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MODELING OF PEDESTRIAN DETECTION AND COLLISION AVOIDANCE IN AUTONOMOUS VEHICLES SYSTEM

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ABSTRACT

Autonomous Vehicles (AV) are an important element of the future of transport and their safety and especially how they will act around pedestrians continues to be more important than ever. The research deals with creating and executing a system capable of recognizing people crossing the road and that will eliminate the crash with MATLAB/Simulink is used as main simulator application. These two broad goals are a functional pedestrian detection and a real-time solution to collision avoidance in case there were pedestrians in the road. This research involves the simulation of the LiDAR and cameras sensors in an attempt to detect people within the vehicle setting. The other aspect that is included is using image processing and object identification techniques so as to detect the pedestrians thoroughly. Following automatic detection of a pedestrian, the system reacts either by brake or steering to avoid collision.

KEYWORD

Autonomous Vehicles, MATLAB/Simulink, LiDAR, cameras sensors.

INTRODUCTION

Self-driving cars are revolutionizing the current transportation industry by providing better and safer mobility. Nevertheless, the safety of pedestrians is one of the most crucial issues. Pedestrians can behave in unexpected ways like just crossing the road unexpectedly and this makes it a difficult task to react in the correct way by the autonomous systems. In the poor lit, unfavourable weather and innumerable city conditions, it is even a greater challenge to identify pedestrians correctly. Self-driving cars should have a solid system that will be able to recognize pedestrians and act on them in real time to avoid accidents. Figure 1 shows a common sensors settings available in an AV.

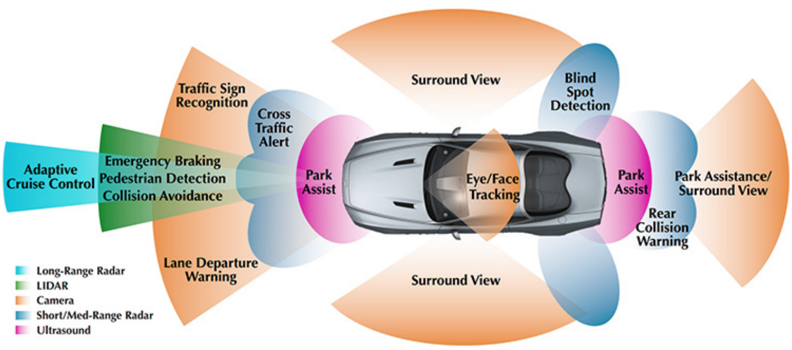

Figure 1: Sensor fusion of autonomous vehicles.

The use of Matlab/Simulink in this research is a valuable aid in developing such systems in a safe and controlled environment. It enables scientists to model the actual traffic conditions and conditions without risking lives and property. This research involves the design of an autonomous vehicle equipped with a peripheral device that senses, detects, and avoids collision with pedestrians using the Simulink. The idea is to develop a system that has excellent performance both in a complex environment to enhance safety and reliability of autonomous vehicles.

METHODOLOGY

The simplified 3 Degrees of Freedom (3DOF) model of a bicycle is applied to simulate motion and shifting directions of an autonomous vehicle using the data of a real car (Proton X50). The model aids in monitoring the location as well as rotations of the vehicle when driving. The virtual sensors in Simulink, which are a camera and LiDAR, are applied to detect pedestrians. The LiDAR scans the environment and determine distances, whereas the camera records visual information. Figure 2 shows the modelling and sensors models developed in Matlab/Simulink.

The virtual world for the simulation is made through the RoadRunner (tool used to construct realistic road constructions), intersections, and pedestrian motions. Such arrangement assists in simulating traffic in the real world to conduct safer lab testing. Figure 3 shows the developed environment in the Road Runner software.

The collision avoidance system was also design and developed in the Matlab/Simulink environment. It utilizes the information of the sensors to either apply brakes or maneuver the vehicle on a possible collision through a pedestrian. It is these actions that are governed by the predictive algorithms of quick and safe responses.

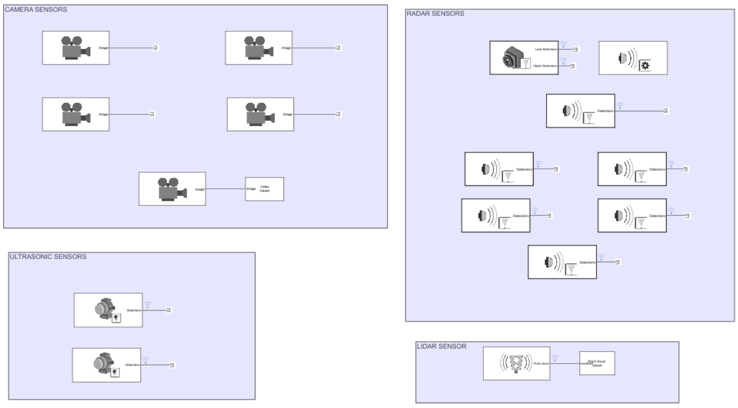

Figure 2: The Sensors for the pedestrian detections.

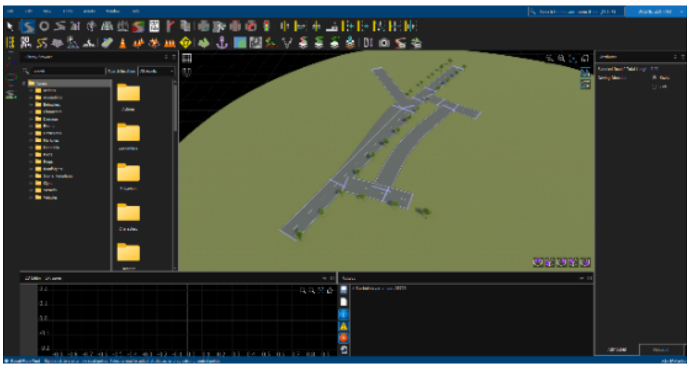

Figure 3: The roadrunner map for the environment.

