SELF-DRIVING CAR USING RASBERRY PI AND ARDIUNO

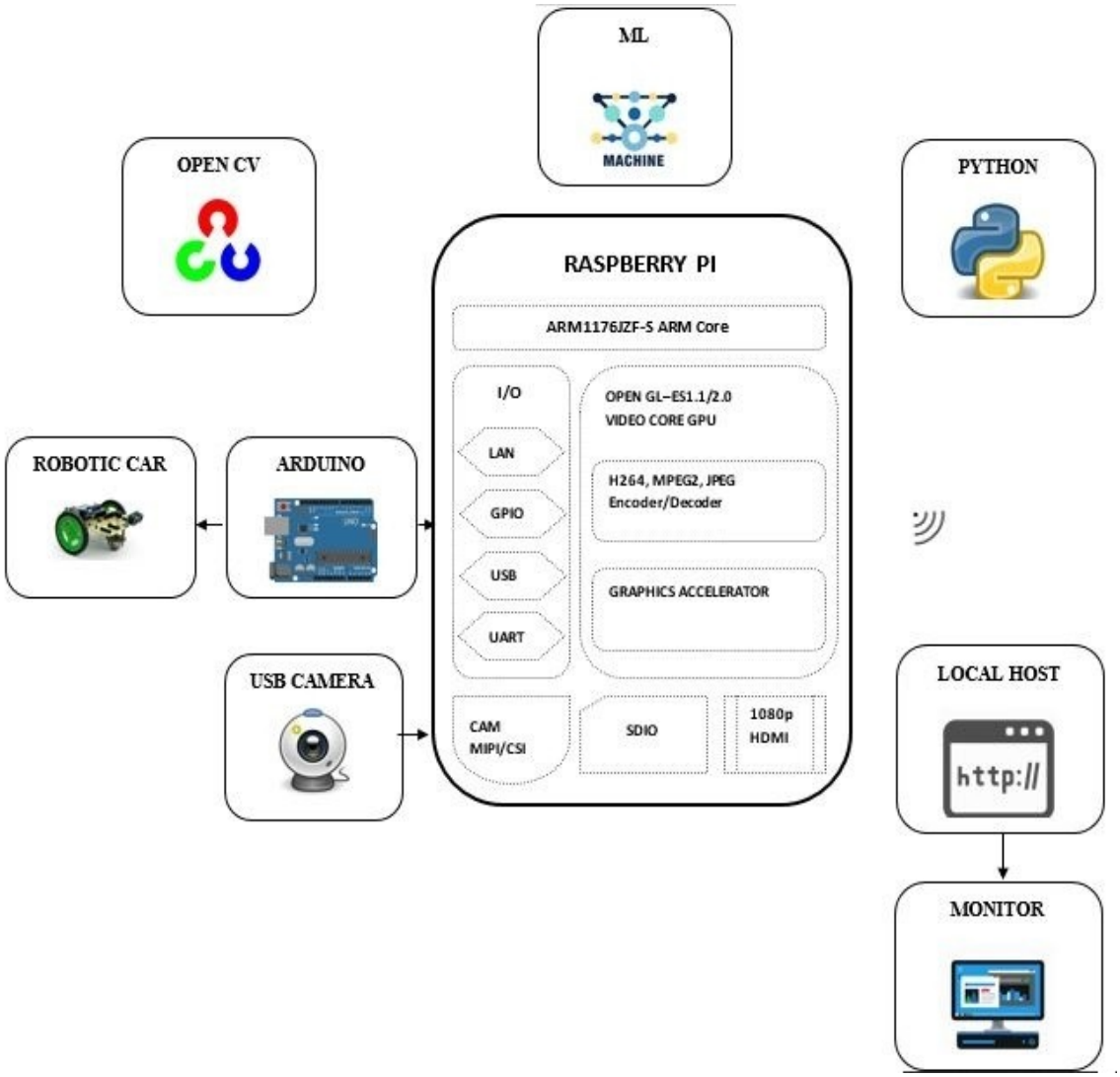
Introduction

Anautonomous car(also known as adriverless car,self-driving car,robotic car) is a robotic vehicle that is designed to travel between destinations without any human intervention.About 1.24 million People are killed in roads every year throughout the world.According to BUET accident research centre the death toll every year is 10-12 thousand and countless number of people are injured or become disabled destroying so many lives and families

Abstract

Self Driving car is the most trending technology which already implemented in Tesla cars, As initially, you can learn about the technology by using this system. For this, we are using OpenCV, Machine learning technology. This system contains Raspberry Pi as the core system, which having functionalities like, Traffic light detection, Vehicle detection, pedestrian detection, Road sign detection to make the car as autonomous. Every process is done using the Raspberry Pi with Python programming.

