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Wireless Speed Control of Vehicles with Detection of Person & Zebra Crossing

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Abstract: ***Pedestrians crossing zebra lines are one of the major concerns for road accidents. Nowadays, the number of road accidents increases due to careless driving and pedestrian motions at crosswalks. It is necessary to detect both person and zebra crossings properly and control vehicle speed accordingly. Here in this paper, a suitable solution that improves both detections can be introducing. Here used the TensorFlow Single Shot Detection (SSD) model is the best and most convenient trained model for Zebra line and person detection. A database is taking for the analysis. The input image could process as a crosswalk detection, which has more used for zebra crossing identification via the SSD model. Suppose detected the person and zebra crossings were at the same time. In that case, it will perform commands such as run, slow down, stop, horn, etc., with the help of wireless serial communication Universal Asynchronous Receiver-Transmitter. A Bluetooth command signal matches UART, which provides the vehicle with the necessary control inputs to execute the prescribed topology properly. Simultaneous detection of pedestrians at zebra crossings is a critical factor. It results most efficiently and to identify the person detection.***

Keywords: Crosswalk, Pedestrian, TensorFlow, Single Shot Detection (SSD), Universal Asynchronous Receiver-Transmitter.

I. INTRODUCTION

In the present scenario, road accidents have become one of the most challenging problems. It is essential to regulate vehicle speed and fair usage of horn sound to save a life on the roads. For this purpose, the highway department has marked the Zebra line, a crucial traffic sign that provides a safe way for pedestrians at intersections. Pedestrians crossing the Zebra lines are one of the significant concerns related to road accidents.

According to the WHO slogan, "Road Safety is no accident" means zero chances for all reasons or factors of accidents. It is possible based on some principles, such as priority, human errors, and public concern. Always taken Safety consideration important. Several factors cause accidents, mainly termed as "DUVERT." DUVERT stands for driver-related, user-related, vehicle-related, environmental-related, road-related, and traffic-related.

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Among these user-related issues are mainly concentrated here to do this. Can detect Pedestrians or road users at crosswalks or zebra crossings in many ways.

Among Indian states, Kerala had recorded a more severe road accident rate for the past six decades. Almost 1739 road accidents registered in Kerala, which nearly doubled to 3470 in1960. Again in 1975 it further doubled to 6938. The state has recorded an all-time high rate of 41579 accidents in the year 2005. At this stage, State Government started several initiative programs in the areas of road development, black spot improvement, traffic education, and road safety awareness. The government was deeply concerned about the increasing number of deaths and injuries to pedestrians, senior citizens, and persons with disabilities. Various researchers developed in the areas of both person and zebra crossing detections. In past years, different algorithms and methods have proposed improving the road safety system by efficiently detecting pedestrians at zebra crossings and performed and completed a detailed survey of recent research done in this area introduced in this paper a thorough analysis. So, it is necessary to switch over to the more efficient and convenient way of person detection to ensure road safety and save lives.

Speeding may be a rising problem in both countryside and city areas. The amount of speed-linked accidents leftovers high. Drivers have to constantly guess their speed and driving to determine a safe rate for the present road conditions, other vehicles, pedestrians, and any of thousand other things that will happen at any moment. Choosing the most straightforward speed has become more challenging as cars became quieter and smoother, and cruising speeds have increased. It has thrown driving safety into the limelight.

Many promoted kinds of machinery are advancing to judge the traveling time using worldwide Positioning System, radiofrequency, etc. People commonly employ these sorts of devices to track their destinations. There's a crucial need for the module in highways to provide the number of vehicles and various high-speed adapting vehicles. The most commonly adaptable methodology for zebra line detection is thresholding. Thresholding is the simplest method of segmenting the image. This method has difficulties predicting abrupt changes of pedestrian motions and challenging to implement in mostly differing geographical areas.

The proposed method introduced the desired solution to control vehicle speed whenever pedestrians crossed the Zebra line. For all these making realizable, the TensorFlow machine learning algorithm present in the proposed topology.

TensorFlow is a finish-finish open-source stage for machine education used to recognize Zebra crossing, detection of the pedestrian, and recognition of humps in the Zebra lines. A data set-based input image took for analysis. This input image is processed for Zebra crossing detection and person recognition via the TensorFlow SSD model.