RESULT AND DISCUSSION

Sensor Fusion and Detection System

Figure 5 shows the sensor fusion model for the developed AV model. The radar, LiDAR, cameras and ultrasonic sensors are used to identify pedestrians or any other object in its proximity. Radar provides protection at the front, rear, and side in the long-distance. LiDAR provides precise 3D perspectives and camera is used to capture images, in order to identify things. Ultrasonic sensor is handy in proximity such as in parking. The Birds-Eye Scope in Simulink indicates with a complete view of the surrounding, how all these various sensors can combine to provide the car with a complete image of the environment in which it is driving, therefore making it safer and more predictable.

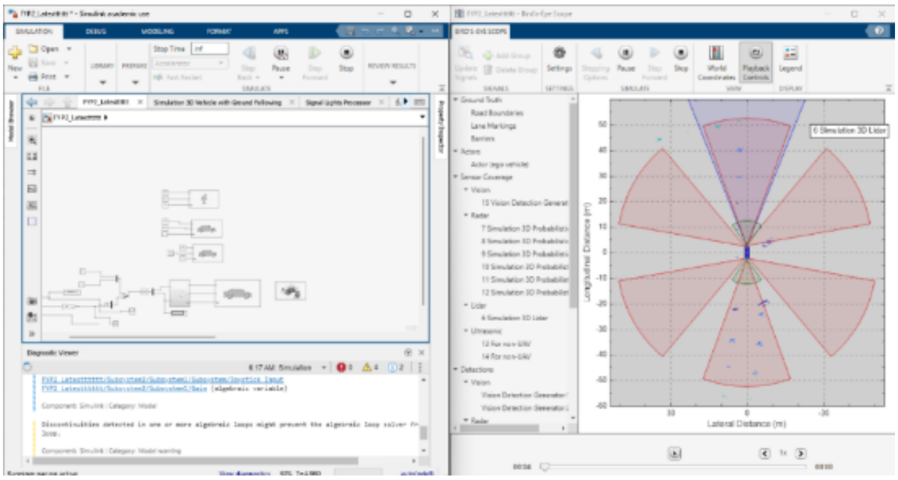

Figure 4: The sensor fusion of the autonomous vehicle.

Simulation Scenario

The simulation has run multiple views, and this includes 3D LiDAR view, bird-eye view, and camera view. LiDAR demonstrates proper shapes of vehicles and people, the bird view allows observing the entire scene and the camera provides detailed documentation of pictures to recognize objects on AI. The union of these views assists the car to know more about the environment and drive safely.

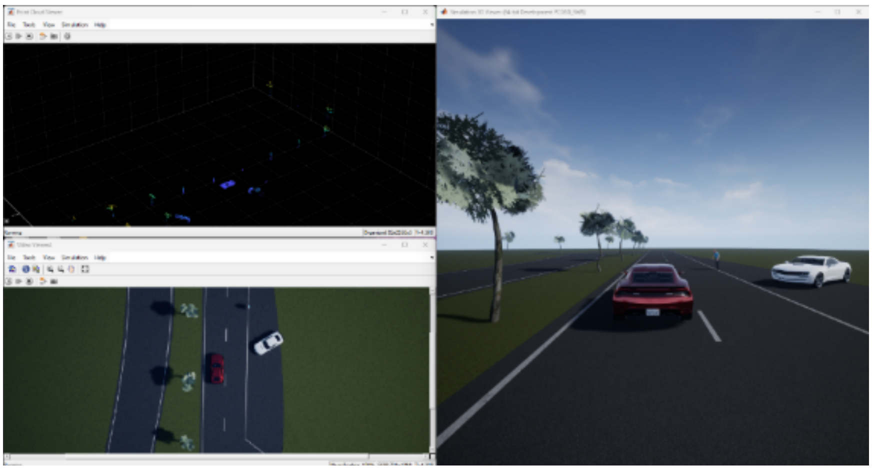

Figure 5: The LiDAR sensor, top bird eye view and the camera sensor.

Identification under Various Conditions

Figure 6 shows the detection done by the deep learning algorithm which it detects pedestrians and cars, and puts bounding boxes around them on the camera. This does well when the weather is good and there is good lighting. However, during rain, in fog, or at nights, there can be missing and errors on cameras. This is the reason why sensor fusion is necessary. LiDAR and radar environment is more useful in bad visibility and ultrasonic sensors can be used at short range. The combination of them makes the system more dependable even in poor weather conditions and poor light conditions.

Figure 6: The scene during sunny day, rainy day and night.

CONCLUSION

This project demonstrated the process of the construction and testing of pedestrian detection and collision avoidance of autonomous vehicles within Simulink. The system would be able to detect the presence of pedestrians with LiDAR and camera sensors and apply the brakes or steer as a reflex to missing new ones. Logitech G29 steering simulator introduces the human element to the real-life testing process. Even though the simulation was effective, it has its limitations. It needs real-world testing and improved sensor integration, and more testing cases. In the future, the system could be upgraded with the usage of other sensors with higher resolution such as the thermal camera, better prediction of pedestrian movements, as well as the use of the hardware in-the-loop testing or even subjecting such systems to real conditions to make these systems more reliable and safe.

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