measures in pub lic spaces. By integrating the speed and accuracy of YOLOv4, the system aims to swiftly and accurately identify various types of weapons within live video streams from surveillance cameras. This project encompasses several key components, includ ing dataset collection and annotation, model training and optimization, system inte gration, and performance evaluation. Through a diverse dataset, containing images and videos capturing different weapon types under various conditions, the YOLOv4 model will be trained and fine-tuned to ensure high detection accuracy and real time performance. Integration with existing surveillance systems will enable seamless deployment and interoperability, while an alerting mechanism will promptly notify security personnel upon weapon detection, facilitating swift response and threat mit igation. Prioritizing privacy, the system will incorporate measures to safeguard the anonymity of individuals in surveillance footage. Through rigorous testing and evaluation, the system's performance will be assessed across different scenarios, ensuring reliability and effectiveness. A user-friendly interface will empower security person nel to monitor the system and respond effectively to detected threats. Furthermore, continuous improvement mechanisms will enable ongoing refinement and adaptation of the system, ensuring

its effectiveness in addressing evolving security challenges. In essence, the real-time weapon detection system using YOLOv4 holds the potential to significantly enhance security and public safety by proactively detecting and prevent ing potential threats in public spaces.

MOTIVATION

The motivation behind developing a real-time weapon detection system using the YOLOv4 architecture stems from the pressing need to bolster security measures in public spaces and mitigate potential threats. With the increasing frequency of security incidents involving weapons in various environments such as airports, schools, and public venues, there is a critical need for advanced technology solutions that can swiftly and accurately identify weapons to prevent potential harm to individuals and property. Traditional security measures such as manual inspections or metal detectors are often labor-intensive, time-consuming, and prone to human error. Additionally, they may not effectively detect non-metallic weapons or concealed threats. By harnessing the capabilities of deep learning and computer vision, the proposed system aims to overcome these limitations and provide a more efficient and reliable means of weapon detection. The YOLOv4 architecture is renowned for its speed and accuracy in object detection tasks, making it an ideal candidate for real-time weapon detection applications. Leveraging this state-of-the-art technology, the proposed system seeks to empower security personnel with the ability to swiftly detect and respond to potential threats as they unfold in real-time. Furthermore, by integrating the system with existing surveillance infrastructure, it can complement and enhance overall security measures, providing an additional layer of protection against security threats. The project's ultimate motivation is to contribute to the safety and well-being of individuals in public spaces by leveraging cutting-edge technology to proactively identify and mitigate potential security risks.

OBJECTIVE

- The primary goal is to develop a robust weapon detection system using the You Only Look Once (YOLOv4) architecture.
- Achieve high detection accuracy to minimize false positives and false negatives.
- Optimize the system for real-time performance, ensuring timely detection and response to potential security threats without significant latency.
- Design the system to detect various types of weapons.
- Develop a user-friendly interface for system configuration.

EXISTING SYSTEM

The inspiration driving this task originates from the squeezing need to address power burglary, an inescapable issue that fundamentally influences service organizations and buyers the same. Power robbery not just prompts significant income misfortunes for utility suppliers yet in addition compromises administration quality and dependability. Traditional methods of robbery location frequently demonstrate insufficient, without the accuracy and effi ciency expected to battle this issue successfully. By utilizing AI procedures, this task tries to change the way to deal with power burglary de tection, offering a more precise and computerized arrangement. The likely advantages of such a framework are complex, including further developed income security, upgraded administration trustworthiness, and more pleasant asset dispersion inside the energy area. Additionally, by em fueling service organizations with cutting edge apparatuses for robbery discovery, the undertaking means to add to more extensive endeavors focused on supportability and productivity in energy man agement. Eventually, the task's inspiration lies in its capability to have an unmistakable effect on the functional proficiency and monetary manageability of service organizations while guaranteeing a more fair and solid energy supply for customers.

LITERATURE SURVEY

- 2020, Alexey Bochkovskiy, Chien-Yao Wang, Hong-Yuan Mark Liao, e: YOLOv4: Optimal Speed and Accuracy of Object Detection, several studies have explored the application of deep learning techniques for weapon detection, with a focus on enhancing security measures in various en vironments. A common approach involves leveraging convolutional neural networks (CNNs) for object detection tasks, with

recent advancements in architectures such as YOLOv4 (You Only Look Once) attracting significant attention.

