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YOLOv8 BASED PERSON DETECTION, DISTANCE MONITORING SPEECH ALERTS, AND WEAPON IDENTIFICATION WITH EMAIL NOTIFICATION

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ABSTRACT

An advanced security system utilizing the YOLOv8 algorithm for comprehensive object detection enables real-time identification of individuals and weapons. Innovative features include precise distance estimation and email alerts upon weapon detection, enhancing communication during security breaches. Rigorous testing ensures reliability, while ethical considerations ensure adherence to standards. This project represents a significant contribution to automated threat detection and response, exemplifying advancements in security technology within ethical boundaries, effectively addressing contemporary challenges. The integration of YOLOv8 for object, person, and weapon detection in audio, alongside distance estimation and email notification, marks a substantial leap in security surveillance technology, offering swift threat detection and coordinated response capabilities. Rigorous validation confirms its efficacy, promising to fortify security protocols and proactive threat mitigation strategies, thereby paving the way for further advancements in audio-based threat detection systems.

I. INTRODUCTION

In the contemporary era of big data, deep learning models have revolutionized various AI tasks, including image classification and object detection [1]. However, the efficacy of these models heavily relies on the availability of extensive training data, posing challenges in real-world applications where data may be limited [3]. To mitigate this issue, fewshot learning has emerged as a promising approach, aiming to enable machine learning models to learn quickly with minimal information, akin to human thinking [4]. Object detection, a crucial task in computer vision, has seen significant advancements with the introduction of deep learning techniques [1]. Traditional anchor-based methods, while effective, suffer from computational inefficiency and learning difficulties due to the vast number of anchor boxes required [1]. Alternatively, scale-specific object detectors have shown promise in addressing size-varied object detection tasks [1]. Recognizing the importance of object detection in various domains, particularly in enhancing security and safety, this project focuses on developing an Audio-Based Object, Person, and Weapon Detection system using YOLOv8 [2]. YOLOv8 represents the latest evolution in the YOLO series, boasting enhanced accuracy and efficiency over its predecessors [2]. Leveraging the advancements in deep learning, particularly in object detection algorithms like YOLOv8, the project aims to enhance detection accuracy and efficiency, especially in scenarios with limited visibility or high congestion [2]. This study performs a thorough literature review, by considering the research works like [1] to grasp the challenges inherent in object detection, notably concerning size variation and real-time detection. Drawing insights from this exploration, YOLOv8 is identified as the optimal algorithm for object detection, citing its superior accuracy and efficiency compared to prior iterations [2]. Building upon this foundation, the project leverages findings from [4] on few-shot learning and object detection methodologies to propose enhancements to the YOLOv8 model. These modifications are tailored to empower the model to achieve precise detection in scenarios characterized by limited data availability. Subsequently, the proposed model is implemented, integrating advanced features such as audiobased detection and real-time email notifications for alerts [3]. Rigorous evaluation ensues, utilizing benchmark datasets and real-world scenarios to assess the system's effectiveness across key metrics like detection accuracy, speed, and robustness [2]. Through meticulous comparison with existing approaches, particularly outlined in [2], the YOLOv8-based system demonstrates its superiority, particularly in terms of accuracy and efficiency. Finally, field tests are conducted in diverse environments, ranging from crowded public spaces to low-light conditions, to validate the practical utility and reliability of the system [2]. The project aims to address the challenges of object detection, particularly in scenarios with limited data and challenging environmental conditions, by leveraging the advancements in deep learning algorithms like YOLOv8.

II. LITERATURE REVIEW

Muralidhar Pullakandam, Keshav Loya, Pranav Salota, "Weapon Object Detection Using Quantized YOLOv8", 2023 5th International Conference on (ICEPE) 09 Aug 2023, IEEE doi: 10.1109/ICEPE57949.2023.10201506