Block Diagram

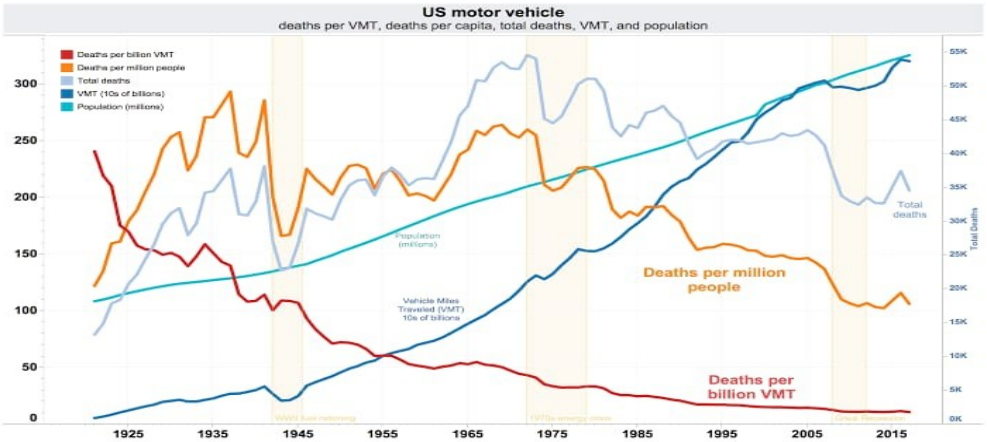


Objectives

1.The main goal of self driving RC car is toavoid accidents.
2.Increasing roadway capacity by reducing the distancesbetween cars
3.People are free to concentrate on other tasks or to rest during theirjourneys.
4.The current location of vehicle can be determined using GPS

Literature Review

According to the National Highway Traffic Safety Administration (NHTSA), in 2016, the U.S. had 6.3MM car crashes, 2.5MM injuries from those crashes, and 37,461 fatalities from those crashes. Areas like avoiding the tens of thousands of fatalities every year are priceless, but here I will try to quantify the problems driverless cars solve. Below is a summary of areas I could quantify where we could have real annual savings in the U.S. alone:



Problem Defination

In order to increase roadway safety autonomous vehicles are under development and are the focus of many research projects. The Rochester Institute of Technology wishes to have a reentry point to the field of autonomous vehicle research and currently does not have a vehicle to use as a starting point. To facilitate RIT's goal a remote control golf cart was determined to be the first stepping stone. The scope of this project includes converting a golf cart to a remote control vehicle. The safety of the vehicle's passengers and bystanders is of the utmost concern. Therefore the vehicle is required to be low speed and contain the ability for passengers to take control.

Scope

The entire project is divide in to two parts

1.To run the chatbot car on the defined track using opencv.