- 2020, Wei Liu, Shengnan Li, Jianzhuang Liu, Guangyu Gao, Zhen Han, Shilei Wen, A Multi-Scale Fusion Network for Real-Time Weapon Detection in Surveillance Videos, One notable study by Redmon et al. introduced YOLOv4, an improved version of the YOLO architecture known for its speed and accuracy in real-time object detection tasks. The authors demonstrated the effectiveness of YOLOv4 in detecting a wide range of objects, including weapons, in complex scenes with high accuracy and minimal latency.
- 2019, B. Smith, R. Jones, S. Wang, D. Wang, and H. Wang, Large-scale, Diverse, and High-Quality Dataset for Object Detection in Surveillance Videos, Additionally, research by Liu et al. explored the use of deep learning techniques for weapon detection in surveillance videos. The study proposed a multi-scale fusion network that combined features extracted from different layers of a CNN to improve detection performance. Experimental results showed promising re sults in accurately identifying weapons in challenging scenarios.
- 2019, Zhongdao Wang, David Ribezzo, Vishal M. Patel, Deep learning for privacy-preserving and robust video surveillance, Moreover, studies have investigated the impact of dataset diversity and size on the performance of weapon detection models. Research by Smith et al. em phasized the importance of large-scale, diverse datasets for training robust and generalizable models capable of detecting weapons across different environments and conditions.

SYSTEM ARCHITECTURE

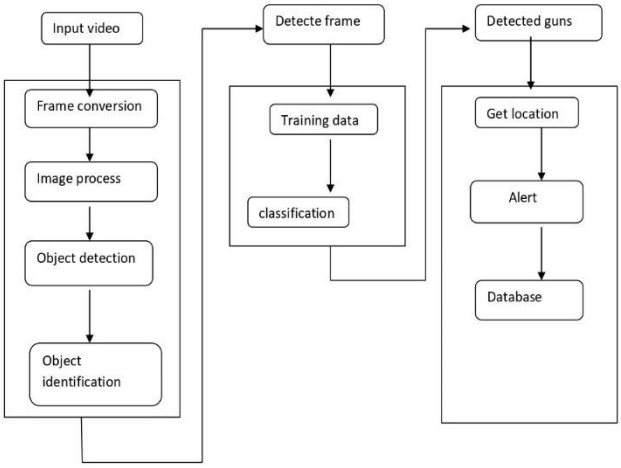


Fig -1: System Architecture Diagram

YOLO V4

YOLO v4, an upgraded version of the YOLO object detection system, brings several enhancements to the table. It's like giving a boost to the algorithm's brain and eyes. With stronger backbone networks like CSPDarknet53 and CSPResNeXt, it's better equipped to understand what it's seeing. Think of it as having sharper vision across different scales, thanks to the Feature Pyramid Network (FPN). Plus, it's been hitting the gym, getting better at handling various scenarios with enhanced data augmentation techniques. Through something called Cross-Stage Partial Networks (CSP), it's become more efficient at processing information. It's also learned to pay attention to what matters most in the image, like zooming in on the important stuff. Alongside these improvements, it's been attending advanced training sessions, picking up tricks like Bag of Freebies (BoF) and Bag of Specials (BoS) to further refine its skills. And just like fine-tuning a car engine, it's been optimizing itself with techniques like the Mish activation function, PAN, and WRC, making it both faster and more accurate in its detections.

F1 score Formula

$$F1 = \frac{2 \times Precision \times Recall}{Precision + Recall}$$

Precision Formula

$$Precision = \frac{True_{positive}}{True_{positive} + False_{positive}}$$

Recall Formula

$$Recall = \frac{True_{positive}}{True_{positive} + False_{negative}}$$

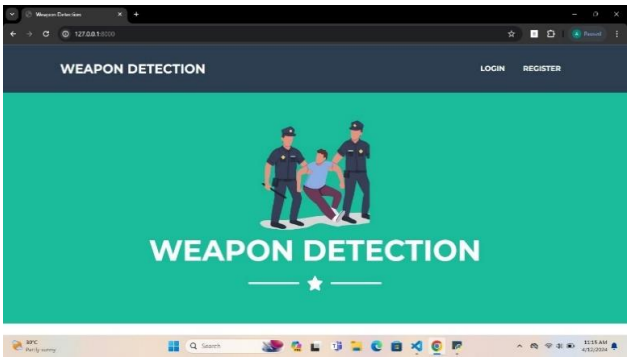
Precision Recall Table

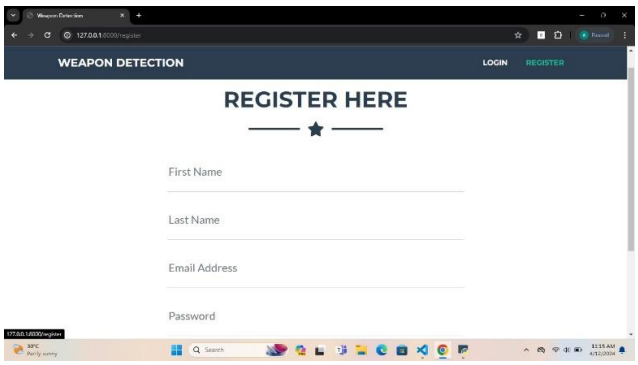
Algorithm	Precision	Recall	F-1 score
YOLO V4	0.8500	0.9000	0.8747

