Implementation of SDC: Self-Driving Car based on Raspberry Pi

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Abstract: - In this paper we discuss about the Autonomous car supported machine learning using raspberry pi. Machine learning may be a sort of AI (Artificial intelligence) that gives computers with the power to find out without being explicitly programmed. Using this idea of machine learning, a car is often automated (self-driving). We train the car with specific images and whenever it detects the trained images, it operates consistent with the trained instruction. The microcontroller utilized in the car is raspberry pi which is employed to regulate the L298 driver, ultrasonic sensor and the raspberry pi camera. We use different components like pi camera which is used to train and detect the objects, L298 driver which operates the dc motor and the ultrasonic sensor to calculate the distance. This autonomous car is the prototype to the self-driving cars which is present growing advanced technology in the present scenario. This Autonomous can also use in industries for transport of goods.

Keywords— Raspberry Pi, Pi-camera, Computer, NumPy, OpenCV, Pygmy, PiSerial.

1. INTRODUCTION

With the growing wants of convenience, technology currently tries to hunt automation in each side doable. Also, in recent years we have a tendency to see the enlargement of variety of accidents due to augmented variety of vehicles and a number of amounts of carelessness of the drivers, it currently looks necessary to hunt automation in vehicles. therefore, to realize the answer of preceding drawback, we have a tendency to gift associate degree autonomously drive automobile which might eradicate human intervention within the field of driving. The automobile would drive itself from one place to the opposite on its own it might possess integrated options like lane-detection, obstacle-detection and traffic sign detection. This options would facilitate the automobile drive itself to the mentioned destination on the track properly, avoid collisions, offer live streaming of the read before of it with the assistance of camera mounted over the automobile and observe traffic signs and adapt them consequently therefore on avoid accidents caused because of disobeying the traffic rules. this might guarantee safer, easier, updated and a lot of convenient quality, therefore providing bent on be a revolutionary step within the field towards automation and quality. This technology also will be helpful in industries to transfer merchandise from one location to a different.

2. HARDWARE REQURMENT

A.   *Raspberry pi 3b+:-*

The Raspberry Pi 3B+ is the latest product in the Raspberry Pi 3 range, boasting an updated 64-bit quad core processor running at 1.4GHz with built-in metal heatsink, dual-band 2.4GHz and 5GHz wireless LAN, faster (300 mbps) Ethernet, and PoE capability via a separate PoE HAT.[6]

Fig:- Raspberry pi 3 b +

B.   *Arduino uno R3:-*

• Arduino is a single-board microcontroller meant to make the application more accessible with interactive objects and its surroundings. The hardware features with an open-source hardware board designed around an 8-bit Atmel AVR (Automatic Voltage Regulator) microcontroller or a 32-bit Atmel ARM (Advanced RISC Machine). Current models consists a USB interface, 6 analog input pins and 14 digital input/output pins that allows the user to attach various extension boards. The Arduino Uno board is a microcontroller based on the ATmega328. It has 14 digital input/output pins in which six can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB (Universal Serial Bus) connection, 6 analog inputs, a power jack and a reset button.

- This contains all the required support needed for microcontroller. In order to get started, they are simply connected to a computer with a USB cable or with a AC-to-DC adapter or battery. Arduino Uno Board varies from all other boards and they will not use the FTDI (Future Technology Devices International) USB-to-serial driver chip in them. It is featured by the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter

Fig: - Ardiuno Uno R3

C.   Motor Driver (H Bridge):-

The L298N could be a twin H-Bridge motor driver that permits speed and direction management of 2 DC (Direct Current) motors at identical time. The module will drive DC motors that have voltages between five and 35V, with a peak current up to 2A. The module has 2 screw terminal blocks for the motor A and B, and another screw terminal block for the bottom pin, the VCC (Voltage Collector to Collector) for motor and a 5V pin which might either be an input or output. this relies on the voltage used at the motors VCC. The module has AN on board 5V regulator that is either enabled or disabled employing a jumper. If the motor provide voltage is up to 12V we will alter the 5V regulator and therefore the 5V pin is used as output, as an example for powering however if the motor voltage is bigger than 12V we have a tendency to should disconnect the jumper as a result of those voltages can cause injury to the during this case the 5V pin are going to be used as input as we want connect it to a 5V power provide so as the IC to figure properly.