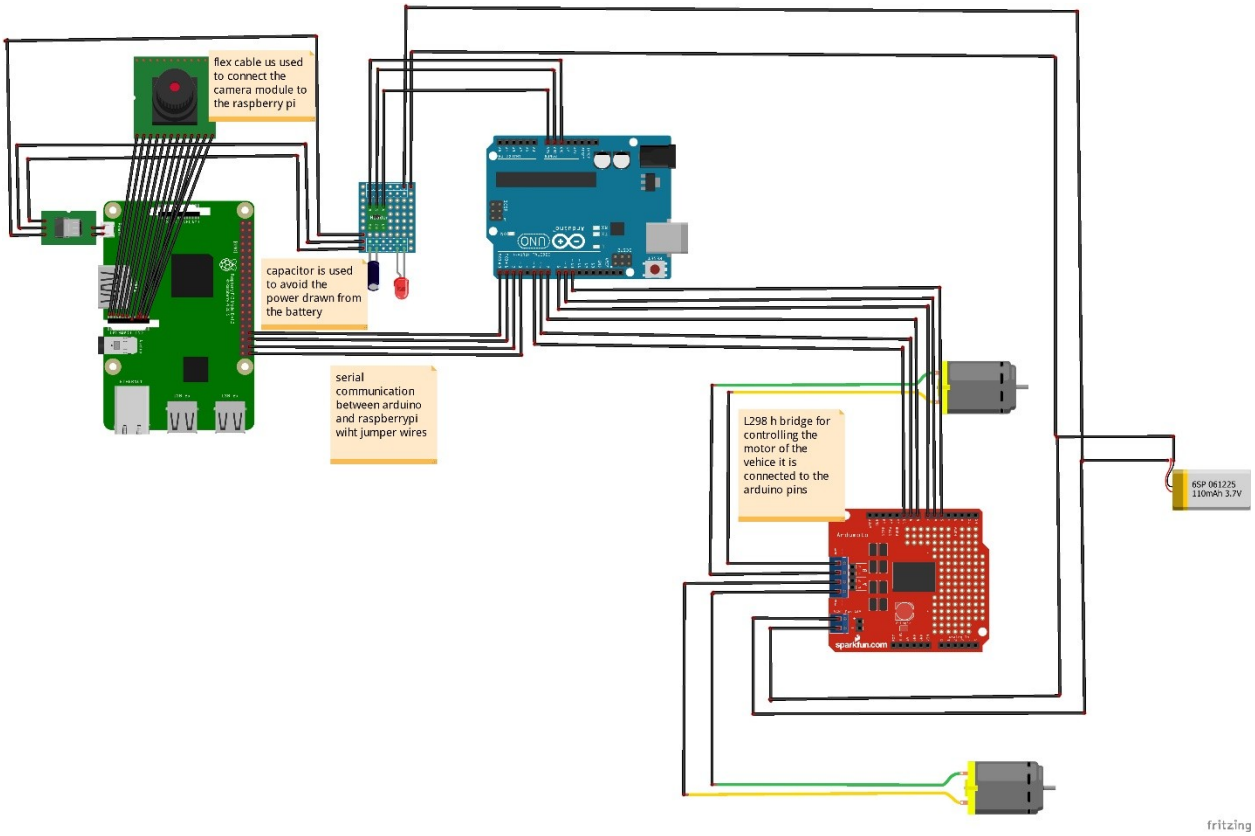
2. The second part consist of the image processing in which the decision are made based on the image fed to the system.

a) turn left and right on the defined path

b) Traffic sign detection and based on the sign ,appropriate decision is put into action

c) Stop or Change the lane when obstacle is detected

Technology Stack



This microcontroller is based on ATmega329P.There are 14 digital input/output pins available out of which 6 can be used a PWM outputs. It also supports 6 analog inputs. It has 16 MHz quartz crystal, a USB connection,a power jack, an ICSP header and a reset button. It has 32 kb of flash memory and 2 kb of SRAM and weighs around 25g .Apart from all these features Arduino IDE is very user friendly and uses basic c as its programming language. After attaching these hardware on the car and connecting Arduino with the controller.

Benefits for Environment &Society

- **Without the need for a driver, cars could become mini leisure rooms. Without the need for controls, there would be more space available inside the vehicle and no need for passengers to face forwards.**
- **Entertainment technology, such as video screens, could be used without any concern of distracting the driver.**
- **Human drivers notoriously bend rules and take risks, but driverless cars will obey every road rule and posted speed limit.**