The outline of this paper summarizes all problem specifications described in detail in the 2nd section. At the same time, 3rd section explains the methodology of the proposed work. Person detection is described in the 4th section, while the 5th gives Zebra line detection. 6th section deals with the results of both detections. The 7th section goes through the advantages of the proposed topology. Applications of this work point out in the 8th section. Finally, it concluded in the 9th section. The 10th section provides the references taken.

II. COMPARISON

This section discussed the comparison of each papers with their merits and demerits.

Papers	Algorithms	Merits	Demerits
Stationary Detection of the Pedestrians Intention at Intersection [1]	Interacting Multiple Model Extended Kalman Filter (IMM-EKF)	This paper focuses on stationary detect ion of the pedestrian's intention to enter the traffic lane at intersections.	Predicting spatial trajectories becomes quickly very uncertain.
Feature Relevance Estimation for Learning Pedestrian Behavior at Crosswalks [2]	Relevance Determination Algorithm	Focus on the behavior of pedestrians at crosswalks. Use a database of real pedestrian trajectories to learn a model which is able to predict if a pedestrian will cross the street.	Chances for false prediction and detection of crossing pedestrian.
Detection of pedestrian crossing using bipolarity feature-an image-based technique[3]	Novel approach	This approach for detecting pedestrian crossings to enhance the safety and mobility of blind people while crossing a road. An image-based technique has been developed to detect the bipolar patterns of pedestrian crossings.	Chances for an illumination-invariant strategy
Inferring Pedestrian Motions at Urban Crosswalks [4]	Traditional model-based motion tracking with data driven method Machine learning algorithm	The approach is built upon a hierarchical structure, where first, the intent of each pedestrian is classified. Then, the approach computes several qualitative metrics, such as time-to-cross.	This cannot guarantee crosswalks with largely differing geometry.
YOLO-Based Simultaneous Target Detection [5]	Simultaneous detection & classification method by a using deep learning model specifically YOLO.	It detects targets & classify them with high accuracy. It shows performance in detection and classification, compared with conventional methods.	Need to conduct experiments in various environments to increase the reliability of the performance.
Color thresholding method for image segmentation algorithm [6]	Color thresholding Image segmentation algorithm	The thresholding is to be done based on color values in images.	It concentrates only on the early part of image processing technique to the Ziehl-Neelsen sputum slide image and it does not involve the diagnosis stage
Zebra-crossing detection for the partially sighted [7]	Hough Transform	To detect straight lines and the vanishing point constraint is adopted to verify concurrency of the zebra crossing. Zebra-crossings are detected by looking for groups of concurrent lines, edges are then partitioned using intensity variation information.	Need for optimization, also to trial with different scenes to evaluate their robustness and performance, and trajectory planning to approach the zebra-crossing found.
A convolutional neural network based on TensorFlow for face recognition [8]	Convolutional neural network based on TensorFlow	Detection and recognition of specific sensitive characters. Experimental results show that the proposed method has better recognition accuracy and higher robustness in complex environment.	To improve the accuracy of face detection, need to use CNN cascade.
An Artificial Intelligence Edge Computing-based Assistive System for Visually Impaired Pedestrian Safety at Zebra Crossings [9]	Artificial intelligence (AI) edge computing technique	This is adopted for zebra crossing image recognition in real time. To help visually impaired consumers safely use marked crosswalks, or zebra crossings. When a visually impaired pedestrian reaches a zebra crossing, they will immediately receive a message about the current situation at the crossing and the traffic light signal.	Very difficult for visually impaired consumers need to wear the proposed smart sunglasses and waist-mounted intelligent device and hold the proposed intelligent walking cane
Block-Based Hough Transform for Recognition of Zebra Crossing in Natural Scene Images [10]	Block-based Hough transform	To calculate the position and direction of the zebra crossing in natural scenes.	Evaluated by testing results based on numerous images. A binocular camera is required to solve the problem of lack of depth information.

III. METHODOLOGY

The methodology describes the proposed topology and operating principle based on both person and zebra crossing detection. Figure 1 shows the block diagram of the proposed work done. Gave an input image to the processing unit, which combines both Person and Zebra crossing detection. It provides the output of the processing unit to the hardware unit via UART serial communication.

