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Nonlinear Coordinated Steering and Braking Control of Vision-Based Autonomous Vehicles in Emergency Obstacle Avoidance

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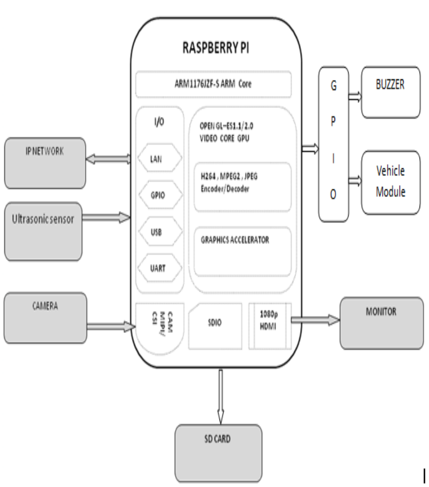
Abstract:
The project mainly focuses on the basis to implement the object detection and a special focus on the braking control in emergency obstacle avoidance based on its ultrasonic, which is a sensor based project i.e., the input to the project will be the trig signal which is continuously take from Raspberry Pi. It will detect the object and it tracks that object distance. Then based on distance camera will captured image and upload to web page and also we can control vehicle through web page using IoT. In raspberry pi have many inbuilt features and many ports which make the used to experience the power of using a processor. The board comes with USB ports to which Camera, keyboard and mouse, Wi-Fi dongle can be connected which gives the feeling of working on a system. The raspberry pi connected to internet. If have any problem vehicle that information send to the owner then owner can control vehicle.

Keywords: Raspberry Pi, ultrasonic, Python,, PHP. Robot module.

I.INTRODUCTION

Robotics is the branch of technology which deals with the construction, design, operation and application of robots. Obstacle avoidance refers to the ability of a robot to detect obstacles in its way if there are any and thus make its own obstacle free path. It makes use of camera module for detecting the obstacle in its path and also raspberry pi. We can develop the robot with a very good intelligence which is capable of easily sensing the obstacle through ultrasonic module. We proposed a model of a robot based on raspberry pi. Requirements of the project include raspberry pi, camera module, 293D motor drivers, DC motors. Raspberry PI is small kit means it is a small computer. This small computer performs a number of tasks. The Raspberry Pi is a series of credit card-sized single-board computer.

II.SYSTEM ARCHITECTURE



III. SYSTEM DESCRIPTION

The raspberry pi based obstacle avoiding robot consists of three main module i.e. ultrasonic, camera module, and raspberry pi. The camera module gets the input image which are obtained are real time operation. The raspberry pi is a platform consisting of all necessary hardware module assembled on it. It receives the images from camera module. Ultrasonic check the distance robot to obstacle occurs then it will send the distance raspberry pi. It gives further instruction to motor driver accordingly. The motor driver actually consists of two sub motors i.e. right and left motor. These motors receives the signal from raspberry pi in case of any appearance of the obstacle in its path the motors work accordingly to signal and moves in left or right direction with the help of left and right motor to avoid the obstacles .

3.1 Imaging Module

The imaging module in the proposed system is realized using a USB web Camera, the main reason behind choosing USB Camera over the Pi camera is the cost effectiveness. The camera features a high-quality CMOS sensor, with an image resolution of 25 MP (Interpolated), an adjustable lens for focus adjustment, a frame rate of 30 fps and f2.0 lens. The USB camera also is equipped with night vision for low light photography. The camera interfaces with the Raspberry Pi via the USB 2.0 port and is responsible for capturing images when requested; the pictures are captured by using the command fswebcam.

Figure.3.1 USB Camera

3.2 Raspberry Pi Core Module

The core module of the system is realized using a Raspberry Pi 3 board; it's a $ 35 bare-bones computer designed and developed by the Raspberry Pi Foundation, the Pi 3 features a BCM 2837 System-on-Chip which includes a Quad-Core 32-Bit ARM Cortex A7 CPU clocked at 900 MHz paired with 1 GB of RAM. It also has Video Core IV GPU for graphical processing applications, it also includes four USB ports for peripherals and 40 Pin General Purpose Input Output (GPIO) pins for interfacing the Pi with external electronic circuits, these GPIO pins are used to interface the Pi to the door lock module. The Raspberry Pi is designed to run various Linux based operating systems and has Raspbian as its official operating system and Python as its official programming language.

Figure. 3.2 Raspberry Pi 2 Module

In this system the core module plays a highly pivotal role and is responsible for various functions, the core module is responsible for acquiring the images from the camera, processing and storing. It's also responsible for maintaining the facial database which consists of pictures of all the authorized persons for reference. It is in charge of employing the face detection and recognition algorithms and has to decide whether is a person is authorized or not. It's responsible for controlling the door lock module by sending lock/ unlocks commands using Python code via GPIO to the motor driver.

