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Automated Safety Surveillance System

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Abstract: *The study introduces an automated safety surveillance and alert system with three modules: trespassing detection, vehicle crash detection, and fall detection. The system sends alert messages through messaging services like Telegram to the concerned authorities when any of these anomalies are detected. These detections are made using a powerful alternative to CNN, RCNN or Fast RCNN called YOLO, in this paper we are exploring state of the art yolo versions like yolov7 and yolov8 for pose estimation and object detection respectively, experimental results show that the system accurately detects anomalies and is a promising alternative to manual surveillance. The system's efficacy makes it useful in various scenarios where manual surveillance is challenging, and automation is required to ensure safety.*

Keywords: YOLO, Real-time object detection, Fall detection, Car crash detection

I. INTRODUCTION

In today's world, surveillance and monitoring systems have become ubiquitous, finding applications in various domains, ranging from banks to military areas. Problems such as accidents, tress passing and human fall. Whatever the type of accidents occur it is life critical. Tress passing can cause the vandalizing the area. This in turn damage public or private property. Human fall can occur due to various factors, maybe due simple trip hazard, or maybe due to other health related issues such as dizziness, sun-strokes and so on.

With the advancements in technology, cameras and storage hardware have become more affordable and compact, enabling their deployment in a wide range of settings. We have applied surveillance system to address, trespass detection, fall detection and crash detection.

Automated safety surveillance systems have become increasingly important in ensuring the safety and security of various environments, including public spaces, workplaces, and transportation systems.

Earlier existing systems were built upon RCNN (Regional Convolutional Neural Network) and Faster-RCNN (Faster-Regional Convolutional Neural Network). These algorithms uses two stage processing for object detection. Hence these consume some ample time for processing. As technology advanced real time object detection using these algorithm became less feasible. To address such issue one technology that has emerged as a powerful tool in this area is You Only Look Once (YOLO), an object detection system that uses deep learning algorithms to identify and track objects in real-time video feeds.

YOLO, an object detection and classification technology, has shown to be a reliable solution for various surveillance purposes as it can identify and categorize objects with high precision and speed. The technology processes video feeds to identify suspicious activities, unsafe conditions or unauthorized entries, alerting emergency personnel in real-time and enabling them to respond quickly, preventing any potential accidents and mitigating risk.

The use of YOLO in automated safety surveillance systems represents a promising direction for improving public safety and security in a wide range of settings.

II. LITERATURE SURVEY

Literature survey done in context to proposed Model is as follows:

The automated video surveillance and alarm system [1] implemented Histogram Method for image processing. Histogram method processes the image as a whole frame and plots the gradient in terms of brightness of the pixels in

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the region ranging from 0 to 255. This consume considerable amount time and resources to obtain the desired results. Hence cannot be implemented in real time

Human pose estimation is done and proposed in [2] the paper. The problem statement is addressed using RCNN (Regional Convolutional Neural Network) .It gave us insight of tracking posture of a person. The model built using RCNN required higher power GPU to operate in real time.

The paper [3] address the issues of intrusion of animals in farm lands. The author used YOLO V3 as an underlying algorithm for detection. The paper provided a suitable insight on how YOLO algorithm is implemented for categorizing the intruding animal in farm land ranging large wild animals to domestic farm animals.

The journal [4] proposes use of YOLO v7 algorithm for object detection. It gives overall insights of YOLO v7. The model that uses the algorithm detect objects in real time. It is a state of art technology.

The overview of YOLO versions is done in [5] documenting version of YOLO from version 1 to state of art YOLO version 8.Also the paper presents the wide ranges of algorithm, from simple object detection to robotics. The limitations of each algorithm and its improvements in next version.

Paper [6] proposes Fall detection of elderly person. The author implemented spatial attention mechanism and Asymmetric Convolution Blocks to replace basic convolution network.

The authors in the [7] paper propose fall detection in elderly people. The author implemented feature extraction from data set. These features are applied to LSTM model. LSTM (Long short-term memory) is an evolved model from traditional RNN (Recurrent Neural Network).

The proposed journal [8] uses YOLO V5 for in context of detecting vehicle. It implements CARLA environment for measure the distance between the two vehicles. Ghost module is implemented that aims to generate more features by using very few parameters.

III. METHODOLOGY

The system proposed in this paper, addresses the three problem statements. They are- Fall Detection, Trespass detection and Car crash detection. We have implemented a state of art YOLO for real-time object detection and built a suitable alert generation system.