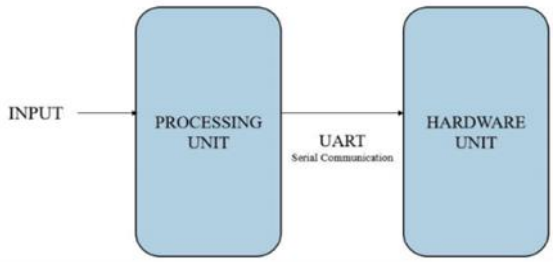

Figure 1: Block Diagram of Proposed Method

3.1 Processing Unit

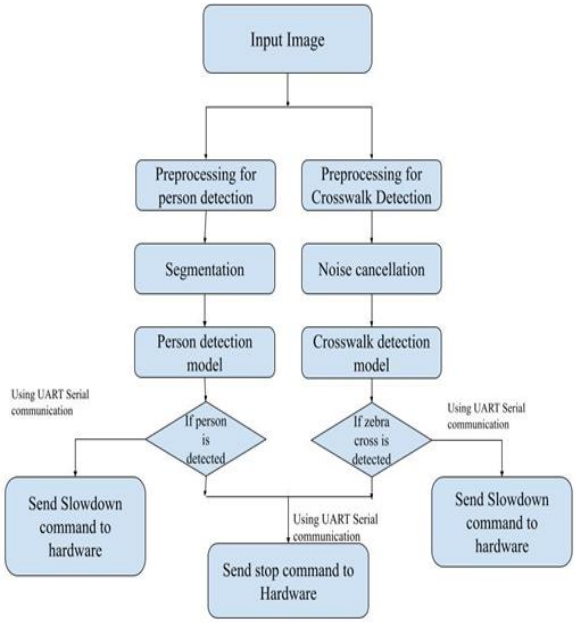

Figure 2: Processing Unit

Figure 2 shows the enlarged version of the processing unit. It consists of two parts named Person Detection and Zebra Crossing recognition. For both purposes, the same input image into consideration. They depend upon both the detections—the hardware unit controlled via UART serial communication. In the final stage of the processing unit, both detections combined, which given as the input to the hardware. In the first section, Performed Person detection.

For performing detections, primarily collected different kinds of videos required for the image processing and completed Data collection for several conditions regarding the requirement. The detailed working principle will continue in the following chapters.

3.2 Hardware Unit

Ambrane power is attached to the project for the power of the Raspberry Pi. Extra a battery connected to the buck converter for powering other components. A 12v battery for the DC motors. The vehicle's drive uses two DC motors To drive two DC motors requires an L293D Motor driver. It requires 5V, which took from buck converter output. Then buzzer is used for hearing the horn in the system. Bluetooth modules connected to TTL (HC05). One to the raspberry pi, and another one to the laptop section for transmitting and receiving data. When it is a zebra line, the speed gets reduced, and the horn sound in beep mode. If it is zebra and person exist, then speed and horn get off condition. Then the situation with regular roadshows high speed and regular horn.

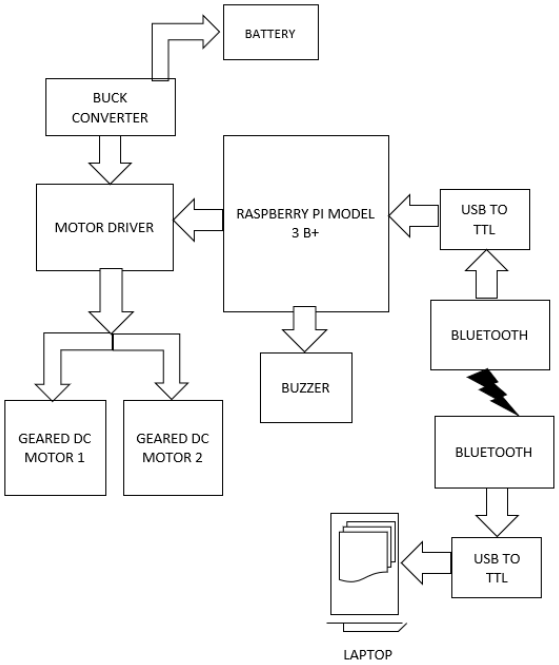

Figure 3 Block Diagram of hardware unit

Figure 3 shows the hardware unit block diagram, which connects to the selected components for the project. It consists of the battery, buck converter, L293D motor driver, geared DC motor, buzzer, raspberry pi, buzzer, USB to TTL, and Bluetooth module.