Fig: -Motor driver

D.   Pi camera:-

- The Raspberry Pi Camera v2 is that the new official camera board discharged by the Raspberry Pi Foundation.

- The Raspberry Pi Zero presently comes complete with a camera port! victimization the new Raspberry Pi Zero Camera Adapter, you may presently use a Raspberry Pi camera to your Zero.[08]

- It's capable of 3280 x 2464 constituent static footage, and in addition supports 1080p30, 720p60 and640x480p90 video.

Fig:- Raspberry pi camera

E.   Ultra sonic sensor:-

- An inaudible sensing element may be a device that may live the gap to Associate in Nursing object by mistreatment sound waves.

- It measures distance by causation out a undulation at a selected frequency and listening for that undulation to improve.

Fig:- Ultrasonic Sensor

3. SOFTWARE REQUIMENTS

F. python 3 IDE:-

- Python is one amongst those rare languages which may claim to be each straightforward and powerful. you'll end up pleasantly stunned to envision however straightforward it's to target the answer to the matter instead of the syntax and structure of the language you're programming in.

- The official introduction to Python is Python is a straightforward to be told, powerful artificial

language. it's economical high-level information structures and a straightforward however effective approach to object-oriented programming. Python's elegant syntax and dynamic writing, alongside its understood nature, create it a perfect language for scripting and fast application development in several areas on most platforms.

- Some Python library used: -

- NumPy library: -

NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays. The ancestor of NumPy, Numeric, was originally created by Jim Hugunin with contributions from several other developers. In 2005, Travis Oliphant created NumPy by incorporating features of the competing Numeracy into Numeric, with extensive modifications. NumPy is open-source software and has many contributors.

- OpenCV: -

It (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision.[09] It has over 2500optimized algorithms, including both a set of classical algorithms and the state-of-the-art algorithms in Computer Vision, which can be used for image processing, detection and face recognition, object identification, classification actions, traces, and other functions. This library allows these features be implemented on computers with relative ease, provide a simple computer vision infrastructure to prototype quickly sophisticated applications. The library is used extensively by companies like Google, Yahoo, Microsoft, Intel, IBM, Sony, Honda, Toyota, and startups area as Applied Minds, Video Surf and Zeit era. It is also used by many research groups and government. It is based on C++ but wrappers are available in python as well. In our project is used to detect the roads and guide the car on unknown roads RPi.GPIO Python Library.[09]

G.   Arduino IDE:-

- The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

- The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++. It also uses special rules of code structuring. The Arduino IDE supplies a software library from

the Wiring project. This library provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program argued to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

4. HARDWARE COMPONENTS CONNECTION

The toy car has 2 motors one for going forward and backward, and the other for going into left and right. The motor driver IC L293D is capable of driving 2 motors simultaneously. The motor 1 is connected to the output 1 and 2, similarly the motor 2 is connected to output 3 and 4. This helps the car to move in forward, backward, right and left direction. The motor driver is connected with Raspberry Pi GPIO pins for the inputs via jumper wires. The motor driver is connected with 12v battery for the power source.