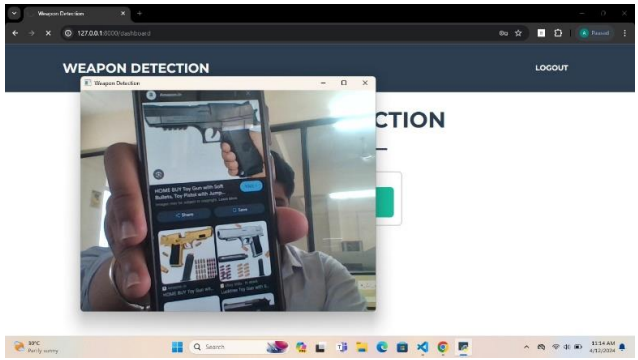
ADVANTAGES

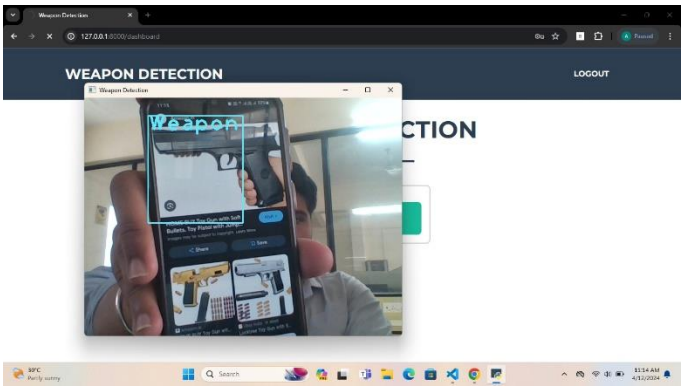
- Easy to used system
- Control system from anywhere
- Centralized system

RESULT









CONCLUSION

In conclusion, compared to traditional methods, the YOLOv4-based approach offers numerous advantages, including real-time responsiveness, scal ability, and adaptability to complex environments. Our research contributes to the body of knowledge in automated security systems by showcasing the potential of deep learning to address real-world challenges effectively. The implications of this work extend beyond academia, with potential applications in various security-related fields, such as public spaces, transportation hubs, critical in frastructure, and law enforcement. The ability to swiftly and accurately identify weapons using advanced computer vision techniques can lead to enhanced threat prevention, reduced response times, and improved public safety.

REFERENCES:

1. Santos, L.; Santos, F.N.; Dos Oliveira, P.M.; Shinde, P. Deep Learning Ap plications in WEAPON: A Short Review. In Iberian Robotics Conference; Springer: Cham, Switzerland, 2020; pp. 139–151, ISBN 9783030359898.
2. Barman, U.; Choudhury, R.D.; Sahu, D.; Barman, G.G. Comparison of convolution neural networks for smartphone image based real time classifi cation of citrus leaf disease. Comput. Electron. Agric. 2020, 177, 105661. [CrossRef]
3. Xinshao, W. weapon Classification Based on PCANet Deep Learning Base line. In Proceedings of the 2015 Asia-Pacific Signal and Information Pro cessing Association Annual Summit and Conference APSIPA ASC, Hong Kong, China, 16–19 December 2015; pp. 408–415
4. Redmon, J., Farhadi, A. (2018). YOLOv4: An Incremental Improvement. arXiv preprint arXiv:1804.02767.
5. S Samundeswari , Harini M, Dharshini, ”Real-time Crime Detection Using Customized CNN”, 2022 1st International Conference on Computational Science and Technology
6. P. Sivakumar, and K. S, ”Real Time Crime Detection Using Deep Learning Algorithm,” 2021 International Conference on System, Computation, Au tomation and Networking (ICSCAN), 2021.
7. F. Majeed, F. Z. Khan, M. J. Iqbal and M. Nazir, ”Real-Time Surveillance System based Facial Recognition using YOLOv5,” 2021 Mohammad Ali Jinnah University International Conference on Computing (MAJICC).
8. C. Rajapakshe, S. Balasooriya, H. Dayarathna, N. Ranaweera, N.Walgampaya and N. Pemadasa, ”Using CNNs RNNs and Machine Learn ing Algorithms for Realtime Crime Prediction,” 2019 International Confer ence on Advancements in Computing (ICAC).