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Vision Controlled Automated Robotic Vehicle using Raspberry Pi

Aswin Kumer S V, Pamarthi Kanakaraja, Kuruvella Naga Arun Sai Krishna, Macharla Devisri, Parvataneni Tulasi

Abstract: ***The automobile industries are concentrating to develop the design for self-driving cars. Nowadays they are many possibilities to implement the automated vehicle, but the drawbacks for implementing are also very high. In this paper, the miniature model of self-driving robot is created and demonstrated using the Raspberry pi with supporting sensors and motor drivers. So, this was mainly because of the security concerns that have raised in the initial testing stages. So, this paper could best describe an application that deals with the safety measures of the autonomous vehicles that are going to be dealt with in the nearer future. This paper tells us about how an application can be implemented using Raspberry Pi, camera module and the ultrasonic Sensor. Considering the different features and the cost, on a small scale a two-wheel vehicular robotic prototype has been designed. In the Autonomous car Raspberry pi is the central processor. Different type of images are captured by the camera module, and if these images have captured the color of traffic lights, then if the captured image is of the Red light then the motors of the vehicle should stop such that breaks of the car in real world should work. If the captured image is of Green light then the motors of the car should run and the vehicle should start to move in the direction it want to move and also using the Ultrasonic sensor if any of the objects that are nearby to the vehicle, then the vehicle should change the direction from which it is moving and this is well described throughout the paper.***

Index Terms: *Raspberry pi, Ultrasonic sensor, Web Camera*

I. INTRODUCTION

Vehicles are an important part of our daily life and raising day by day. The scenario of increased vehicle density in India between 2001 and 2019 is as high that most of the accidents arises from higher traffic size and over speed driving. This is because most of the drivers are not following the speed limits in the particular areas and this leads to the increase in the number of accidents per year in the country. Globally this has been an issue in the automobile industry to provide the safety and security for the people who are using the vehicles in the day to day life [1]. Sadly, even the public transportation is in that state where many accidents are caused due to the usage of old vehicles that do not work properly at the emergency situations. So, these problems have given rise to the new era of the Autonomous cars such that these cars are the machines that are also called "unmanned cars" [2]. In the recent years there has been much research to develop the autonomous cars to bring a new edition of the automobile vehicles that can drive on roads by themselves. These autonomous cars are capable of making decisions about the desired environment through programming and that is developed to enhance the safety and security of the people and also reduce the damage caused to the vehicles[1].

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*Correspondence Author
Aswin Kumer S V*, Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P., India.
Pamarthi Kanakaraja, Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P., India.
Kuruvella Naga Arun Sai Krishna, Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P., India.
Macharla Devisri, Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P., India.
Parvataneni Tulasi, Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P., India.

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II. RELATED WORK

The autonomous cars have been the advancements to the technology in present days. So, some of the recent developed prototypes that made us to work on the technology were named such as Vision based Deep Learning methodology for Self-Driving Cars [1][2]. This paper proposes the development of an agent that can guide the automotive cars like humans do. There were many papers that expresses their views in the invent of these types of Self-Driving Cars[1]. Some of them deal with the Navigation systems that are to be included in the Self-driving cars with their different mechanisms that are to be applied in these vehicles[4]. Many technologies that are used to develop these vehicles are the mechanisms that are already in use such as Fuzzy Logic and the Sensors and the IOT technology that has grown high in the recent technologies.

III. PROPOSED METHODOLOGY

The system consists of an ultrasonic sensor, camera, Raspberry pi board and the Open-CV software. The detection of the light is done by camera and the ultrasonic sensor measures the distance from the object/Obstacle. The camera is used to detect the color of the light. The ultrasonic sensor and the camera, both are interfaced with the raspberry pi board and processed through the Open-CV software.

A. Raspberry Pi 4 B+

Raspberry Pi four Model B is that the latest product within the style Raspberry Pi vary of computers. It offers revolutionary possibilities to increase processor speed, multimedia system performance, memory, and property compared to the Raspberry Pi 3Model B+ prior-generation, while maintaining backward compatibility and similar power consumption.