5. LANE DETECTION

H.   Lane Detection Algorithm

Traditionally, lane can be detected by 2 approaches specifically feature based mostly technique and model-based technique. The feature-based technique localizes the lanes among the road pictures by combining the low-level options, like painted lines or lane edges etc. consequently, this method needs well studied road having well-painted lines or robust lane edges, otherwise it will fail. Moreover, it is the disadvantage of not imposing any international constraints on the lane edge shapes, this method could suffer from occlusion or noise.
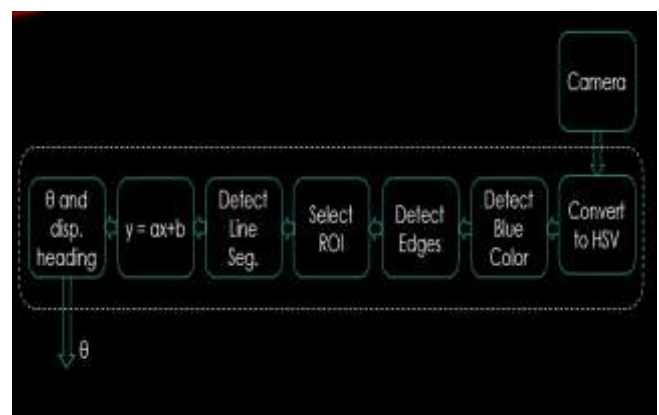

Fig: - Lane Detection Algorithm

On the alternative hand, the model-based technique simply uses a few of parameters to represent the lanes. presumptuous the shapes of lane area unit usually bestowed by either line or parabolic curve; the process of

police work lanes is approached as a result of the process of shrewd those model parameters. This way, the model-based technique is much additional sturdy against noise and missing information, compared with the feature-based technique. To estimate the parameters of lane model, the chance performs, Hough rework, and also the chi-square fitting, etc. area unit applied into the lane detection. However, because the most lane models area unit solely cantered on sure shapes of road, therefore they lack the pliability to modelling the arbitrary form of road. within the projected algorithmic program to discover the lanes, a combination of feature and model base is utilized. In general, this algorithmic program is valid for all reasonably roads (whether they're marked with white lanes or not).

The overall technique consists of seven major parts:

1.   Extract the color vary for the road

Extract the acceptable higher and lower vary to work out the colour of the portion on that the automotive is standing. this is often the primary and most significant a region of this algorithmic program. victimization this vary, a binary image of this read is created.

Fig: - Original image

2.   Outline the region of interest

A region of interest is defined starting from the bottom towards upward. As the view is taken from the camera on the car, the road surface closest to the car is at the bottom of the image. Thus, the region of interest is defined from the nearest region to the farther distances by moving upwards in the image created. The height of the region of interest is usually not more than half the height of image. This removes the sky area from the visual field and saves unnecessary computations and is better than the method proposed by H.Dahlkamp [10]. As we move away from the car, the width of the road seems to be narrowing. So, the actual region of interest is in a shape of a trapezium [10].
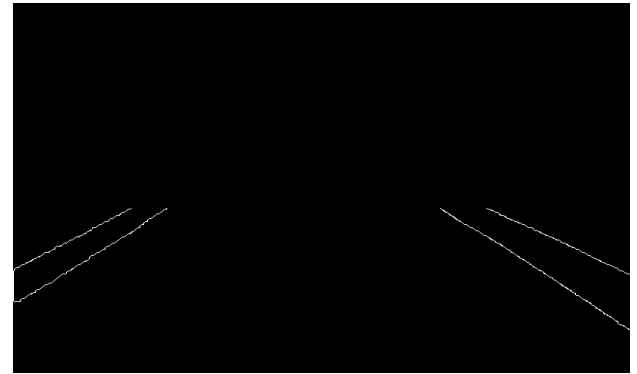

Fig: - Region of Interest Frame

3.   Convert advanced region of interest into straightforward form

This is an important step in crucial the boundary of the road. within the region of interest, the contours area unit determined. Since the automotive is on the road, the foremost vital contour that contains the central a region of all-time low region is that the road. change the form of this contour victimization approximations.

Fig: - Heading line

4.   Confirm the form of the road

We draw Hough lines on the manipulated contour. variety of Hough lines area unit obtained on the left and right edges of the road. Out of these, solely few lines represent the actual edge. Rests of the lines area unit because of the noise (due to irregularities within the road) on the sting.