3.3Embedded Server & IoT

Another crucial function of the core module is to act as an embedded web server, the primary responsibilities of this server include, transmitting the visitor/ visitors images via email to the owner for emails from the owner and find the security code from the emails for authorization. This system employs an embedded server approach for communicating with the user and with the internet/ intranet. Python code is used to program certain aspects of this system such as sending and receiving emails and text messages. Standard Python libraries corresponding to the web such as urlib2, cookielib for online service; imaplib, poplib, email, SMTP, etc. for sending and receiving emails are imported and used accordingly. The system is also configured using Apache to act as a server, which is useful to remotely monitor the conditions. The owner can log in to the server using a dedicated static IP assigned to the Raspberry Pi, another important function of this server is to provide a secure back door to lock/ unlock the door by bypassing the face recognition feature in case of a failure or emergency. This is a secret feature and is only accessible by the owner.

IV.HARDWARE IMPLEMENTATION

This section emphasizes on the actual hardware implementation of the proposed system, the various modules, components, peripherals and the interconnections between them are discussed here. The first stage of the implementation is to prepare the Raspberry Pi 2 module for its first boot; this is done by downloading the latest version of the Raspbian operating system from the official Raspberry Pi website. A microSD card is the formatted using SD Formatter; it's then flashed with the Raspbian OS using Win32 Disk Imager. The first boot is then completed on the Raspberry Pi connecting the required peripherals, such as power supply, keyboard, mouse, Ethernet cable, etc. The Raspberry Pi for optimal operation requires a quality power supply; the Pi can be driven by using any Micro USB based mobile phone chargers with a good current rating, and this system is powered by a 5V 2A power bank for uninterrupted operation. Since the Raspberry Pi doesn't natively support wireless internet a USB Wi-Fi dongle is used for connectivity; the Pi also has an Ethernet port which can be used to gain wired internet access. Using Python programming language preinstalled on Raspbian the source code of the system is provided and tested appropriately. The USB Camera is interfaced; the GPIO pins are programmed using commands in Linux and Python in this stage. The camera is interfaced to the Pi via the USB port and the door lock module is interfaced via the GPIO pins on the Pi.

V. EXPERIMENTAL RESULTS

5.1 Vehicle in ON state

Once the proper connections are provided then we need to insert the SD card loaded with Raspbian OS into it by following the procedure.

5.1.1 Raspberry Pi3 screen

The Result or the execution of this project in the raspberry python software contains in a sequential stepwise procedure

Step: 1 Raspberry Startup screen

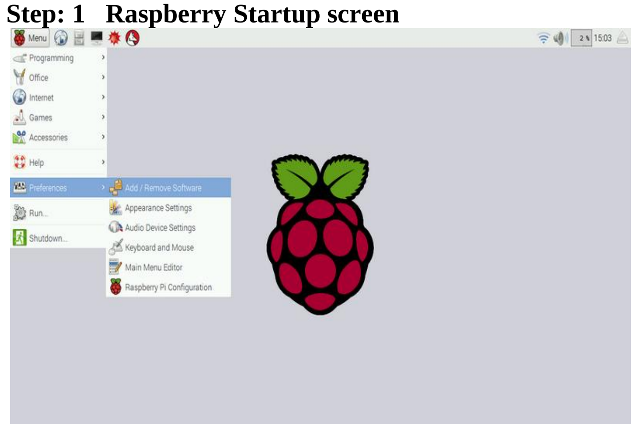


Figure.5.1: Raspberry Pi screen on first boot

On providing the power supply to the Raspberry Pi3 board the screen should look like above shown in figure 5.5. In some versions of OS to get the above screen we need to type **startx** command in the terminal shown on the screen then the above screen appears.

Step: 2 Terminal windows

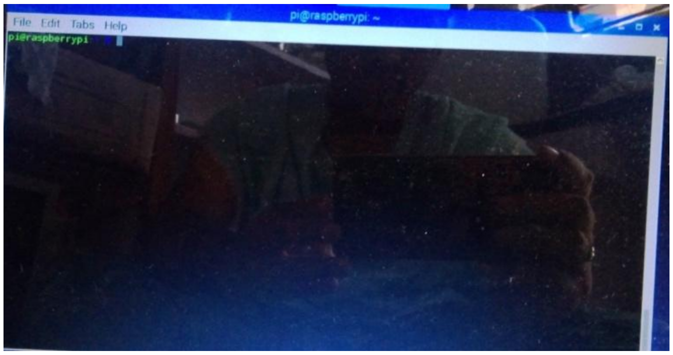


Figure.5.2: Terminal window

The fig 5.3 shows the terminal window used in Raspberry pi where the program can be written and executed by using appropriate commands into it. It is also used to configure any library files and can also be used to add/remove files from the directory.