- Over 80% of car crashes in the US are caused by driver error. There would be less user errors and fewer mistakes on the roads if all vehicles became driverless. Drunk and drugged drivers would also be a thing of the past, and passengers might even sleep without risking safety.
- Travelers would be able to journey overnight and sleep for the duration.
- Traffic could be coordinated more smoothly in urban areas to prevent bottlenecks and traffic jams at busy times. Commute times could be reduced drastically.
- Driving fatigue and getting lost would be things of the past.
- Sensory technology could potentially perceive the environment better than humans could, seeing farther ahead, better in poor visibility, and detecting smaller and more subtle obstacles. Plus, several cameras might be used at once, and cameras have no blind spots, so they will be more aware and vigilant than a human driver ever could be.
- Speed limits could be safely increased, thereby shortening journey times.
- Difficult maneuvering and parking would be less stressful and require no special skills. The car could even just drop you off and then go park itself.
- People who have difficulties driving—such as disabled people, older citizens, and children—would be able to experience the freedom of solo car travel.
- There would be no need for drivers licenses or driving tests.
- Presumably, with fewer associated risks, insurance premiums for car owners would go down.
- Efficient travel also means fuel savings, simultaneously cutting costs and making less of a negative environmental impact.
- Greater efficiency would mean fewer emissions and less pollution from cars in general.
- Reduced need for safety gaps, lanes, and shoulders means that road capacities for vehicles would be significantly increased.
- Passengers should experience a smoother riding experience.
- Self-aware cars would lead to a reduction in car theft.

Application

Computer Vision:

Waymo is a US-based company that offers namesake autonomous vehicles, which they claim can helpauto manufacturers and ride-hailing businesses make the roads safer for both pedestrians and motorists using a combination of computer vision, audio recognition, and machine learning technologies. Waymo claims users can experience a safer driving experience through the AV's vision system, which is capable of object and event detection and response. The vision system's cameras constantly scan the road for moving and static objects, such as pedestrians, cyclists, other vehicles, traffic lights, construction cones, and other road features it passes along the road through a 360-degree view of its surroundings.

General Motors:

By 2019, General Motors aims to offer ride-sharing services with perception software, which they claim can help operate self-driving cars safely in busy urban environments using a multisensor vision system. General Motors claims the system cansafely navigate city streets with a 360-degree view of the

world. The system is fitted with five light detection and ranging (LiDARs) sensors, 16 cameras, and 21 radars. Using laser light, the LiDAR measures the distance of both fixed and moving objects from the vehicle. The radars complement LiDAR in that they are able to perceive solid objects in low light conditions. Long-range sensors track speeding objects, such as oncoming vehicles, while the short-range sensors provide detail about moving objects near the AVs pedestrians and bicycles.

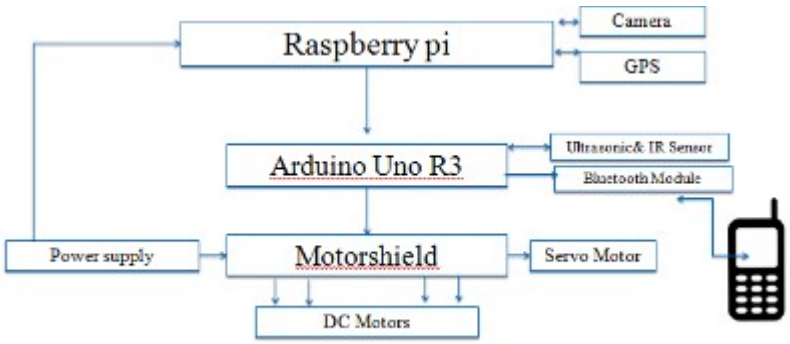
Quanergy Systems

Quanergy Systems is a Silicon Valley-based company with about 200 employees. The company offers a software called Qortex for Transportation, which they claim can help autonomous vehicle manufacturers increase car safety using computer vision technology. Quanergy claims that the application detects objects based on imaging data captured by the system's LiDAR sensors. This data could include 3D images of people on the streets, other vehicles, buildings, animals, trees, and signs on the road. The underlying algorithms then measure the distance of the objects from the vehicle, as well as identify and classify them. Once an object is classified, the system triggers an action based on the real-time scenario.

Virtual Simulations

Microsoft offers a software called AirSim, which they claim can help autonomous vehicle manufacturers test vehicle safety of and train their machine learning algorithms using deep learning, computer vision, and reinforcement learning for autonomous vehicles. The company states that, in offering this open-source application for testing algorithms, it aims to make the development of self-driving cars available to more companies. Initially developed as a tool for game development, the new version of AirSim includes car simulations, new environments, and a programming interface that allows developers to run their algorithms.

Proposed system



The proposed system design attribute-based different function such as obstacle detection, voice recognition etcand image processing etc. This all task are complete by using the different software and hardware components.

The system contains four modules,

1)Obstacle detection.

2)Image processing.