5.   Filtering the noise

The lines on the left fringe of the road area unit a tilt towards right and also the different manner around. So, any line that is a tilt towards left and lies entirely within the left [*fr1] the image is discarded. Similar lines are discarded from the proper [*fr1]. For the left edge, a line with the tiniest angle or having the tiniest quantity positive x intercept or y intercept is chosen as a result of the left fringe of the road. Similarly, notice the proper fringe of the road. A general case can be delineated.

6. Create it sturdy and unaffected from noise

For the moving automotive, the modification among the direction of road can't be abrupt. the sides of the road cannot modification the angle in distinct fashion. So, any line that is far remote from the road in previous frame is simply discarded. Another issue referred to as "tolerance" is taken into account. Basically, it's the count of the continual frames which could be accepted while not having the power to figure out the sting in entire preceding method. Its most price is three. If we have a tendency to aren't able to confirm the sting of the road, tolerance price is decremented by one. If it reaches zero, we have a tendency to hear to hunt out the new colour vary of the road at the run time.

7. Confirm the turns within the road, if any, and provides directions to the automotive

The various cases of the road (left flip, right turn, divergence, spherical – concerning etc.) area unit thought-about. Suppose there's a left flip as shown in Fig six. Divide the region of interest in three elements in quantitative relation 2:3:5. Compare the lines obtained altogether 3 elements with the potential form of the road. The dotted lines in every section in figure show the lines that area unit obtained applying Hough lines in these sections individually.
