Pedestrian Detection System with Speed Control

Shashikala R[#], Chaitra[#], Kavya[#], Krithika Pai[#], Chaitra[#]

[#] *Electronics and Communication Department, Shri Madhwa Vadiraja Institute of Technology and Management, Udupi, Karnataka, India*

***Abstract*— Pedestrian are the most vulnerable users of the road. There are millions of vehicles on the road and the conditions such as inclement weather, poor lightning, traffic and other road hazards restrict the visibility of drivers which increases the risk to pedestrian. In addition, human error is known to be one of the leading causes of accidents. This paper focuses on detection of pedestrian using real time video stream. Video is captured using Raspberry Pi camera module. Along with this Haar cascade classifiers are used as a technique to detect pedestrian in the video captured. An additional security is provided using obstacle detection implemented using an Ultrasonic sensor and speed control using PWM technique based on the position of the obstacle detected.**

***Keywords*— Haar cascade classifier, Ultrasonic sensor, PWM, Raspberry Pi.**

I. INTRODUCTION

In recent years, many auto manufacturers along with other technology based companies have done extensive research on pedestrian detection systems, integrating output signals into the control system of cars, as away to further curb pedestrian fatalities. Most pedestrian detection systems use sensors, which are integrated into the vehicle or attached with an after-market kit, in order to 'sense' the pedestrians in the nearby vicinity of the vehicle and alert the driver with warnings. Recent research in the field of Intelligent Vehicles has focused on using advances in information technologies to prevent human error. Advanced Driver Assistance Systems(ADAS)try to warn and prepare the driver in the event of possibly hazardous situations. Among ADAS, pedestrian detection is an important issue due to the vulnerability of pedestrians in the event of accidents. Some modern built-in sensor systems are able to output warning signals directly to the car's control system and apply automatic breaking to help avoid a crash. Modern pedestrian detection systems use a variety of techniques to 'sense' the presence of pedestrians, such as infrared sensors, visibility light cameras, laser and radar technologies. In order to process the data from these sensors microcontrollers and microprocessors are often used.

Another objective of this paper is to design speed control and automatic breaking system in the vehicle. The speed and automatic breaking system will involve electronic circuit such as sensor, control system, microcontroller, signal transmitter and signal receiver, peripheral interface circuit(PIC). The concept in designing speed control and automatic breaking system is strategic control of the accident being vehicle. Ultrasonic sensor is used to detection of the obstacle and Pulse Width Modulation(PWM) for control the speed of the vehicle. The system will be designed to prevent the driver and passenger from accidents. The ultrasonic sensor is fitted in front of vehicle. This ultrasonic sensor transmits the signal continuously towards the environment. When obstacle is detected then the signals reflected and receiver receives the echo-signal from obstacle. The received signal is controlled by the microcontroller for the control system purpose. The controller controls the speed of motor as per the distance and reduces the speed of motor and warns to the driver to reduce the speed. When driver or user fails to reduce the speed of the vehicle then the controller automatically reduces the speed.

II. METHODOLOGY

The main objective of this paper is to build a model for pedestrian detection and speed control based on position of obstacle. Pedestrian detection system requires a camera for video feed, a processor for detection of pedestrian using image processing and a display to notify pedestrian detection. It is achieved by capturing the video stream with Raspberry Pi camera, which is high definition visible light camera compatible with all Raspberry Pi models. The Raspberry Pi is a series of small single board computers. All models feature a Broadcom system on a chip with an integrated ARM compatible central processing unit (CPU) and on-chip graphics processing unit (GPU). Video is processed using Raspberry Pi 3 model B, which is the third generation Raspberry Pi. Raspberry Pi 3 model B is a 64-bit quad core processor, it is ten time faster than the first generation Raspberry Pi. Raspberry Pi 3 model B has 1GB memory. Operating system for Raspberry Pi module boots from MicroSD card running a version of the Linux operating system or Windows 10. It requires power supply of5V, 2.5V.

Automatic Breaking is a technology for automobiles to sense an immediate collision with another vehicle, person or obstacle. To provide protection by applying the breakers to slow the vehicle without driver input that is the speed control. The principle used for the automatic breaking system is the PWM for DC motors which are present in latest electric cars. PWM is also called as Pulse Duration Modulation(PDM). Pulse width modulation is a technique used to encode a message into a pulsing signal. Although this modulation technique can be used to encode information for transmission, its main use is to allow the control of the power supplied to electrical devices, especially to inertial loads such as motors. The average value of voltage and current fed to the load is controlled by turning the switch between supply and load on and off at afast rate. The longer switch is on compared to the off periods, the higher the total power supplied to the load.