For the top user, Raspberry Pi 4 Model B provides desktop performance comparable to entry-level x86 PC systems. Main options for this device include a superior 64-bit quad-core processor, dual-display support for resolutions up to 4 K through a pair of micro-HDMI ports, hardware video encoding up to 4Kbps, up to 4 GB RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and PoE compatibility (via a separate PoE HAT add-on)[1].The dual-band wireless native space network and Bluetooth have commonplace compliance certification, permitting the board to be designed into conclusion with considerably reduced compliance testing, rising each worth and time to promote.

Fig. 1: Raspberry Pi 4B+

B. C310 HD Web Camera:

For bright and crystal-clear image view, the Logitech C310 HD Webcam features 1280x 720 pixel resolution. The webcam from Logitech allows you to capture 720p HD video and upload it with a single click on social networking sites. The Logitech Vid HD makes video calling easy and fast. It is used to capture and process the light totheprocessor.The camera uses 3.3V of supply to allow the board to use the remaining power. The power supply require s 1A for inputs and outputs[4].

Fig. 2: C310 HD Web Camera

C. Ultrasonic Sensors:

Ultrasonic detectors measure distance using the properties of sound waves. The sensor is used to measure the object's range of information. The horizontal and vertical distance are indicated by the camera for a fixed field, so that the sensor detects the exact distance of the object within the range of the sensors [3] [7] [5]. Angle of sight is used to measure the distance of the barrier.The main task of avoiding obstacles is to control the vehicle in a state of noncollision and drive in an obstaclefree path. The distance of the target is also found through the pro cess of mapping. This is a very small machine with high sens itivity and low power consumption.

The detector operates by transmitting and receiving through this system by the sound waves [3]. The detector can emit frequency waves. Such frequencies are produced back in the form of an echo when the object comes forward[8]. The time between the sound waves and the received echo is determined[7]. One of the de-merits of this method is that the reflecting surface is not adequately formed, or dis-merited.

Fig. 3: The HC-SR04 Ultrasonic Sensor

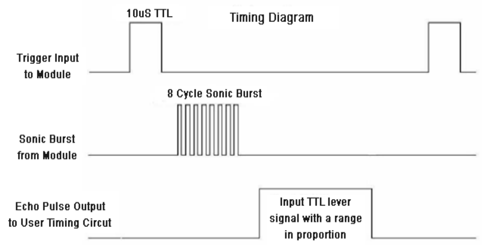


Fig. 4: Input trig and output echo of Ultrasonic Sensor

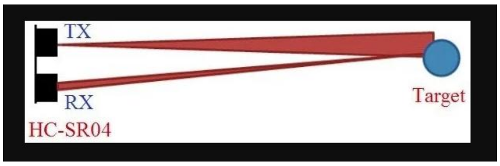


Fig. 5: Basic principle of Ultrasonic censor

IV. BLOCK DIAGRAM

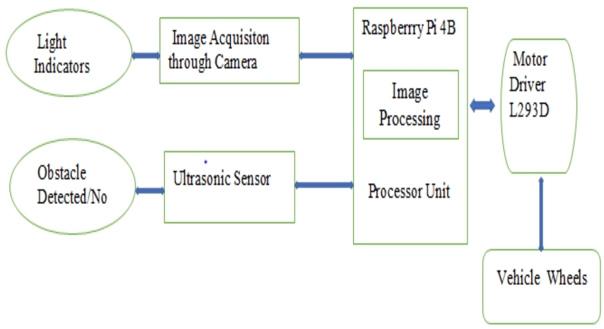


Fig. 6: Fundamental steps of the proposed methodology

V. IMPLEMENTATION

A. Obstacle Detection:

This module is used to measure obstacle distance between automated vehicle and obstacle using the basic censor module the HC-SR04 Ultrasonic Sensor module. The input TRIG Pin is kept HIGH for some duration let it be 10µS, to transmit the 40KHz ultrasonic frequency [3][4].

The echo pin of Ultrasonic censor, transmits consecutive 8 wave pulses of ultrasonic wave at frequency of 40Hz. When we transmit these pulses the state of echo pin in the sensor changes to high state [6]. It remains high until the wave comes back to the censor. when the echo pin stays high we can calculate the obstacle distance between the automated vehicle and the obstacle which is based on time taken for wave to come back to the automated vehicle.

The distance can be measured by using the below formula.