The following steps describes detail methodology implemented in the model:

- Data Collection: Using a large-scale object detection, segmentation, and captioning dataset such as COCO, which contains a diverse set of images with various object categories and complex scenes, we collect the required data for training the model.
- Model Selection: Select a deep learning model architecture for object detection task. For fast and accurate detection, a one stage detector, YOLO is used, for pose estimation in trespass detection ‘yolov7-w6-pose.pt’ and for car crash and trespass detection modules we use ‘yolov8m.pt’ and ‘yolov8.s.pt’ models respectively, which are in PyTorch format, and are selected according to the systems hardware capability and useable accuracy of its detections.
- Model Training: For our use case there is no requirement for training the models on custom dataset so we choose the above mentioned pre-trained open source models.
- Model Usage: Using CUDA, CUDNN and pytorch, the usage of GPU in system can be enabled if the system has dedicated GPU, or the model defaults to using CPU which is not fast enough to compute in real time, the hardware acceleration using GPU enables faster detection times and near real-time detections.

Difference between existing fall detection algorithms and detection using pose estimation: While the normal fall detection algorithms’ use simple logic of measuring the dimensions of the bounding box and comparing the width with height, where, when the width of the bounding box is more than the height it is considered as fall, this algorithm though effective in falls it generates many false triggers, as simple as crouching can result as a fall in this algorithm, but these can be easily eliminated by using pose estimation, which identifies the locations of key body joints, such as the elbows, wrists, knees, and ankles, and estimates the orientation and position of the body segments connecting them. The accuracy of this model is near 100% provided the entire body or all the joints are visible in the input, limitations being high computational power required for fast calculations, the number of subjects in the frame also has impact on

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performance, with increasing number of subjects there is a decrease in performance, which can be overcome by using better hardware. The results are shown in *Fig 4* which indicates fall has been detected.

Using YOLO V8 for vehicle crash detection and trespassing: The logic behind vehicle crash detection is similar as that of other simple crash detection algorithms where if the bounding boxes of two objects overlap each other will result as a crash, using YOLOv8 model we are improving the accuracy and speed of bounding boxes and of detections respectively. *Fig 2* and *Fig 3* shows the successful detection of trespassing and car crashes. Similarly we are improving the detections of person in trespassing detection.

Using Telegram Bot for receiving detections: By programming a simple telegram bot, we can send images when any of the three detections occur, by using OpenCV's built-in function in the detection loop we write the detected image to a file and by using Telegram bot's built-in function we send the file to the receiver id.*Fig 5* depicts an example for alert generation for car crash detection.

Deployment: Deploy the model in a user-friendly interface, such as a web application using flask*Fig 1*, to allow users to upload video path or use live video feeds as input to view real time detections and to receive alerts via Telegram bot.