IV. PERSON DETECTION

An input image took for both Person and Zebra Crossing detections. Here BGR image is given as a database input. Python program adopted for achieving easy and efficient coding—an Open Computer Vision 4 library package selected for Python programming. The fourth version of Open CV is more stable and industrially using, which choose here—familiarized with the procedures for dataset creation and training the model.

The software's like LabelImg and colab set up for training the model. The target is to recognize Persons on roads. In this section, how Person detection performs is going to be discussed clearly. It contains specific procedures while YOLO custom 1st was chosen and then changed to SSD due to the less accuracy for YOLO.

YOLO is an accurate and good model which can achieve the efficiency of object detection. Its use for real-time object detection, which can detect a list of specific objects, including individuals.

They have then executed a sample program for dataset creation, and training using the YOLO custom model, for this selected the desired images from the videos for person detection. The next step, labeled the chosen images using Labeling Software and annotation done as shown in Figure 6.

Then developed Python code and thus required data set created. Next, I debugged the program with different video inputs and results obtained.

Figure 4 Single Person Detection

Figure 5: Multiple Person Detection

They compared the results when the video with a single person and multiple persons are loaded. Figure 4 and 5 represents the results respectively. When the footage with various persons is loaded, the product obtained is less accurate because of the custom dataset. Further used the same input database for person detection after a pre-processing technique. Then the image is segmented and converted to RGB. Then gave it to the SSD model.

4.1 Single Shot Detection

The SSD architecture adopts an algorithm for detecting various object classes in a picture by providing confidence scores associated with the presence of any category of objects. In addition, it creates changes to the shape of the things in the boxes. It is suitable for real-time applications as it does not re-evaluate bounding box assumptions. The SSD architecture is CNN-based, and for detecting the target classes of objects, it follows two stages: extract the feature maps and apply convolutional filters to see the things. Detection of objects is still an issue in pc vision and recognition of patterns. The critical image classification challenges, such as noise robustness, transformations, and obstacles, are inherited; new challenges, such as detection of various artifacts, overlapping images, and identifying their positions within a picture, are also added. SSD achieves better harmony between quickness and accuracy. It only runs a traditional network once an image is inputted and displays a function diagram.

Figure 6: Person Detection using TensorFlow

Figure 6 shows the Person Detection using the SSD model. They compared the results of both the YOLO custom model and SSD. While comparing, the SSD model detects every single person in rectangular boxes more accurately. Hence for real-time implementation and to improve the efficiency of person detection, an SSD dataset is preferable. Python code for Person detection completed.

V. ZEBRA LINE DETECTION

The next target is to recognize Zebra Crossings on roads. In this section, how the Zebra Line detection performed is going to be discussed clearly. It contains specific procedures while Block-Based Hough Transform is chosen first and then changed to SSD due to the calculation error.

5.1 Block Based Hough Transform

The block-based recognition includes preprocessing and parallel lines detection. It uses to calculate angles of parallel lines and record scores of pixels in blocks.

In the preprocessing, each patch of blocks transformed to grayscale. It is because the zebra crossing is composed of light and dark stripes in the grayscale image. Then the adaptive thresholding method is adopted to minimize the effect of shadows.

In Parallel Lines Detection, the block-based Hough transform first adopts to detect parallel lines. In the transformation, the local origin sets at the top left of the block, and non-zero edge pixels are transformed from the Cartesian space to the polar coordinate space, as below:

$$\rho = x \cos\theta + y \sin\theta \qquad (1)$$

The radial coordinate ρ represents the distance from the local origin to the straight line passing through (x, y), and the angular coordinate θ represents the angle between the normal of the line and the x-axis. The range of θ is $[-\pi/2, \pi/2)$, which can narrow with prior knowledge of the direction of the zebra crossing.

According to their polar coordinates, the edge pixels vote for an accumulator array. The advantage of the block-based Hough transform is that the spurious maxima votes cause by noise suppression. It is because the edge pixels of zebra crossings in blocks are dominant and dense.