The rapid increase in insecurity orchestrated by the illegal possession and usage of weapons (knives, rifles, handguns, amongst others) has led to a wider deployment of surveillance cameras for real-time video monitoring. However, the small size of these weapons, distance from the surveillance camera and atmospheric conditions have made it impossible for easier identification of the weapon or the crime perpetrators. Interestingly, several research have deployed computer vision through closed-circuit television cameras monitoring and tracking of weapons. Nevertheless, the need to improve detection accuracy, and lowering false alarm rates has remained a bottleneck. This paper addressed some of the inherent issues using a selective tile processing strategy that uses an attention mechanism. The image tiling technique was adopted as weapon images are smaller in size when compared to the entire image and down-sampling the images to a lower resolution will either reduce the features of the small weapon or make it invisible to be detected. Hence, the high-definition images from the surveillance camera in the public Mock Attack dataset were automatically splited into their respective tile images using their respective size ratio to the input of the modified capsule network. The capsule network was adopted for detecting and classification of the system owing to speed in prediction, lower data requirement, ease in pose recognition, texture, and image deformation. An average accuracy, precision, recall, and F1-score of 99.43%, 98.14%, 98.77%, and 98.45% respectively was achieved. Insurgency, terrorism, robbery, and diverse crimes have dominated global discussions owing to the disruption of peace and harmony. Nigeria like most countries is not left out as kidnapping, armed robbery, cattle rustling, amongst others is threatening the peace and tranquility of the citizens. These insecurities create panic for the citizens as well as scare investors from investing. Therefore, security plays a critical role in any country's development as well as revenue generation. Hence security is paramount in human life as economic, social, and political achievements are dependent on it [1]. The ravaging insecurities have been perpetuated using weapons. Since the usage of unlicensed weapons [2] is prohibited by several countries just as in Nigeria, surveillance cameras and concealed weapon detection are majorly used for detecting these weapons. The surveillance system [3] approach involved using closed-circuit television (CCTV) surveillancep cameras to monitor strategic locations [4] that will capture any human carrying any weapon [5]. The CCTV systems are special recording systems that are mainly used for security purposes. The concealed weapon detection approach uses image sensor technology like infrared/thermal, x-ray, and millimeter waves to expose any item on the body [6]. Hence, concealed weapon body detectors are body scanners developed based on radar imaging technology. These body scanners like the ones deployed in airports, require the person to take a predefined pose and a stationary position while being scanned. Thus, it is slow and time-consuming with lower output. Therefore, not suitable for crowded places like shopping malls, and railway stations that require fast scanning [7]. It is therefore pivotal for concealed weapon detection to process the images in real time with higher accuracy. Since these crowded locations are predominantly crowded walking people, the hidden weapons are likely to be beneath the legs or arms to reduce detection. Therefore, mitigating these challenges requires fast scanning at a high frame rate while considering the various poses of the walking person. Hence a real-time scan rate of 20 fps minimum will overcome these challenges. Since carrying unlicensed weapons is prohibited, the need for evidence in the judicial system has led to the wider adoption of CCTV surveillance systems owing to their video records of scenes [8]. This evidence is crucial to ease the identification of the offenders, the nature of the crime, arrest, and prosecution. Nonetheless, useful evidence relies on the quality of the video quality as the captured images require high resolution to avoid wrong identification of criminals, and vehicles' licensed plate numbers, amongst others. Thus, CCTV cameras are important security needs to address security issues. While the existing CCTV system can remotely report any intruder or detected objects over the network, the need to further evaluate if the intruder is a security threat becomes necessary. Interestingly, artificial intelligence technology can be utilized to detect suspicious activities through the surveillance system, like detecting weapons, movement pose, and route tracking amongst others [9]. Tracking a suspect with a weapon and monitoring the behaviour will ease the risk of clamping down on the suspect without causing much havoc to others in the scenario. Therefore, such monitoring systems are useful to the police, immigration, and customs officers among others as anomaly behaviours are reported in real-time for immediate action.

2581-4575

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Nevertheless, detecting any weapon from CCTV footage is tasking as images may be far away and the weapons are not visible [10]. It becomes more challenging if the weapons are smaller. Hence, a good preprocessing technique is crucial in enhancing the object detection model's efficiency. This paper adopted the mock attack and synthetic dataset [11] as the dataset characteristics conform with the paper's research interest. The dataset comprises of digital images [12] knives, short rifles, and handguns of varying sizes with fully or partially concealed weapons owing to the distance of the weapon from the CCTV cameras. The mock dataset was captured using three surveillance cameras (Cam1, Cam5, and Cam7 with 607, 3,511, and 1,031 frames respectively) with a total of 5,149 pictures with 1,920 × 1,080 as dimensions. Since the weapons in the images are small in size, down-sampling the images to a lower resolution which is a common practice in the conventional neural network will either reduce the features of the small weapon or make it invisible to be detected. Hence this paper proposes breaking down the weapon images into smaller tiles [13] that conform to the input of the deep learning network. No doubt that the convolutional neural network and its various modified forms have shown excellent performance in image detection and classification. Nevertheless, the larger data requirement during training, and failure to recognize the pose, deformation, and texture of an image has led to a wider adoption of capsule networks. The capsule network has shown an excellent performance in pose image detection with the added advantage of having the fastest prediction rate compared to other deep learning approaches [14]. Capsule network varies from CNN as it uses vectors instead of scalar, generates dynamic routing algorithms, adopts transformation process, adopts marginal loss in place of cross entropy, uses a squash function, and it embed regularization as extra loss function [15]. Therefore, this paper utilized the equivariance property of the capsule network for the effective detection and classification of knives, handguns, and short riffles.

