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Autonomous Obstacle Detection and Tracking System

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Abstract-The most challenging domain in intelligent vehicle operation is collision avoidance. In case of extremities drivers show a great tendency to break vehicle than to steer although steering could be a better move. Automatic systems which could take the active control of vehicle and take optimal decision will be the most promising solution for collision avoidance in driverless system .This paper presents an automatic collision avoidance system that circumvents the obstacle in front of the vehicle by deviating from the path its moving through. This system incorporates three techniques –obstacle detection, lane detection and inverse perspective mapping technique. Lateral obstacle detection is made possible with the help of ultrasound sensors placed in the front end of the vehicle. A front end single camera is used for image acquisition and lane tracking. This system provides robust accident prevention with at most precision for action delivery at the right time of application.

Keywords—Lane Detection, Inverse Perspective Mapping (IPM), Obstacle Detection, Intelligent Transport System (ITS).

I. INTRODUCTION

A wide range of research works are done in the field of collision detection system [4]. Studies show that collision detection systems can provide warning prior to potential danger which allows them to take preventive actions at the right instant [1]. Very often vehicles are found with multi camera system on board which provides information of the surrounding environment in depth [5]. However, these systems carry high processing and configuration overheads which are undesirable in cost and consumed power. This paper focuses on vehicle intelligence task for collision avoidance on road, which is cost efficient and less affected by external interferences. Autonomous obstacle detection and tracking system is an integration of three techniques lane detection, ultrasound based obstacle detection and inverse perspective mapping to establish robust collision avoidance task [6]. The proposed system has a camera fitted in the front end of the vehicle whose image will be a top to down view. With the intrinsic and extrinsic parameters from camera calibration, the obstacle detection system could establish a transformation table for mapping the coordinates of real road surfaces into the distorted image coordinates. The objective of IPM method is to remove the perspective effects caused by cameras, and the higher performance of IPM methods made it possible to achieve better image processing results. The system is designed to provide warning on detection of obstacle. This system helps in discrete distance to moving object detection and is resistant to external disturbances such as vibrations, infrared radiation, ambient noise, electromagnetic radiations etc. Thus, this technique provides an efficient accident prevention method with precise obstacle detection, recognition and collision avoidance.

II. METHODS AND DESIGN METHODOLOGY

This system identifies obstacle in front of it and performs a collision avoidance task. Autonomous obstacle detection and tracking system circumvents the obstacle in front of it by deviating from the path it following and return to original lane of travelling. This system utilizes the power of ultrasonic sensor and image processing to achieve its task. This system is a modular device for obstacle detection. System identifies the obstacles in front the vehicle, say in the range of 10cm and then triggers the control program for path deviation .An LCD monitor on the module displays the distance of the obstacle from the vehicle. Finally when the obstacle is identified to be in the potential range, system activates voice command module system in order to provide alert for the driver. Figure 1 shows the block diagram of the autonomous obstacle detection and tracking system. The whole set up can be divided in to four section; A) Image acquisition and processing unit B) Obstacle detection C) Microcontroller unit D) Vehicle control design. The system uses PIC 16F887A for its control operation and MATLAB for image processing. Three modules are used for the setup of this system ultrasonic sensor, APR 9600 voice module and Xbee 2.9 for serial data transmission.APR 9600 is used as the voice module for the system which provides warning prior to collision to the drivers. The Xbee 2.9module is used has transmission capability range of 100 meters. The Ultrasound sensors transmit a 40 KHz pulse for obstacle detection. This sensor exhibits

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transmission in the range of 10cm-400cm.

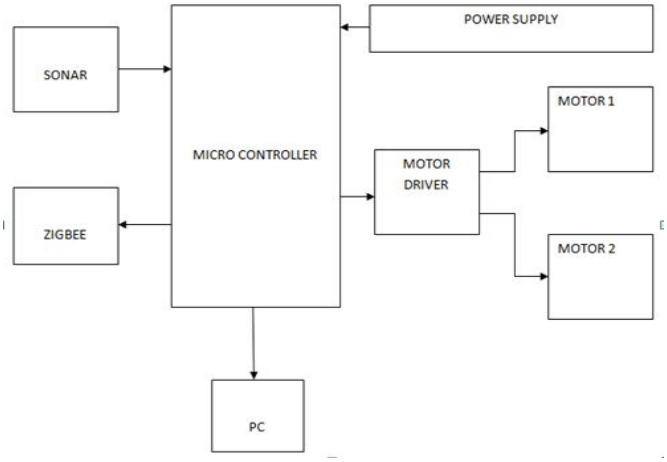

Fig.1 Block Diagram

A. Image acquisition

There are many sources for the video acquisition in the field of signal processing. The main important thing is vision based approach. In vision based approach, the camera is mounted on the vehicle which is capable of reaching real time performances in detection and tracking of structured road boundaries with slight curvature, which is robust enough in presence of shadow conditions. There are two types of view from a camera that can be obtained using a single lens of camera namely fish eye lens view and bird's eye lens view. The fish eye lens is an ultra wide angle lens that provide strong visual distortion intended to create a wide hemispherical image whereas a bird's eye lens is an elevated view of an object from top with a perspective as through the observer were a bird. In our case the camera acquires bird view type image and hence it's transformed for the purpose of image processing. Thus this approach provides a better view of road for real time application. The camera used for our particular application is Logitech webcam module. Unlike an IP camera, a webcam is generally connected by a USB cable, or similar cable, or built into computer hardware, such as laptop. Webcam is simply used as a real time video camera without requiring network connectivity.