The effectiveness of the first method, the tests, is analyzed—experiments of the first method described in detail. Finally, it presented the limitations of the first method. Evaluate the performance of each investigation; three indices defined as below:

$$\text{precision} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}} \quad (2)$$

$$\text{recall} = = \frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}} \quad (3)$$

$$F1 = 2 \times \frac{\text{precision x recall}}{\text{precision} + \text{recall}} \quad (4)$$

In the 2nd equation, precision represents the fraction of true positives among the predicted positives, and in the 3rd equation, recall represents the fraction of true positives among the actual positives. In the 4th equation, the F1 score is the harmonic average of the precision and recall, reaching one with perfect precision and recall. Then thresholding white pixels from the collected images and found out contours of the thresholded images, following select large contours from the above ones. Among these, select the rectangular shapes in it by finding out height and width. If the above contours match with zebra lines, draw the required cables, shown in blue in Figure 7. For that purpose, considered 2 points to draw slope lines and found whether it intersects or not which are in green color in figure.

In all conditions distance between the parallel lines are different, and its calculation is a complicated procedure in both figures. While considering pedestrians on a crosswalk, Zebra line detection performs well, but in-vehicle perspective, the accuracy of detection was significantly less, as shown in Figure 8. Since Block based Hough Transform results in less accurate Zebra Crossing detection, an advanced technology named as SSD model algorithm is adopted for efficient and precise detection. A data set-based input image took for analysis. This input image is preprocessed for crosswalk detection, which is used further for Zebra crossing recognition via the SSD model. Zebra Line detection on vehicle perspective using the SSD model performs for better accuracy.

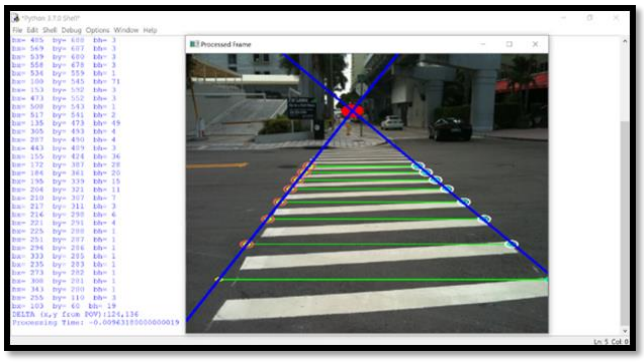

Figure 7: Zebra Line detection Using Block Based Hough Transform in pedestrian -perspective

Figure 8: Zebra Line detection Using Block Based Hough Transform in Vehicle Perspective

Figure 9: Simultaneous detection of both person and zebra line

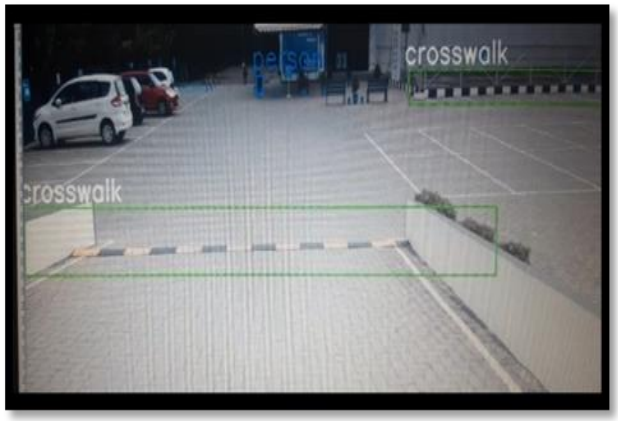

Figure 10: Crosswalk with hump and Yellow zebra line detection

Finally, combined the programs for both person and zebra line detection on image-based input. Then, it debugged and executed the desired program, giving accurate recognition, as shown in Figure 9. Yellow color Crosswalk detection is also performed and shown in Figure 10. Thus, completed the program based on video-input.

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VI. RESULT

YOLO, a unified model for object detection. The model is simple to construct and can be trained directly on entire images. The model trains validated and tested upon two Methods. Corresponding to the YOLO custom method, the method attains less accuracy (shown in Figure. 5). SSD is more versatile than the YOLO custom model. Therefore, the SSD model achieves high accuracy on the YOLO custom model, as shown in Figure. 9. Finally, simultaneous detection of both Person and Zebra crossings performs efficiently. Figure 9 shows both the detections very accurately and clearly. Adopting technology like SSD makes it more convenient and easier to recognize the individuals and Zebra line.