Step:3 Display after motors program execution

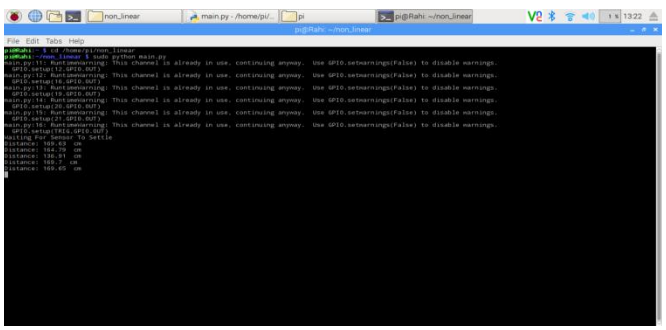


Figure.5.3: Output on the screen after motor program execution

To execute the motor program the command should be "**./filename**". In my case it is ./motor_driver, then the screen looks as shown in fig 5.7 above. This program is used to run the robot in any direction for instance to run the robot in forward direction the command should be F or f and output will be displayed as robot is moving in forward direction.

Step:4 Ultrasonic sensor output screen

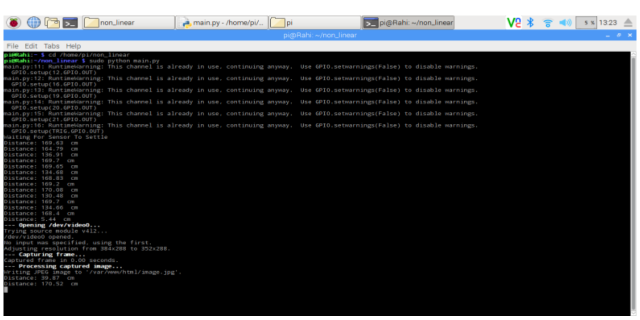


Figure. 5.4 Ultra sonic sensor output screen

Once the ultrasonic sensor program is executed using the command **"python ultra.py"** the output on the screen will be as shown in fig 5.9**.**In order to calculate the distance from the object we need to use ultrasonic sensor.

Step:5 CAM output window

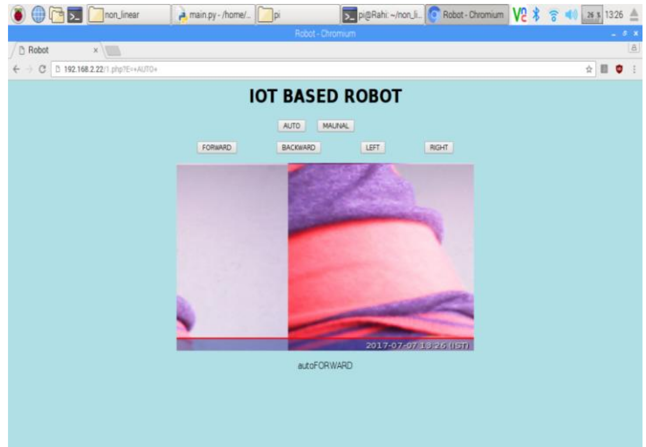


Figure.5.5: USB cam output screen To get the live streaming of the location

through USB cam the instruction should be **"sudo motion"** . On successful execution we can see live video by entering the IP address in the browser as shown above fig 5.10.

Step:6 Output Screen

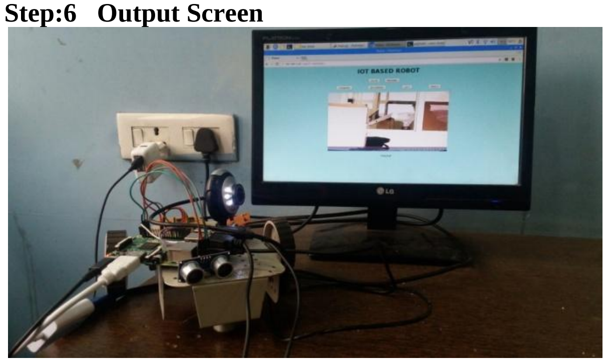


Figure.5.6 Output Screen

After successful operation the final output screen is shown in the fig 5.6. Left side window in fig 5.6 is used to enter the commands to execute the code and also to operate the robot by giving the right directions. The window on the right side is used to monitoring the location using the USB cam by entering the IP address in any of the browser. The overall kit along with screen can be seen in fig 5.6.

VI. CONCLUSION

The robot will be able to move as per the command given after detecting the obstacle through the ultrasonic module. When the ultrasonic detect the obstacle is detected using the echo and trig pulse the pi will command the motor as per the directions i.e. left or right and it will change its path accordingly.

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