Distance= Velocity of sound/(time/2)

B. Speed Control based on color detection using USB Camera

In this a camera can be attached to the Raspberry Pi port. We can find out whether the motor should run or not depending on the images captured by the camera. Each captured image using the USB camera connected to the Raspberry Pi will be processed to determine whether its color is green or red. If the dominant color is green then the GPIO output pin state will be made as high to move the vehicle by running its motor. Just like traffic signal sign, if the color is red to stop the vehicle the GPIO output pin will be set to low. To determine the color in the captured images and to change the state of GPIO output pin python code will be helpful.

VI. RESULTS AND DISCUSSIONS

This project deals with automatic speed control of vehicle and obstacle detection which helps to control and reduces the accidents due to overspeed driving. Autonomous cars will improve road safety, fuel efficiency, increase productivity and understandability. This is the advanced obstacle detection algorithm it can avoid the obstacle and go through another way. This module will process the data which it streams by capturing screenshots using raspberry pi camera module. Using Open CV by adopting python, understanding of the image by identifying objects will be better.

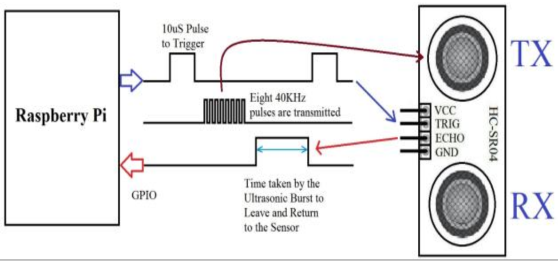


Fig. 7: Working model of Ultrasonic censor.

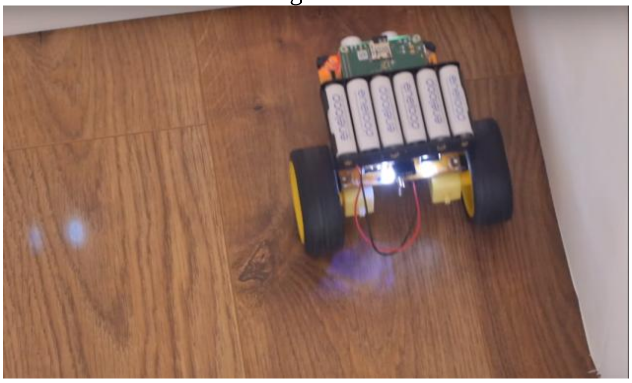
The Ultrasonic sensor gives us time taken by the waves to return back to it after hitting the obstacle [3][7]. If sensor and obstacle are not exactly aligned in perpendicular direction then the wave is reflected at some angle which results in wave reflection onto the another object before returning to the automated vehicle, which results in the wrong calculations of measuring distance between the automated vehicle and obstacles. These measurements are higher than the distance of obstacle. For the calculation of 50cm case, we get readings using censor with the loaded automated vehicle which is more than two or three times of actual distance calculation [5]. These calculated measurements are ignored when we execute the model, However It is not possible to calculate the distance accurately so we cannot predict the performance of automated vehicle using this calculations.

Table I: Distance measurements by automated vehicle.

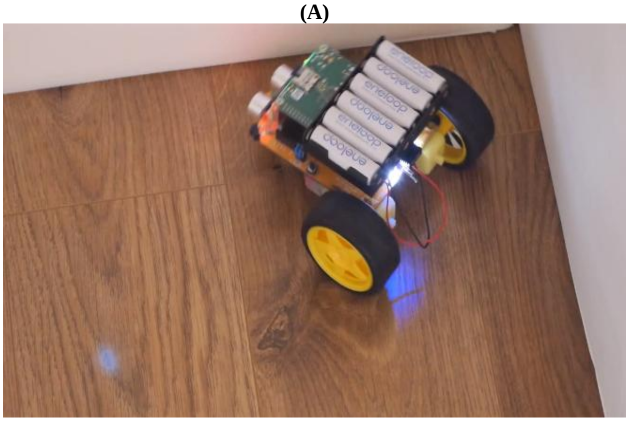
Test Name	Programming Language	standard Mean	Standard.Deviation value
Test01	Python	50.30 49.83	0.259 3.407
Test02	Python	18.16 18.25	0.055 0.2
Test03	Python	5.666 5.7	0.18 0.1866

Fig. 8: Image captured by camera

The captured image is sensed by the raspberry pi with the code dumped into it and according to it the color is recognized and the motors run according to it.