Figure 11 shows both the hardware section of the project and looks like a vehicle model. It consists of the hardware parts like Raspberry pi, Buck converter, USB to TTL, L293D Motor driver, Battery, Power bank, DC motor, and Buzzer.

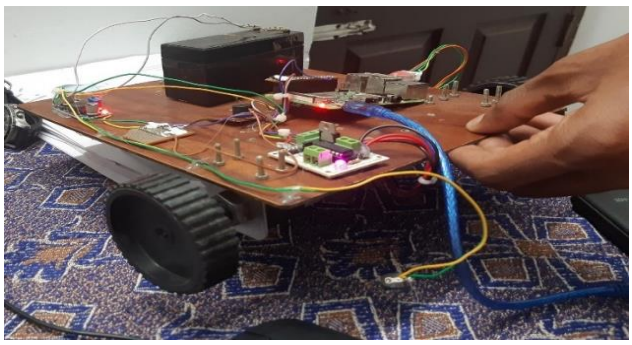

Figure 11: Hardware section of vehicle

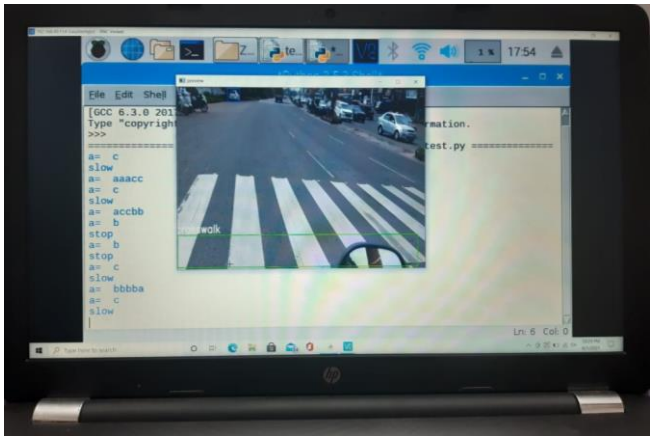

Figure 12: Hardware section program result

Figure 12 shows both the hardware section program in raspberry pi. It displays in the VNC viewer connecting through Wi-Fi and IP address. Here three variables are taken a, b and c. Each letter has its uses—then 'a', representing the normal road, fast speed, and giant horn. Next, 'by describing the zebra crossing and person in the street, stop rate and stop horn. Finally, 'I'm representing the zebra road or person in the road, slow speed, and beep horn—it which seen in the above figure.

VII. ADVANTAGES

The main benefit of this method is to help passengers cross the street safely without facing any hazard from high-speed vehicles. This scheme helps to avoid impulsive driving by drivers. The car will move only at speed designed at zebra crossings. Finding individuals and zebra cross at the same time is much faster compared to other individuals. This method is a very cost-effective and excellent lying way of speed control. The illustration can see the zebra cross and person found from my dataset assessment.

VIII. APPLICATIONS

Prominent examples apply in rural and urban areas. This system can be implemented in any vehicle. Then horn ringing and speed control are helpful in areas such as hospitals, schools and courts. Next is the safety crossing for animals in forest areas. For creature detection can use the SSD model. SSD model is fit for identifying horse, sheep, cow, elephant, bear, and zebra, a giraffe from images and real-time camera feed and recordings. Different things can be classified. These will be, in general, more troublesome as individuals move out of the frame rapidly—some other real applications, including logo detection and video object detection.

IX. CONCLUSION

Humps with zebra lines are also detected efficiently with this method and finally, combined and debugged the programs for both person and zebra crossings detection. By adopting the SSD algorithm, both detections perform accurately and efficiently. Speed and Horn control have to implement in the hardware. Hardware circuit constructed to ensure road safety according to the detections. If the persons and Zebra crossings are detected simultaneously, then the vehicle has to be stopped. If only Zebra crossing or another person is detected, the car has to slow down. In addition, the horn sound minimized at Zebra crossings along with speed regulation. Both speed control and horn sound control were made possible with the help of wireless serial communication called UART. In UART, a Bluetooth command signal adapts, which gives required control inputs to the vehicle for proper execution. Finally from this system identified YOLO and Block based Hough transform not good and the best and final application provide in the Single Shot Detection due to high speed.

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