3)Voice recognition.
4)GPS system

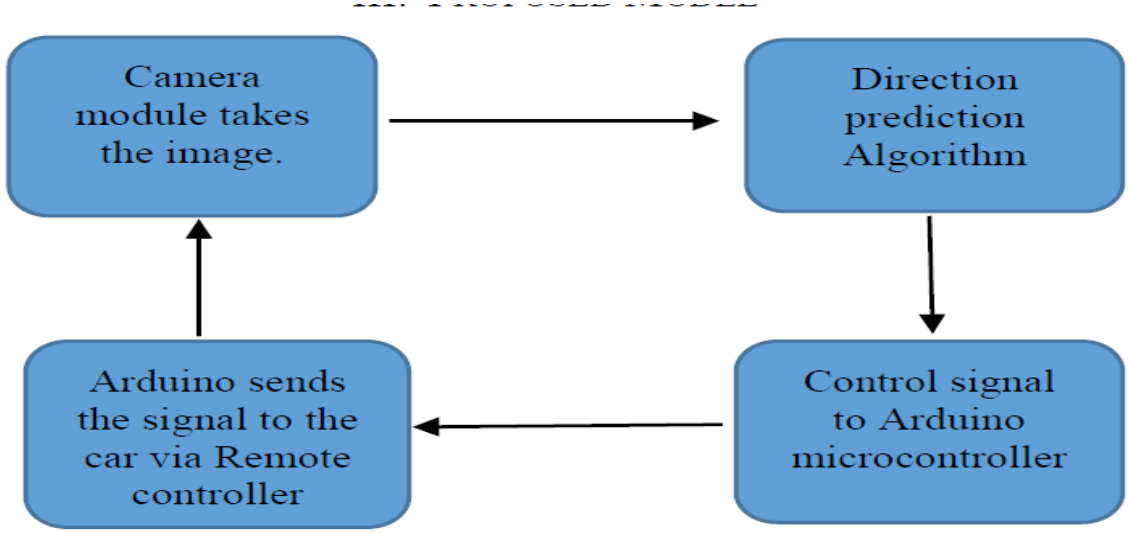
1.Obstacle detection.-This proposed system are used for the two type of sensors first is ultrasonic sensor used for the obstacle detection another one is IR sensor used for motion detection, Human detection and smoke detection.

2.Image processing:-In this system Raspberry pi used for the image processing. Imagecapturing camera, Raspberry Pi board torun image recognition programs on it. DVI compatible monitors also connected with this system during initial stages to the captured images and give the user indication and Also having self-driving on the track, stop sign and traffic light detection.
3.Voice recognition:-Voice recognition is the process of taking the spoken word as an input to a computer program. This is important to virtual reality because it provides a fairly natural and intuitive way of controlling the simulation while allowing the user's hands to remain free.