(A)



(B)

Fig. 9: (A)&(B) The working model.

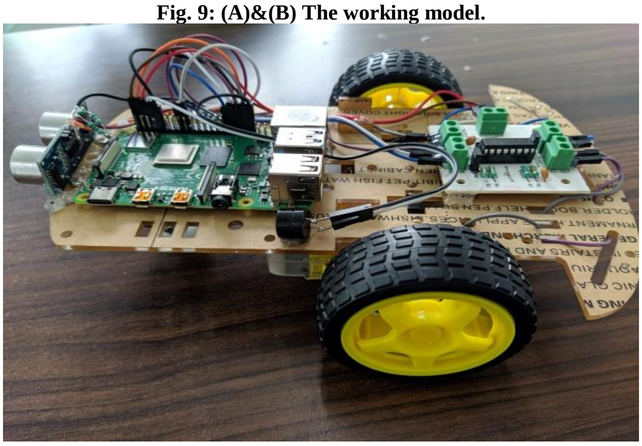


Fig. 10: Overall Implementation

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VII. CONCLUSION

The Raspberry pi used in this implementation operating under Hyper Threading (HT) Technology, which is simultaneously checking the ultrasonic sensor data and act accordingly to avoid obstacles, as well as it is sensing the colors to displace the vehicle. Finally, the autonomous vehicle based on the color identification is designed and implemented using Raspberry Pi Model-4 with real time operating system.

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AUTHORS PROFILE

Dr.Aswin Kumer S V graduated in Electronics and Communication Engineering from Pallavan College of Engineering, Kanchipuram in April 2008 and received his Master's degree in Embedded System Technology SRM University, Kanchipuram in May 2012. He received his doctoral degree for the implementation of image fusion using Artificial Neural Network from SCSVMV (Deemed to be University), Enathur in February 2019. He is working as an Associate Professor in Department of Electronics and Communication Engineering at KLEF (Deemed to be University), Guntur. He has more than 11 years of teaching experience. His areas of interest are Digital Communication and Digital Signal Processing.

Pamarthi Kanakaraja is currently working as an Assistant Professor in KLEF (Deemed to be University). He has 8 years of working experience On Embedded Designing & Programming Concepts. He is a Technical EMBEDDED DESIGNING concepts Adviser for many Engineering and Polytechnic (DIPLOMA) Students. He also published papers in various international journals. He is a Regular Contributor in EFY (Electronics for You) International Technical magazine. His area of research is Embedded in Designing, Internet of Things (IoT) & Artificial Intelligence (AI).He is now doing research in radio frequency and microwave engineering .He has done many projects based on IOT and embedded systems.

Kuruvella Naga Arun Sai Krishna, Under graduate Student, Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation(Deemed to Be University), Vaddeswaram, A.P., India. His area of Interests are VLSI technology , Machine Learning, Embedded in Designing and (IoT)Internet of Things. He has done some projects in digital systems and digital communications. One of the major project he has done is Automatic Irrigation System on Sensing Soil Moisture Content which is very useful in real time farming applications. He has done certification in Introduction to FPGA Design for Embedded Systems offered by coursera. He has done various academic projects related to the embedded systems and digital electronics.

Macharla Devisri, Department of Electronics and Communication Engineering , Koneru Lakshmaiah Education Foundation, Vaddeswaram, A.P., India. Area of Interests in VLSI, Machine Learning, Embedded in Designing (IoT)Internet of Things. I have done a few hardware projects in my core domain and has basic programming knowledge in VLSI. My passion towards doing research in Machine Learning in extreme level. I want to take my research in a way where it helps people in all ways. She has done a few projects in Digital system design, Embedded system, CMOS VLSI technology which are real time based. One of the project is Arduino based heart rate monitoring system using heart beat sensor.

Parvataneni Tulasi, Under graduate Student, Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation(Deemed to Be University), Vaddeswaram, A.P., India. Area of Interests in VLSI, Machine Learning, Embedded in Designing (IoT) Internet of Things. Also, done some academic projects in the core competencies required in the VLSI domain and has the knowledge in the basic VLSI programming. Basic interests to do a research in Robotics and make sure that the technology helps people in all the possible ways. In this regard to know more about the design of basic Line following Robotic vehicle. Also done some of the academic projects using Embedded Systems that can be used in real time analysis such as weather monitoring system etc.