The term duty cycle describes the proportion of 'on' time

to the regular interval or 'period' of time; a low duty cycle corresponds to low power, because power is off for most of the time. The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off there is practically no current, and when it is on and power is being transferred to the load, there is almost no voltage drop across the switch.

For speed control mechanism first, the distance of the obstacle in front is sensed using Ultrasonic sensor. Ultrasonic sensor requires 6V-12V supply; it provides output of 5Vif obstacle in range and 0V if obstacle is not in range. First input-output trigger is adopted through supplying atleast 10us sequence of high level signal. The module automatically sends eight 40khz square wave and automatically detect whether there is returning pulse signal. If there is signal returning through high level output and the time of high level continuing is the time of that from the ultrasonic transmitting to receiving. Functions of ultrasonic sensor aredetection of signal level of continuous wave, measurement of pulse reflection time etc.

Based on the sensor output given to the microcontroller, the distance is calculated and compared with a standard reference distance. If the distance is within the defined critical limits, the microcontroller activates the break control mechanism and slows down the vehicle or brings it to a halt. The sensor keeps track of any obstacle in the front continuous and it is given as input to microcontroller. This simple concept of measuring the relative distance between the two vehicles along with our proposed speed control mechanism will help in reducing the accidents to a great extent. For this prototype DC motors are used to drive the vehicle. A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. Often, this type of motor relies on forces that magnetic fields produce. Regardless of this type, DC motors have some kind of internal mechanism, which is electronic or electromechanical. In both cases, the direction of current flow in part of the motor is changed periodically.

The speed of a DC motor is controlled using a variable supply voltage or by changing the strength of the current within its field windings. Here it required two 12V DC motors. One characteristics of this DC motor is the operating voltage. When a motor is powered by batteries, low operating voltages are typically preferred since fewer cells are required to obtain the specified voltage. Other factors to consider are operating current, speed, torque and power. The chosen DC motor has weight 125gms, torque 2.5kgcm, no-load current maximum of 60mA and load current maximum of 300mA.

A. Flow Chart

Fig 1 shows the flow diagram of the proposed paper. Initially vehicle will be in motion. Raspberry Pi camera module takes the video continuously and checks for pedestrian. The captured video is processed with the help of Raspberry Pi 3 model B using Haar cascade classifier algorithm for upper body detection and display the image only if the pedestrian detected. So, driver is notified only when pedestrian is detected.

Simultaneously, Ultrasonic transducer is used for obstacle detection. The output of the module will be the input to the PIC microcontroller, which checks the distance between the

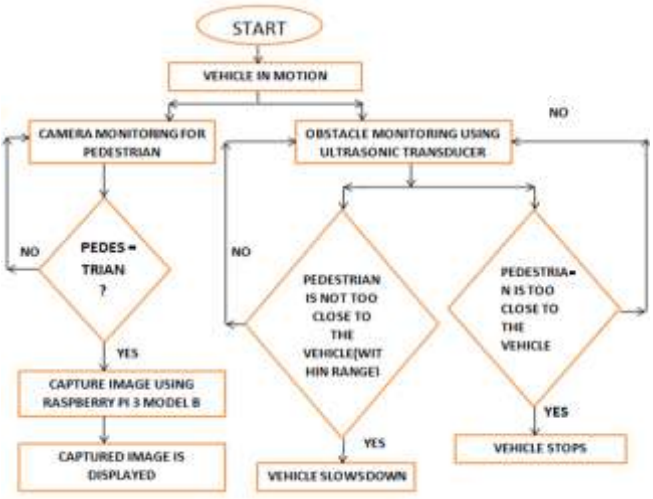

Fig 1 Flow chart for proposed system

obstacle and the vehicle. Based on the distance speed control takes place.If the distance between the vehicle and obstacle is within the range but not too close then, speed of the vehicle will be decreased. If the distance between the vehicle and obstacle is within the range and too close then, vehicle will stop. Else vehicle will continue to move at the same speed.