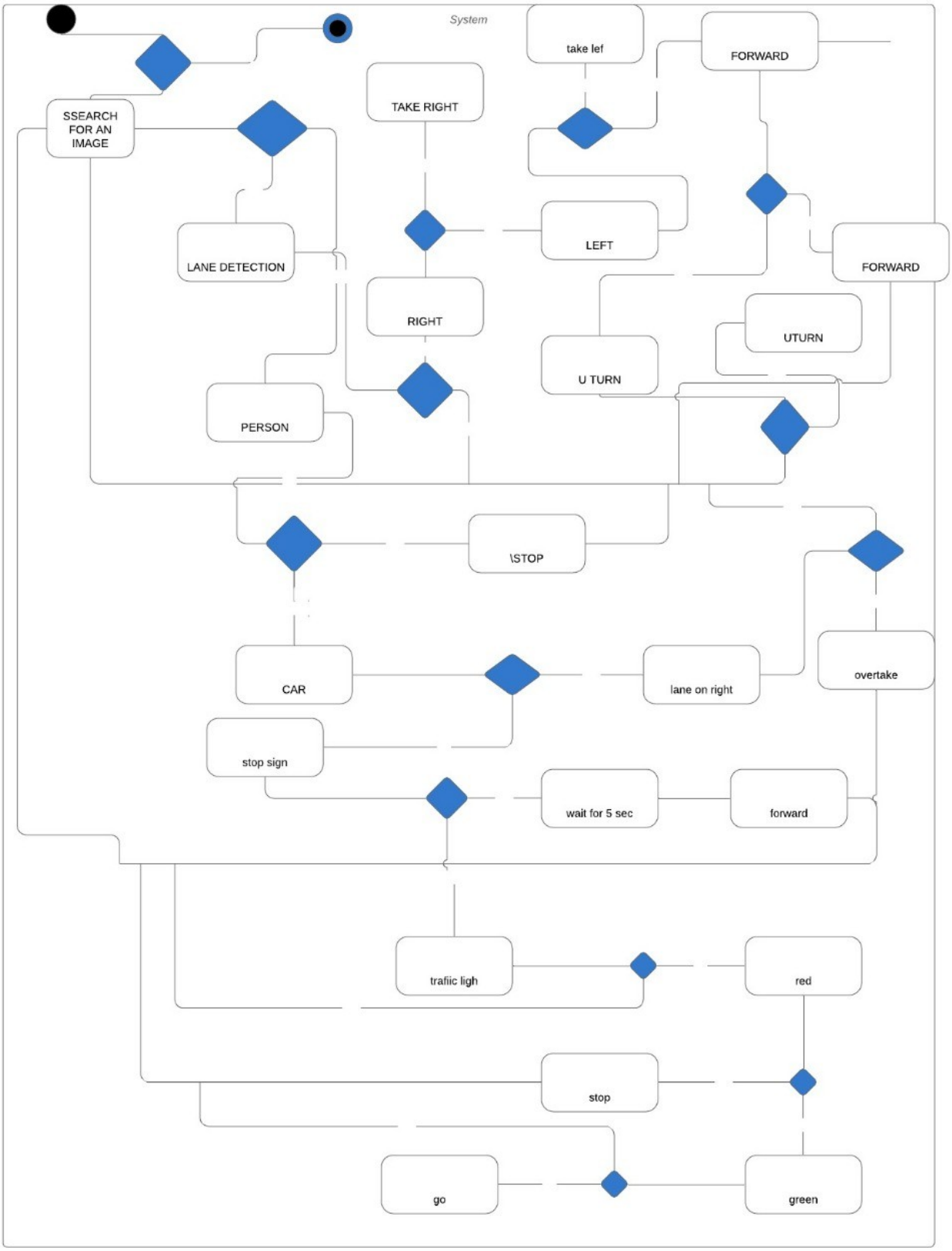
4.GPS system:-When global positioning system is used to thecurrent location of vehicle can be determined. Alsofind path from source to destination.

Design(Flow Of Modules)