IV. RESULTS

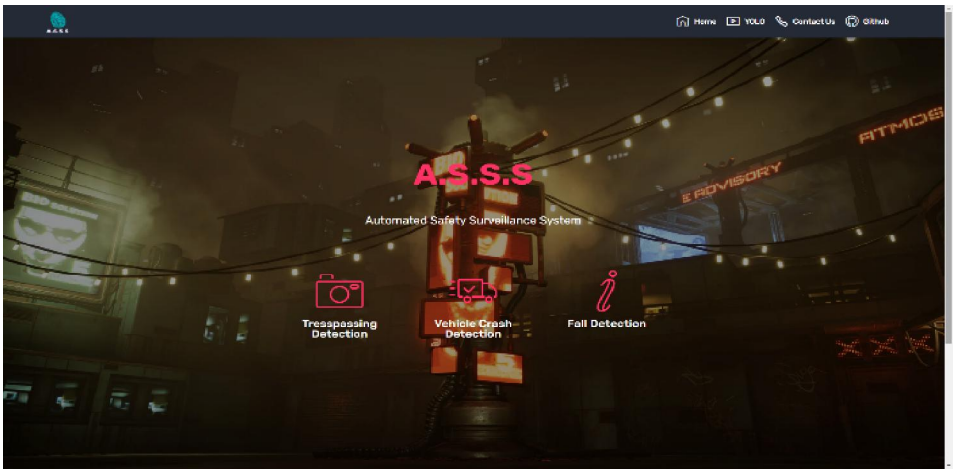

Fig 1. Home web page to access the modules

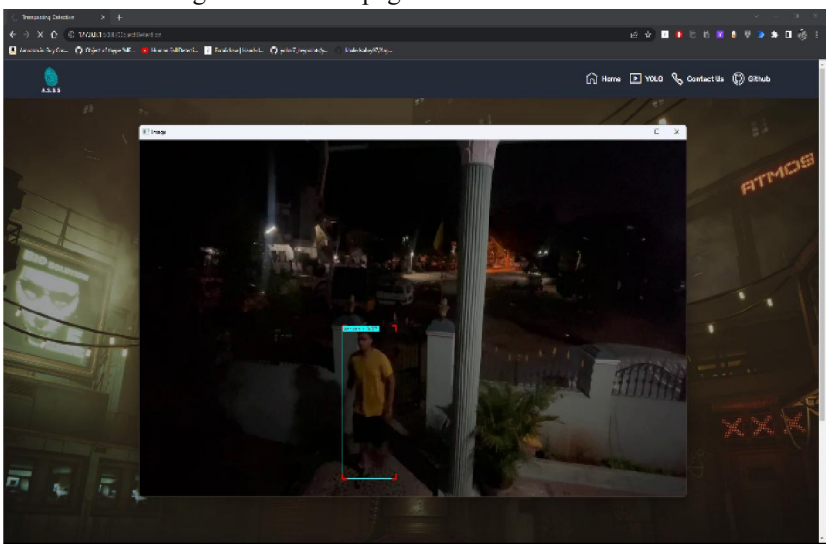

Fig 2. Tress pass detection

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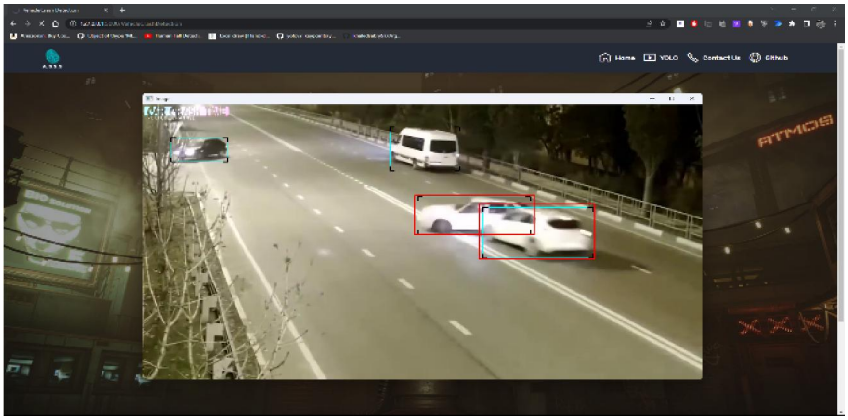

Fig 3. Crash detection

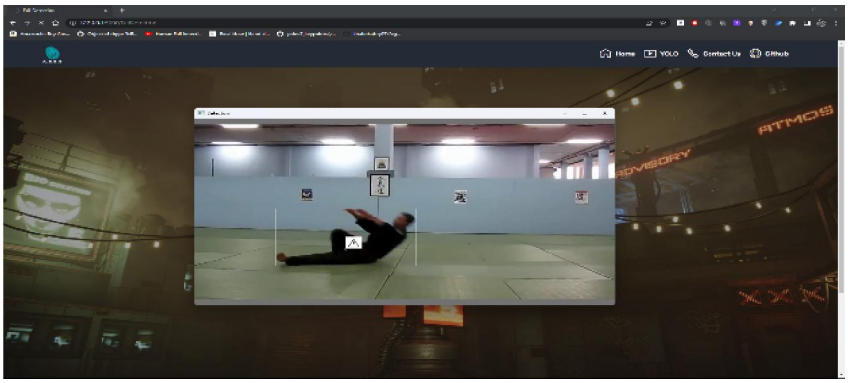

Fig 4. Fall detection.

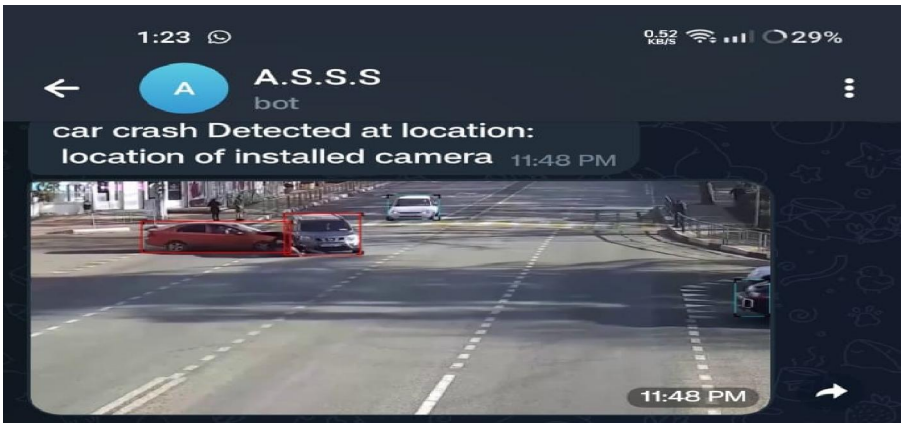

Fig 5. Alert in Telegram app

V. CONCLUSION

In conclusion, the Automated Safety Surveillance System is designed to detect and alert users of potential safety hazards in real-time using the state-of-the-art YOLO object detection algorithm. By comparing the proposed system with existing systems, we have demonstrated the superior performance of the YOLO-based system in terms of speed, accuracy, and versatility.This system architecture is designed to handle large amounts of data and provide real-time monitoring and alerts. The sub-system architecture is modular and allows for customization and integration with other systems.

We have completed setting up all the prerequisites and object detection part of YOLO is completed.

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Overall, the Automated Safety Surveillance System using YOLO represents a significant step forward in the field of safety surveillance and has the potential to save lives and prevent accidents in various settings.

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