B. Obstacle detection

The detection of the obstacle in front or by the side of a vehicle is required in a large number of sensors and systems. In recent years, many methods providing the ability to identify the rigid objects –sedans and trucks- have been developed. These methods provide important information to the driver. In this paper a method for the detection, tracking and recognition of obstacle (pedestrians) across moving observer's trajectory is suggested. A combination of data and model driven approaches are attained. This system identifies object in front of the vehicles in the range of 10 cm and performs a collision avoidance task. It utilizes the power of ultrasonic sensor for measure system. The ultrasonic transmitter and the ultrasonic receivers are mounted at a small distance between them and a PIC16F877A microcontroller system [7]. If the obstacle is detected, it triggers the control program for path deviation. An LCD screen on the module displays the distance of the obstacle from the vehicle and system activates voice command module in order to provide alert for the driver.

C. Microcontroller Unit

In the autonomous obstacle detection and tracking system microcontroller used is a PIC 16F877A microcontroller chip which is powered by 5V supply to the VDD. The clock required to drive the microcontroller is driven by a 16 MHZ crystal oscillator .The ports RB0 and RB1 is connected to the trigger and echo pins of ultrasound sensor. This sensor is used to determine the distance from the vehicle to obstacle and when it falls in the range of 10cm the system identifies this by sending signal 'o' is send via USART. Then the controller performs the track deviation by checking the values of the ports RC0-RC3 and RB3-RB2. The motors are driven with the help of L293D driver IC to deliver the power required to drive the DC motors. ZigBee module connected to the RC5-RC6 to transmit data serially. Figure 2 shows the circuit diagram for of the autonomous system.

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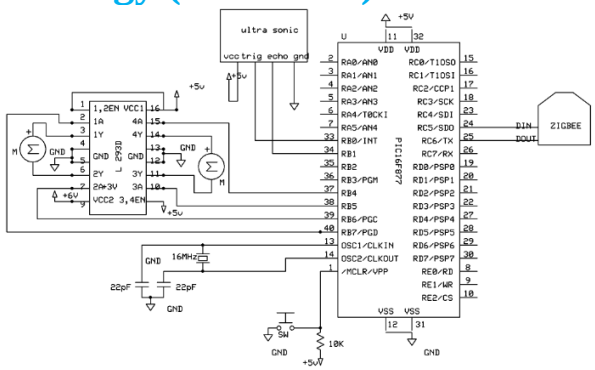

Fig.2 Circuit diagram

D .Vehicle control design

The DC motors powered with a 12v supply is connected to the output pins 3, 6, 11, 14 of L293D driver IC. The control is activated by serially transmitting ASCII characters 'f, 'r, 'l, 's' for respective control movements of the vehicle. The ports B, C of PIC controller is used for motor control by changing the control bit values of these ports. The Table 1 shows the control bit values with respect to the control movements.

Table I
Vehicle Control Pattern

R0	R1	R2	R3	DIRECTION
0	1	0	1	FORWARD
1	0	0	0	RIGHT
0	0	1	0	LEFT
0	0	0	0	STOP

III. RESULTS AND DISCUSSION

This project demonstrated autonomous obstacle detection and collision avoidance by programming the hardware in such a way to circumvent the obstacle ahead of it in the range of 10cm and moving on to the other track .The two major techniques used in this project is lane detection and inverse perspective mapping has been successfully implemented using matlab software. The hardware control had been established by transmitting serial data via zigbee transmitter and receiver from the matlab decision logic program to the microcontroller .The data transmission from matlab to the controller took about 4 seconds to set hardware into action. Ultrasound sensors in front of the vehicle were used to determine the distance of the obstacle from the vehicle. These sensors showed their distance measured on the LCD screen for display of obstacle detection. Also voice module was used to provide the user an alert for the obstruction detected. Thus this system proved obstacle detection and collision avoidance with automation. The figure 3 shows the autonomous obstacle detection and tracking system vehicle product developed and figure 4 shows the lane detection matlab output. The matlab output obtained is the real time lane detection snap shop taken while the vehicle was on move in the track which is a transformed image rotated at an angle of 45 degrees to remove the perspective effect due to the top-down view of image captured by the front end camera .