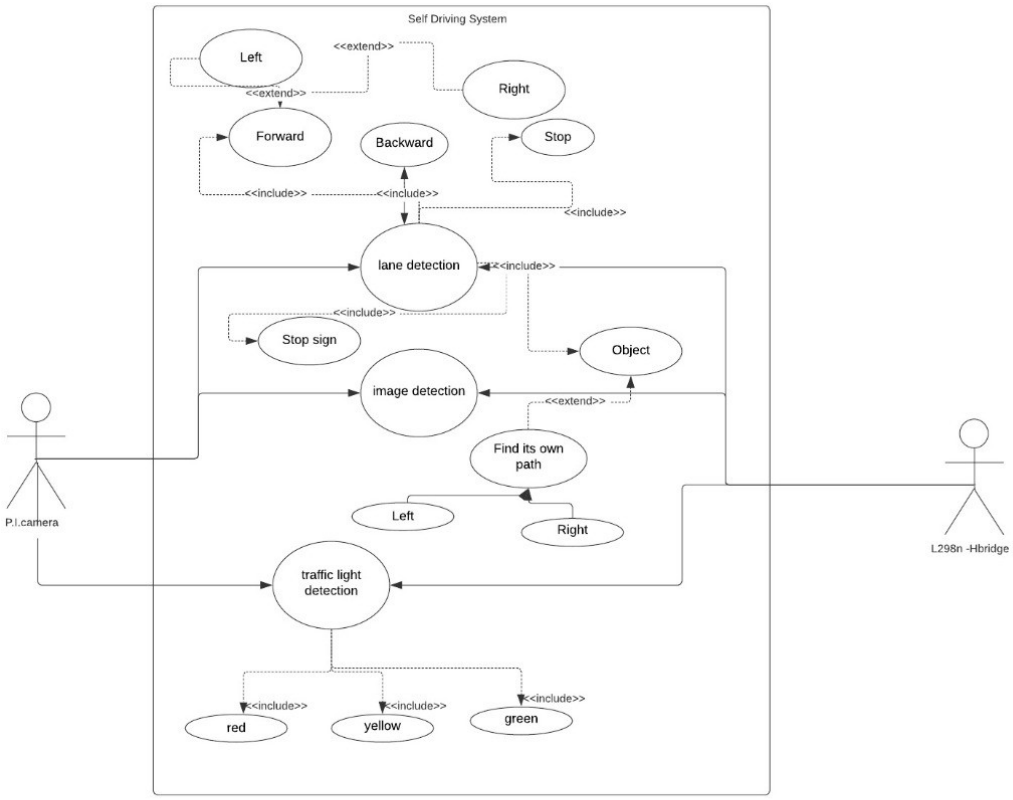
An external device, PICamera will be responsible for image capturing from the environment and passes to the RaspberryPI processor. Now, RaspberryPI has the captured image and will perform some analysis on it by using the image detection algorithm producing some function value and further passes it to the CNN model. In our case, the images are well- defined i.e Stop sign signal, Object detection (Car, human, etc), traffic lights (Red, Green and Yellow) and Lane detection. The corresponding functions are made in the raspberryPI algorithm. So, whenever an image passes through an image detection algorithm, the corresponding function is called and the value of that function is passed by raspberryPI to an Arduino through GPIO pins to RX-TX i.e Pin no.1 to 4. The value that's inputted in the Arduino, the corresponding value's decimal form is taken by calling a function. Based on that function, the Arduino gives command to a L298HBridge through 8bit PWM (Pulse With Modulation) Pins. Then, the bridge will take action on the motor



Activity Diagram



Use Case Diagram



Description Of Use Case Diagram:

The above Use Case Diagram The main role is Pi Camera is used to detect which of the operation should be performed when any obstacle ,Lane direction, potholes or traffic signals occurred.

1. First Pi Camera take the front image and divide the image into pixels, then each pixels will be justify in CNN. After than decision will made.

2. If it is Traffic Signals, in that case it's about Colour .Then there will be following rules:

- **i. If it is Red Colour, then the Car will be Stop.**
- **ii. If it is Green Colour, then the Car will Start moving Forward direction.**
- **iii .If it is Yellow Colour, then the Speed of Car will be decrease.**

3.If the Image detected by Pi camera said it is Lane Direction picture, then there will be two ways to go:

- **i. If it is Right sign, Then the car will be moved in Right Direction**
- **ii.If it is Left sign, Then the car will be moved in Left Direction**

4.If there is no Path and it observed the U-Turn sign, then the cars is used to take U-turn.

Modules

1 : PICamera

Pi camera is great gadget to capture time-lapse, slow motion with great video clarity. The dimensions of camera are 25mm to 24mm by 9mm, which connects to Raspberry Pi via a flexible elastic cord which supports serial interface. The camera image sensor has a resolution of five megapixels and has a focused lens. The camera provides a great support for security purpose. Various characteristics of the camera are it supports 5MP sensor, Wide image, capable of 2592x1944 stills, 1080p30 video on Camera module v1

2 :Raspberry pi:

The Raspberry Pi is a small low cost single board computer having a processor speed ranging from 700 MHz to 1.2 GHz for the Pi 3.The on-board memory ranges from 256 MB to 1 GB RAM. The boards supports up to 4 USB ports along with HDMI port. Along from all this it has number of GPIO pins which support protocols like I^2C.Moreover it also supports Wi-Fi and Bluetooth facility which makes device very compatible with other devices. It supports Scratch and Python programming languages [10]. It supports many operating systems like Ubuntu MATE, Snappy Ubuntu, Pidora, Linutop and many more out of which Raspbian is specifically designed to support Raspberry Pi's hardware

3 :Arduino Uno:

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around 25g [13].Apart from all these features Arduino IDE is very user friendly and uses basic c as its programming language After attaching these hardware on the car and connecting Arduino with the controller. The setup looks something like shown in the figure. below

4: *Arduino IDE*

Ardino IDE is the platform were the programs are written for Arduino board.It has compile button which helps in compiling the code along with the upload tab which helps to upload the code on the board.Programs written on Arduino IDE are often called Sketches and are saved as .ino extension.The editor has numerous other features like verify, save, upload , include library and serial monitor.Apart from this ,the developers have
made easy to use functions, which makes coding easy and fun.Moreover there are number of examples provided for each and every interface which helps the user learn more about functions and hardware as well.

