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Embedded Based Smart High-Speed Vehicle Detection System

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Abstract

This paper presents a smart highway speed checker using raspberry Pi and an ultrasonic sensor. The main purpose of using Raspberry Pi in this project is to send the message about speed violators in the form of images with the help of an RPi camera. The ultrasonic sensor is used to calculate the speed of the vehicle. The RPi is programmed by raspbian os. The image that was taken was sent to nearby traffic authorities about the speed violation of vehicles. This system is designed to detect the vehicles moving at high speed and calculate their velocity. To capture the image of vehicles an image processing software called Open CV is used. This system also uses the Simple Mail Transfer Protocol (SMTP) for sending the mail to the corresponding speed violator as a warning. Several types of capturing sizes of the videos are used in this system to check and measure the performance of the embedded board that is used. Thus this technology is more useful for checking .high-speed vehicles on highways

Keywords: SMTP(Simple Mail Transfer Protocol), OpenCV, RPi(Raspberry pi), WLAN(Wireless Local Area Network), OS(Operating System), GPIO(General Purpose Input & Output)

Introduction .1

Accidents that occur due to rash driving on highways are increasing day by day and people are losing their lives. When traveling on highways, drivers must follow the rules. One of the rules is they don't cross the maximum speed limit allowed for their vehicle. But some people neglect that rule and rising acceleration crossing the speed limit leads to the occurrence of accidents. According to the news, on average 70 percent of the accidents on highways are due to overspeeding vehicles. Generally, we know in the cities there are many ways to stop the over speeding of vehicles by placing speed breakers, or by keeping a policeman, etc..., But on highways, it is difficult to place the policeman or speed breakers for every certain kilometer. Many projects are invented to rectify this problem. Initially uses a timer circuit, IR Transmitter, and receiver for their device. With this device in case of any speed violation then it will alert traffic authorities [1]. It is modified with microcontrollers in place of timers for their operation[2]. This modified one reduces hardware components that operation is done by the program in software. But still alerting traffic authorities when the device detects any speed violation it does not give which vehicle has crossed the speed limit. So to overcome this drawback we are developing a device that alerts the policeman and also captures the vehicle number with a camera. In this project, we are using Raspberry Pi for controlling the system in place of a microcontroller[3]. An RPI camera of 8 Megapixels is used in the device to capture the vehicle number by implementing image acquisition[4]. An ultrasonic sensor is used in the device. It is an easy way to calculate the speed of the vehicle compared to other methods[5]. This captured image is sent to nearby control stations, and they will take necessary action. The main intention of our project is to design a device that is capable of detecting over-speed vehicles and informing policemen about the vehicle. This will become a better approach compared to other speed checking devices with only speed detection and an alarming .system

Existed Model .2

The present devices are implemented with timers and counters, NAND gates, 7-segment displays, and buzzers. By using these electronic components, the speed limit can be recognized and displayed on the 7-segment display panel. It also shows the speed at which this vehicle is traveling per hour. If this vehicle crosses the speed limit, a buzzer .will sound to warn the police

And how it works is to use the IR sensor to calculate the speed of the vehicle. The IR sensor is two parts one is the IR transmitter and the other is the IR receiver on both sides of the road. In addition, in this system, the police set the speed limit according to the traffic conditions in each place. The control system

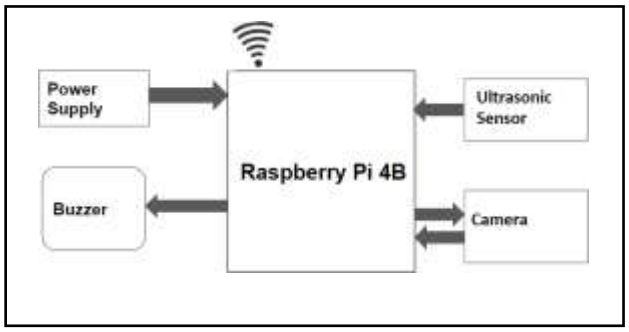
calculates the time it takes for the vehicle to move .between the transmitter and receiver