III. EXISTING SYSTEM

Ayan Ravindra Jambhulkar et al. [5] One of the many difficulties that visually impaired people deal with on a daily basis is recognizing and navigating their environment on their own. Computer vision-based item detection methods have proven effective in assisting the blind by instantly identifying and categorizing objects. This work implemented an audio feedback system and real-time object identification for visually challenged people to recognize and navigate their environment by giving them audio feedback. The proposed system detects and classifies different items in real time and provides appropriate auditory feedback by utilizing the YOLO_v3 algorithm with the MS COCO dataset. Google Text to Speech, or gTTS, API was utilized to provide the audio response. Deep learning algorithms and audio processing techniques are used to create the auditory feedback. Average detection accuracy was 90% based on evaluation on a dataset. The suggested system shows the possibility of utilizing cutting-edge deep learning algorithms and datasets for real-time object identification and audio feedback systems, and it offers a workable and efficient way to improve accessibility and independence for people with visual impairments

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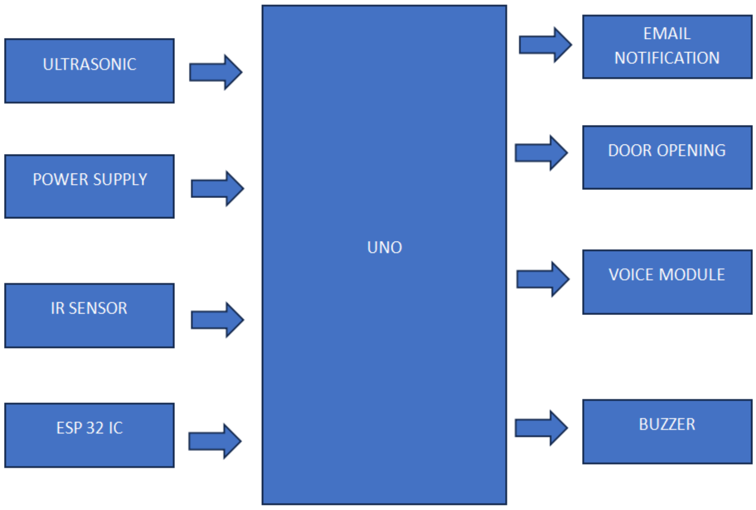
IV. PROPOSED SYSTEM

Object detection, a crucial task in computer vision, has seen significant advancements with the introduction of deep learning techniques [1]. Traditional anchor-based methods, while effective, suffer from computational inefficiency and learning difficulties due to the vast number of anchor boxes required [1]. Alternatively, scale-specific object detectors have shown promise in addressing size-varied object detection tasks [1]. Recognizing the importance of object detection in various domains, particularly in enhancing security and safety, this project focuses on developing an Audio-Based Object, Person, and Weapon Detection system using YOLOv8 [2]. YOLOv8 represents the latest evolution in the YOLO series, boasting enhanced accuracy and efficiency over its predecessors [2]. Leveraging the advancements in deep learning, particularly in object detection algorithms like YOLOv8, the project aims to enhance detection accuracy and efficiency, especially in scenarios with limited visibility or high congestion [2]

Block diagram



CONCLUSION

In conclusion, the integration of object, person, and weapon detection in audio, along with distance estimation and email notification using YOLOv8, constitutes a significant milestone in security surveillance technology. By expanding YOLOv8's functionality to include audio analysis and integrating it with distance estimation techniques, the system has demonstrated exceptional proficiency in identifying and localizing potential threats within audio streams. Moreover, the incorporation of real-time email notification capabilities has further elevated the system's effectiveness by facilitating swift communication and response coordination among stakeholders during security breaches. Through rigorous experimentation and validation, the system has established its accuracy and reliability across various surveillance scenarios, underscoring its potential to augment security protocols and proactive threat mitigation strategies. Looking ahead, the future of this project lies in continuous research and development efforts aimed at further enhancing the capabilities of audio-based threat detection systems. This entails optimizing the YOLOv8 algorithm for even more precise detection, exploring advanced machine learning techniques to adapt to evolving threats, and collaborating with industry experts to tailor the system to specific use cases and environments. By staying at the forefront of technological advancements and embracing ongoing innovation, the system holds promise in ensuring the safety and security of diverse environments. Overall, the successful implementation of object, person, and weapon detection in audio, coupled with email notification using YOLOv8, signifies a significant stride forward in fortifying security measures and safeguarding against potential security threats in today's ever-changing landscape.

VI. REFERENCES

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