5:Open CV

OpenCV is an open source computer vision library which is capable of handling images/videos from fairly basic tasks to utter complex tasks like facial recognition. It supports C++, C, Python and Java programming languages and supports Windows, Linux, Mac OS, iOS and Android. Written in optimized C/ C++, the library can take advantage of multi-core processing. Enabled with OpenCL, it can take advantage of the hardware acceleration of the underlying heterogeneous compute platform [14]. In this project it is serving a major support, it helps to crop out the section of the video from the Raspberry-Pi cam interface as shown above and converts it to the grayscale, resize it and then passes it to the Convolutional Neural Network. Spyder is a powerful interactive development environment for the Python language which has advanced editing, interactive testing, debugging and introspection features and a numerical computing environment. It has a matplotlib as plotting library which helps to plot 2D/3D graphs

6: *Raspberry Pi Cam Interface*

To remotely capture the live feed from the camera to the laptop we need to develop an interface which would serve this purpose.This is were the software Rpi-cam interface comes into the picture. It's the program which helps you capture the live feed by just letting the ip address of the Raspberry pi.One can record and download video/image in various resolutions with different number of settings. Below is the view of the software under action.

7:Testing

The car was trained under different combinations of the track i.e. straight, curved, combination of straight and curved and etc. Total of 24 videos were recorded out of which images were extracted.10868 images were extracted and was categorically placed in different folders like left, right, straight and stop. Below is the sample image of each of the scenario in its gray scaled version These images were resized to 320 x 240 and on which the network was trained on. The Convolutional Neural Network had 128 input nodes, 2 hidden layers of 32 nodes each and finally the output layer consisting of 4 nodes for each of the 4 output. To avoid overlearning of the network dropout of 0.5 was considered. 'Relu' activation function was used between the input and hidden layers and 'Softmax' activation function was used in the output layer. The Batch size was set to 10 and

number of epochs was set to 3 and it took 5-6 hours to train on the GPU mode. This was all about the network configuration that was used to train the model. Let's now see how well the car performed on each track. make the system reliable but at the same time it would make the overall design attractive and risk-free from accidents.

8: CNN

Python:

It is the programming language used for Machine Learning or Artificial Intelligence tasks.

OpenCV:

It is a powerful computer vision package. It can be trained to detect objects in images (or video).

Tensorflow:

It is Google's popular deep learning framework. Tensorflow is used to make smart decisions based on the neural network.

Google Colab:

Colab is a free cloud-based Jupyter Notebooks that let you write and train deep learning models in Python. The popular python libraries supported are TensorFlow, Keras, OpenCV, and Pandas

OpenCV for Computer Vision:

Perception Sensor of our PiCar is a USB DashCam. A DashCam gives us a live video, which is essentially a sequence of pictures. We will use OpenCV, a powerful open source computer vision library, to capture and transform these pictures

Numpy and Matplotlib are two very useful python modules that we will use in conjunction with OpenCV for image processing and rendering.

Tensorflow For CPU:

Raspberry Pi is not recommended to perform any deep learning (i.e. model training), as its CPU is vastly insufficient for backward propagation, a very slow operation required in the learning process. However, we can use the Tensorflow CPU to do model prediction based on a pre-trained model. Model Training which uses only forward propagation, a much faster computer operation.

TensorFlow for Edge TPU Co-Processor:

Inferences can only do so on a relatively shallow model (say 20–30 layers) in real time. But for deeper models (100+ layers), we would need the Edge TPU. A live video screen coming up, and it will try to identify objects in the screen at around 7–8 Frames/sec. COCO (Common Object in COntext) object detection model can detect about 100 common objects, like a person etc.

The object detection model used in this program is called ssd_mobilenet_coco_v2