Proposed Model .3

An ultrasonic sensor is connected to Raspberry pi 4 B to detect the vehicle based on the distance of the vehicle and calculate its speed. The calculation of the speed of the vehicle is processed by the microprocessor(Quad-core Cortex-A72) which is built into the processor raspberry pi 4 model B by the instructions given in a program that is dumped into the board. It checks whether vehicle speed exceeds the speed limit of that region or not. If the vehicle crosses the speed limit the camera which is connected to the RPI board captures the vehicle number plate. Images of the vehicle are sent through email to nearby stations like tollhouses and control rooms etc. Buzzer makes a sound when a sensor detects vehicles driven at high speed till captured image mail to .control rooms. It is an alert to traffic authorities

DesignComponents.4

The main hardware components used in this project are raspberry pi 4 B with 2GB RAM, an RPI camera, an Ultrasonic sensor, a buzzer, and a basic power adapter for the power supply of the RPI. The .software requirement of this project is Rasbian



Raspberry Pi 4 B.4.1

Raspberry Pi is a single-board embedded system simply a mini-computer board. Raspberry Pi 4 B is an updated version of the raspberry pi. This RPi 4 B was built with Quad-core Cortex-A72 (ARM v8) 64-bit processor. It consists of LPDDR4-3200 SDRAM its storage capacity depends on the model(1GB, 2GB, 4GB, or 8GB). In this project, we use 2GB capacity SDRAM. It has a 2.4GHz and 5.0GHz wifi module, Bluetooth 5.0 module, and Gigabit ethernet. There are 4 USB ports 2 USB 2.0 and 2 USB 3.0. RPI contains standard 40 general purpose input-output pins. It has 2x micro HDMI ports, 2 lane display port,2 lane camera port, 4-pole audio and video port, and an SD slot for storage of data and programs. We can give power 5V DC via USB-C connector or 5V .DC via GPIO pins

Ultrasonic Sensor.4.2

Ultrasonic sensors operate on the same principle as radar and sonar. Radar and sonar evaluate the attributes of a target by interpreting the echoes of radio waves and sound waves, respectively. The ultrasonic sensor produces high-frequency sound waves and evaluates the echo received from the sensor. The sensor calculates the time between sending a signal and receiving an echo to determine the distance to the object. Systems typically use transducers that generate sound waves in the ultrasonic range of over 18,000 hertz by converting electrical energy into sound, and when they receive an echo, they convert the sound waves into electrical .energy that can be measured and displayed

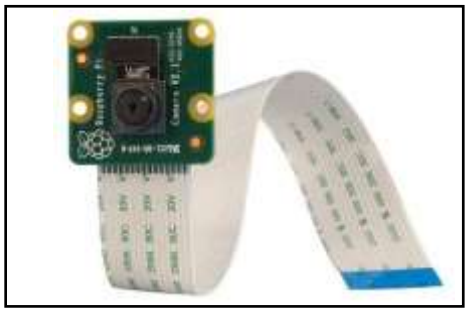
VCC – 5V, input power
TRIG – Trigger Input

ECHO – Echo Output
GND – Ground

- Power supply: DC 5V
- Operating current: 15mA
- Operating frequency: 40Hz
- Range: 2cm-400cm / 4m
- Resolution: 0.3cm
- Measurement angle: 15 degrees
- Trigger input pulse width: 10uS
- Dimensions: 45mm x 20mm x 15mm

Raspberry Pi Camera V2.4.3

The Raspberry Pi Camera V2 is a high-quality camera. It is equipped with an 8-megapixel Sony IMX219 image sensor. This is a custom design for the Raspberry Pi board. It can display still images at x 2464 pixels and supports 1080p30, 720p60 3280 and 640x480p90 video. All software is supported on the latest version of the Raspbian operating system. It is connected to the Pi board via a short ribbon cable .to a 2-lane MIPI-CSI dedicated port



Application.4.3.1

- CCTV security camera
- Motion detection
- Time-lapse photography
- Slow motion photography

Buzzer.4.4

We use a 5V active buzzer. With a Python script running on your Raspberry Pi, we make the buzzer produce a repeated beep. When you have completed this tutorial, you will be able to connect an .active buzzer to your Pi via the GPIO pins