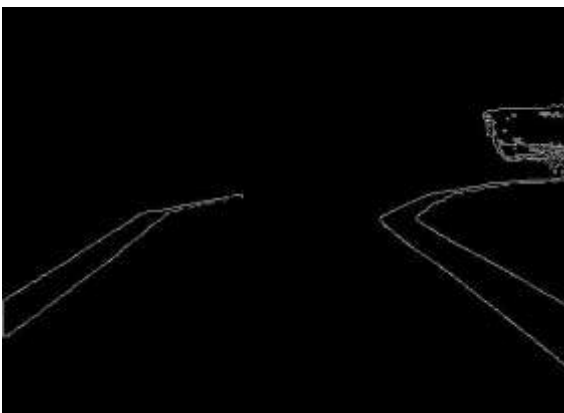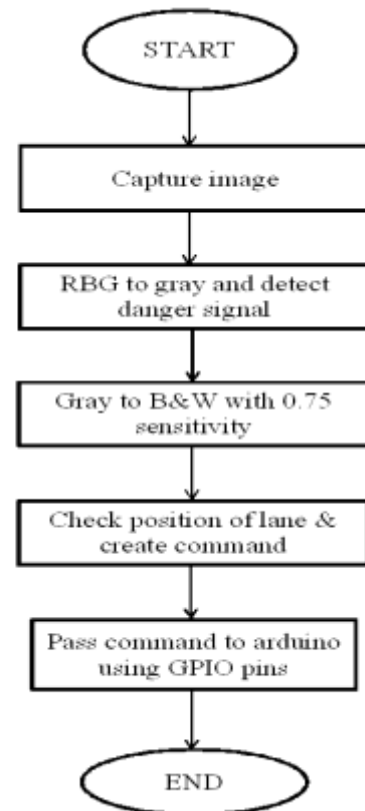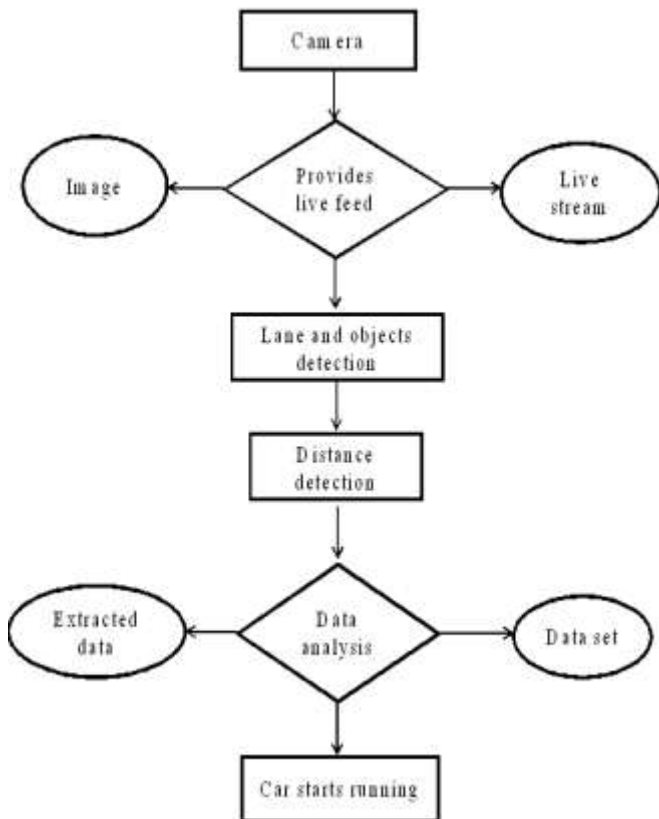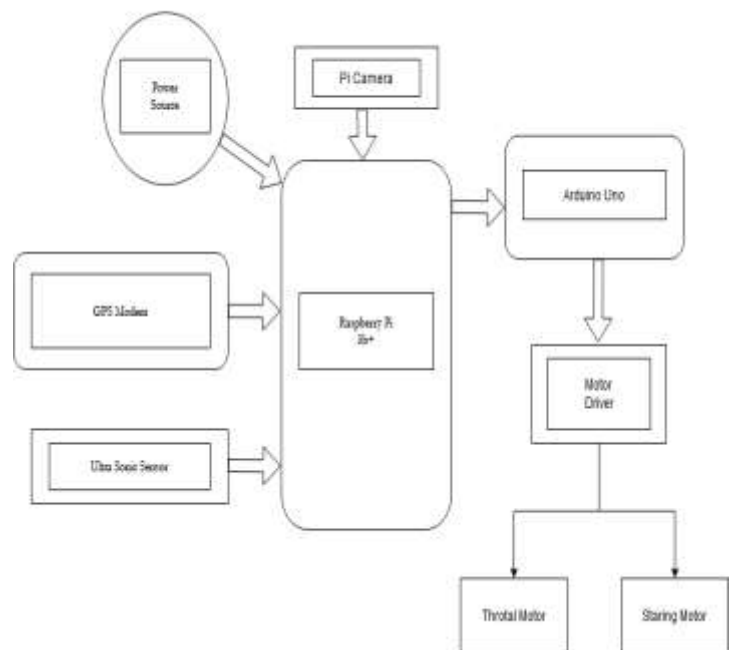

Fig: - Edges Frame

6. FLOW CHART

Here during this algorithm Lane detection is completed in region of interest only as described below. Region given in red mark is our region of interest and therefore the columns are helpful to decide the position of lane and also decision of turn is also carried out on the basis of this. Consider the given box is the picture capture by the camera.

7. ER DIAGRAM

9. BLOCK DIAGRAM

10. RESULTS

8. WORKING

- The self-driving car is a road-based machine which is used for driving the car automatically.

- The self-driving car works on a simple small board processor raspberry pi 3b+.

- When the SDC (SELF-DRIVING CAR) gets start the pi camera captures the live streaming of the field and sends the information to the raspberry pi.

- Raspberry pi converts the color video into the gray scale video.

- Then raspberry pi processes the video, and sends the command to the arduino using GPIO (General Purpose Input Output) pins.

- Then the arduino process the command and send the command to the motor drivers.

11. CONCLUSTION

In this paper, we have implemented a self-driving car. The hardware components and their assembly are shown in the above discerption. The collisions with obstacles are avoided Using ultrasonic sensors. The lane detection algorithm mentioned in the paper has been successfully implemented on a small toy car.

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