B. Block Diagram

The block diagram is shown in Fig 2. The proposed system has two parts. First part is pedestrian detection and second part is speed control. Input to the pedestrian detection system is fed by Raspberry Pi camera module as continuous video. Raspberry Pi camera is 8-megapixel, visible light camera. It provides high sensitivity, low crosstalk and low noise image capture in an ultra-small and lightweight design. The camera has image control functions like automatic exposure control, automatic white balance, automatic band filter, automatic 50/60Hz luminance detection and automatic black level calibration. The camera module connects to the Raspberry Pi board via 15-pin ribbon cable, to the detected 15-pin MIPI CSI connector. CSI connector is meant for serial interface. Video acquired by the Raspberry Pi camera module will be processed to detect pedestrian using 'Upper-body detection using Haar cascade classifier' implemented using Open CV. Open CV is used for creating prototype and systems, it uses c/c++ library functions, which directly provides the computer with the machine language code and hence helps in faster execution.

A Haar cascade algorithm makes use of the image subtraction morphological process to detect the face. In this

cascade of different images of the same person is taken and recorded in the database. All the pixels in the influence of white region are subtracted from the pixels in the influence of black region. This method of subtraction is performed on each of the image in the cascade but all the images might not give us the best results.Many of the images have a lot of errors. The image with the least error is selected. The results of the all the images are added together and are mentioned as weak classifier. All the weak classifiers are added to form a strong classifier.Subtraction can be applied on images one by one. If the last image is not a useful it is discarded. This process work with the predefined set of trainers present in Open CV. The driver is notified only when the pedestrian is detected successfully with the image of the pedestrian.

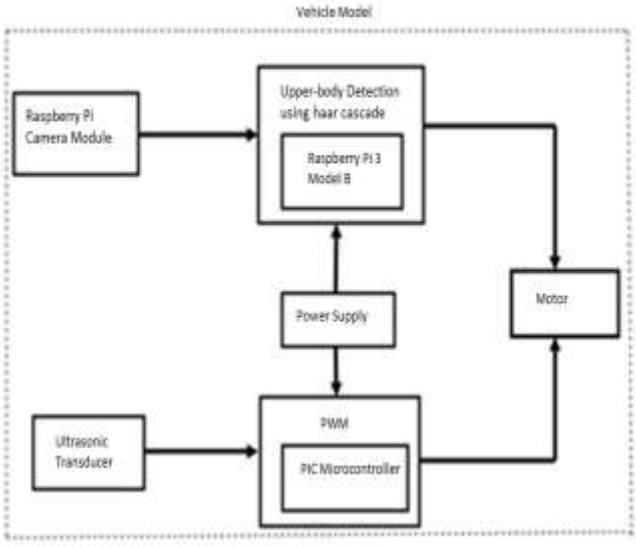

Fig 2 Block diagram of proposed system

To implement automatic breaking, Obstacle must be detected. The ultrasonic sensor determines the distance to a reflective surface by emitting high-frequency sound waves and measuring the time it takes for the echo to be picked by the detector. Ultrasonic sensor has two parts: an emitter, which produces 40kHz sound wave and a detector, which detects 40kHz sound waves and sends an electrical signal back to the microcontroller. In order to determine the distance to an object, it is necessary to implement a timing loop in the microcontroller code to measure the length of time required for the sound wave generated by the emitter to traverse the distance to the object. Ultrasonic sensor has sentry angle of maximum 15 degree and sentry distance of 2 millimeter to 8 meters. Transmitter sends an electrical signal and sets the timer. After receiving the reflected signal timer stops. That is, when there is an obstacle infront of the vehicle. Now, total time taken is calculated and converted into distance.

To implement speed control mechanism, the most effective and efficient method is to use the PWM. The Microcontroller used for determining the distance is PIC16F877A which has two inbuilt CCP modules. PIC microcontroller can take Capture input of 16-bit with maximum resolution of 12.5ns gives Compare output of 16-bit with maximum resolution of 200ns and PWM output for maximum resolution of 10-bit. PIC microcontroller has operating speed of DC 20MHz clock input and DC 200ns instruction cycle.It requires low power, has high speed CMOS FLASH/EEPROMtechnology. In Pulse Width Modulation mode, the CCPx pin produces up to a 10-bit resolution PWM output. Since the CCP1 pin is multiplexed with the PORTC data latch, the TRISC<2> bit must be cleared to make the CCP1 pin an output.

Based on the distance between the vehicle and obstacle speed control is implemented. 50% duty cycle is implemented in PWM technique when obstacle detected is within certain range. It reduces the speed of the vehicle. If obstacle is too close to the vehicle then, 0% duty cycle is implemented in PWM technique. This stops the vehicle. Vehicle continues to move at same speed in the absence of obstacle or beyond the range. Duty cycle 100% being fully on. The power supply used for the system is 12V, 5Ah rechargeable battery.