Rasbian OS.4.5

Raspberry Pi OS is a free Debian-based operating system optimized for Raspberry Pi hardware and is the recommended operating system

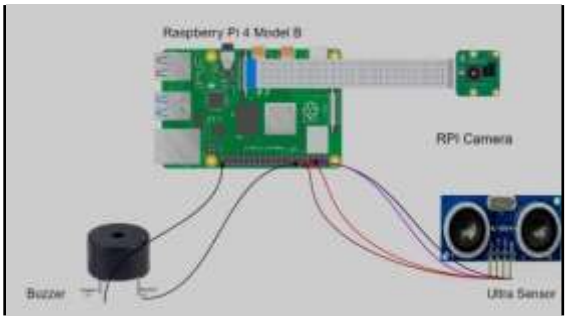
for normal use with Raspberry Pi. The operating system comes with over 35,000 packages. Easy to install on your Raspberry Pi. The Raspberry Pi OS is being actively developed with a focus on improving the stability and performance of as many Debian .packages as possible on the Raspberry Pi

Python.4.6

Python is a powerful programming language that is easy to use, easy to read and write, and allows you to connect your projects to the real world using the Raspberry Pi. The Python syntax is clean with a focus .on readability and uses standard English keywords

Working .5

Raspberry Pi camera is connected to Raspberry Pi with the help of a camera module port that is inbuilt available in Raspberry Pi board. The ultrasonic sensor has 4 pins which are Vcc, Gnd, echo, and trigger pins. Among them trigger and echo pins are connected to the General Input Output Pins of the Raspberry Pi board. The VCC pin and Gnd of the ultrasonic pin are connected to +5V and Gnd of the Raspberry Pi board respectively. Raspberry pi is operated by an operating system Rasbian which is developed from an open-source operating system called Linux. The program written for this project is implemented in python. The RPI board is powered through the Type-C port. The RPI board requires at least 5 volts and 3 amps of power. The Pi4 can draw more power than its predecessor. When idle, the Pi 4 B consumes 3.4 watts. This is only 17% more than 3 .+ B



Initially, at time 0, a short ultrasonic pulse is emitted, which is reflected by the vehicle. The sensor receives this signal and converts it into an electrical signal. When the echo stops, you can send the next pulse. This period is called the cycle period. The

recommended cycle time should be at least 50 ms. When a 10 µs wide trigger pulse is sent to the signal pin, the ultrasonic module emits eight 40 kHz ultrasonic signals to detect echo back. The measured distance is proportional to the echo pulse width and can be the calculated speed of vehicles using the mentioned formula. If no vehicles are detected, the .output pin outputs a high-level signal of 38ms

Speed=Distance/Time

Where

Distance-Vehicle distance from the sensor

Time - Cycle Period/2

The calculated speed of the vehicle is compared with the speed limit which is based zone. If the vehicle crosses the speed limit then the camera will activate and capture the vehicle number plate that the camera placed at a certain distance and height. The captured image mailed to nearby stations like toll plazas, and control rooms. The buzzer is activated during the process of mailing. This total operation is controlled by the RPi processor which instructions are given in a .program implemented in python

Output .6

The output of this model is an email attached with the vehicle image which is captured by the RPI camera that drives at high speed and exceeds the .speed limit in that zone

Future Scope .7

- We can include cloud services to store data for future purposes. We can be sent messages to the drivers who cross their .vehicle speed limit while driving
- We install an Automated Number Plate Recognition(ANPR) system to capture the vehicle number plate which crosses its speed limit at the same time to check whether the .vehicle number is licensed or not
- We use a Digital Image processing program that isolates the vehicle number from the .picture frame and digitalizes the number

Advantages .8

- .It can reduce manpower
- It can be easy to install and also operates .easily
- It is used to identify the correct victims who .have exceeded the speed limit

Conclusion .9

Here we implemented the "Embedded Based Smart over Speed Vehicle Detection on Highways" from point of view of safety on the Highway. We feel that if the highway is supported with such a faithful system then will not only help to maintain the traffic rules but also reduces accidents. In this paper speed calculation using ultrasonic sensors is mentioned .successfully

Reference .10

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