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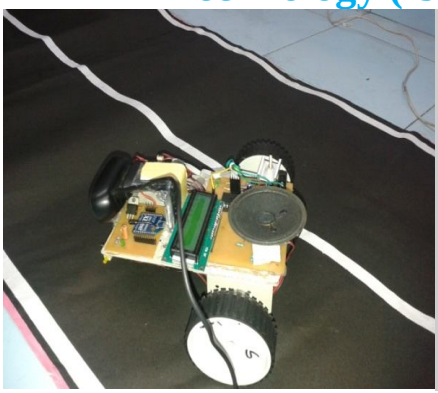

Fig.3 Developed Model

Fig.4 Lane detection out put

IV. CONCLUSIONS

The autonomous obstacle detection and tracking system is an embedded design that demonstrates a small vehicle intelligence task for collision avoidance on road. Hardware performs collision avoidance activity when the ultrasound read out distance on the LCD was in the range of 10cm. The vehicle circumvents the obstacle in front of it by deviating from the path it was moving through. The lane detection and inverse perspective mapping technique had been established with help of image acquired using a video camera further processing was done with help of MATLAB. This system demonstrated a simple portion autonomous vehicle in collision avoidance. Thus techniques of image processing and PIC microcontroller programming using MPLAB IDE has been well understood with help of this project. The Proteus simulation testing was also performed with regard to this project. Further an APR module was used to alert the driver regarding the obstruction detected. This method helps in discrete distance to moving object detection and is resistant to external disturbances such as vibrations, infrared radiation, ambient noise, electromagnetic radiations etc. Thus, this technique provides an efficient accident prevention method with precise obstacle detection, recognition and collision avoidance.

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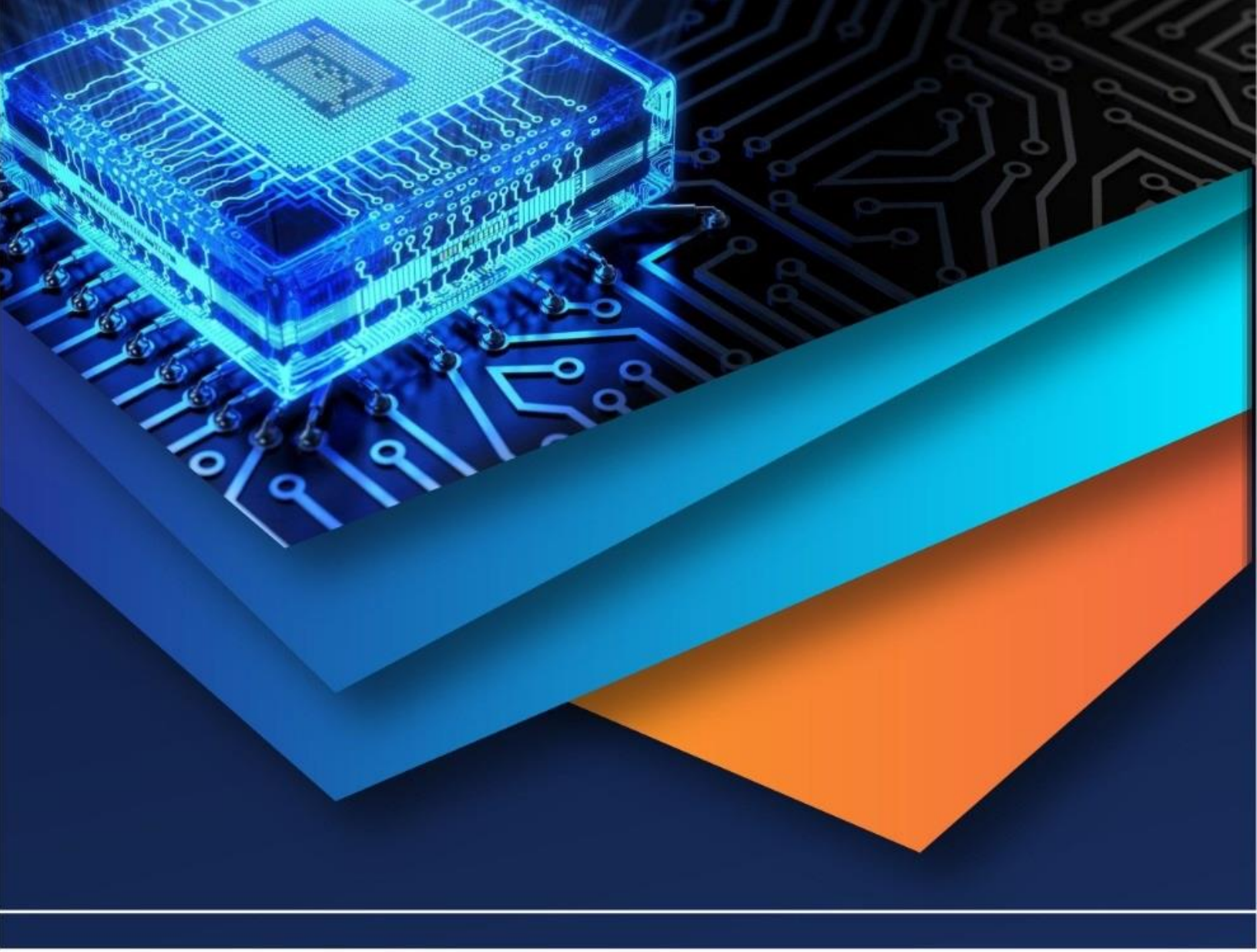

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