III. RESULTS

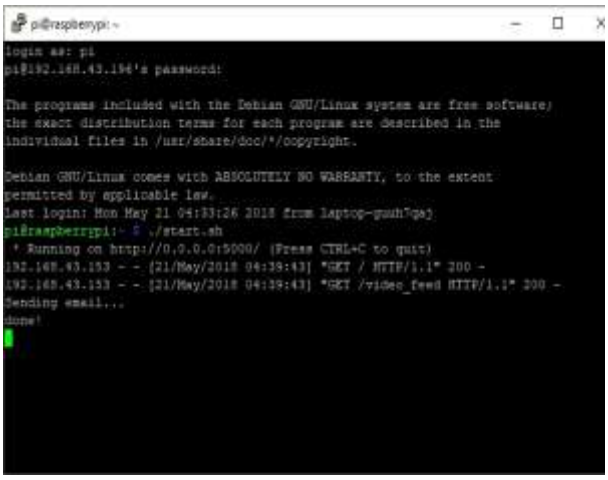

Fig 3 Initial setup

Fig 4 Image of continuous video s

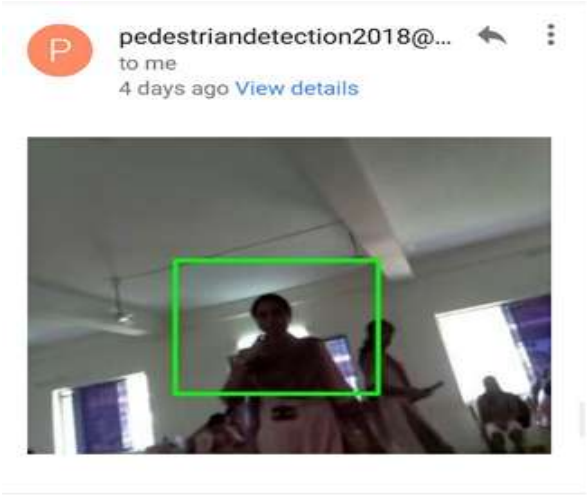

Fig 5 Image of the detected pedestrian

This paper focuses on complete driver assistance system providing pedestrian detection and speed control. In the first part of the project, Raspberry Pi Camera is successful in taking continuous video stream. Raspberry Pi module has successfully detected the pedestrian using Upper-body detection using Haar cascade classifier. Driver is notified with image of the detected pedestrian sent to his mail. In this prototype Haar cascade algorithm is used for pedestrian detection. It uses multiple features in order to detect particular object.Here to detect upper body, it extract features from different parts of the image like eye, face etc. The proposed system detects only one pedestrian at a time.

Fig 6 Proposed Prototype

In the second part of the project, Ultrasonic transducer is able to detect obstacle. The PIC microcontroller calculates the distance between the vehicle and obstacle. If the obstacle is within the range but not too close then 50% duty cycle in PWM mode is implemented by PIC microcontroller so vehicle will slow down. If the obstacle is too close to the vehicle then 0% duty cycle in PWM mode is implemented to stop the vehicle. If the obstacle is out of the range then vehicle continues to move with the same speed. From the observation ultrasonic transducer does not have much range. Instead of using two controllers for two different systems in this prototype, single processor can be used to reduce the complexity.

Fig 3 shows the Initial setup. This step is to establish the connection between camera and Raspberry Pi module. As the code runs it begins with capturing video. Once the pedestrian is detected notification is sent to the driver. Fig 4 and Fig 5 shows video stream taken by the camera and image of the detected pedestrian respectively.

IV. CONCLUSIONS

The integration of pedestrian detection and speed control is successful and implemented on the vehicle. Here the Raspberry Pi camera module is used to take the video continuously and signal is processed using Raspberry pi module.Haar cascade classifier algorithm is best suited for fast object detection.Upper-body of pedestrian is detected using Haar cascade algorithm. Obstacle is detected using ultrasonic transducer and signal is processed through PIC microcontroller. PIC microcontroller is fast and simple to implement.

This paper represents design and implementation of an Automatic Braking system indented to use in vehicles that can solve the problem where drivers may not apply brake manually, but vehicles can reduce speed automatically when obstacles are present. An efficient braking system is proposed for electric vehicles that avoids all the drawbacks of existing mechanical brakes. The paper also incorporates the use of PWM technique for speed control system. There were several factors that affect the detection of pedestrian like poor lighting during night time, poor network connections etc. Hence proper research is required to overcome these difficulties.

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