Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 05, May-2021

Study of Customized Autonomous Car by using Raspberry-Pi

[1]Bharath P
Student
Department of Electronics and Communication Eng.
VVCE, Mysore, India

[3]Sinchana Datta P
Student
Department of Electronics and Communication Eng.
VVCE, Mysore, India

[2]Bhumika S
Student
Department of Electronics and Communication Eng.
VVCE, Mysore, India

[4]Yashaswini K
Student
Department of Electronics and Communication Eng.
VVCE, Mysore, India

[5]Prof. Jayanna S S
Assistant Professor
Department of Electronics and Communication Eng.
VVCE, Mysore, India

***Abstract*—In recent times, transportation has become one of the inseparable parts of human race. Advancements are made based on making cars faster and safer according to our needs. According to statistics, most road accidents take place due to lack of response time to instant traffic events. With the autonomous cars many problems faced in the traditional driving system can be effectively addressed. This can be achieved by implementing automated systems to detect traffic events happening in the real time and take necessary actions. This will transform the lifestyle of people by creating an efficient way of driving on roads autonomously. The ability to track and detect the stationary or moving objects is said to be one of the most challenging tasks for decades. To design such recognition system in self-driving automated cars, it is important to maneuver through real time traffic events. In this paper, we have reviewed some recent papers related to the topic of discussion and we have identified the required components and technologies to be used in order to navigate safely, independently, quickly and comfortably. We have proposed a system which can perform detection of lanes, obstacles, sign boards, neighbouring cars, signals, etc in near real time system. And also, working of this self-driving car prototype totally relies upon cheaper alternatives which yields better results in all the possible ways.**

Keywords*— *Autonomous cars, cameras, sensors, actuators, computer vision, detection of lanes, cheaper alternatives.

I. INTRODUCTION

Autonomous cars are developed to make our life easier, simpler and more productive. In this smart era, it is very important and necessary to use modern technology to simplify our day-to-day activities. Senior citizens and disabled people face a lot of difficulty in driving. Autonomous vehicles have been programmed to assist them in all possible ways towards safety and accessible transportation. Statistics from the National Highway Traffic Safety Administration (NHTSA), says that 94% of accidents occur due to human error and laxity of drivers. Also, studies shows that 60% of the energy consumption is from automobiles which has further led to greenhouse gas emission. These numbers convey how automobiles are causing serious threat and severe causalities to precious lives. Automated vehicles can eradicate human error and can also help in reducing the number of undesired deaths caused due to human error. It is aimed to bring a huge improvisation in society by overcoming many of the problems and it will bring a positive impact on future beyond just commute. Autonomous cars will be the future of transportation in the upcoming smart era. Driverless cars are providing mobility to many people who cannot drive which is an added advantage to commuters who wish to use car on daily basis. The main objectives to be considered for developing an autonomous car is that the prototype must be able to plan the best path by considering all kind of obstacles, traffic signals, lane detection and various other constraints. It must be able to percept and understand the immediate environment and should pass on the processed information properly to take necessary actions. After a detailed study of all the papers we have identified the key aspects required to build an autonomous car to bring about solution to the problems discussed above.

The main processing unit consists of both Raspberry-pi and Arduino UNO to perform specified operations. Since the prototype to be developed is power intensive, there is necessity of slave device to overhead from main controller. Arduino UNO board is used to control the movement of the vehicle. Programs are compiled using Arduino IDE and then sketch is dumped into the board. Speed variations can be achieved by making slight changes to the sketch. Raspberry Pi 3 model B+ is specifically used in this case because it can handle larger video and image streaming smoothly without any hassle. This master device performs image processing using computer vision and it is also used for machine learning algorithm. These algorithms help in training the device to

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 05, May-2021

detect sign boards, obstacles and much more. Further these also used to calculate the distance between the car and obstacle. Based on these results the car will decide whether to make a move or not.

Inputs to the main processing unit are from sensors, camera and GPS. Different sensors like ultrasonic sensor, heat sensor, Radar, Lidar etc can be used to improvise the accuracy in detecting the objects. Usage of these sensors merely depends the functions of the prototype to be designed. Either one of them or all of them can be used according to their applications. Though sensors perceive more information, cameras are used because they give immediate raw data collected from the instantaneous environment and they are cheaper when compared to other alternatives with almost same functionalities. In this prototype we use Pi-camera. Further, raw data collected is given to the main processing unit which decides on what action to be performed by using computer vision. GPS is used for navigating the device safely and securely.

These inputs from camera, GPS, and sensors are given to

- Line follower module to recognize curves and drivable area.
- Light and traffic detection module.
- Obstacle (vehicle, pedestrian roads, humps etc) recognition module.

By considering all the above mentioned factors, necessary decisions are taken pertaining to the motion of the vehicle. This prototype of an autonomous vehicle consists of few gear motors, which is installed for controlling the vehicle. Signals will be sent to wheels powered by motor drivers and these in turn help to control the speed of the vehicle or to stop the vehicle or to overtake another vehicle/obstacle accordingly.

II. LITERATURE SURVEY

In [1], the goal was to develop a new combinational model which consists of different level of perception which includes swarm intelligence, integrated data of each automated vehicle and data from individual sensors. Swarm intelligence can be compared to a natural phenomenon which helps gliding animals like flies and birds to fly in optimum speed without colliding with each other. This natural phenomenon can be used to avoid collisions with neighbouring cars and to maintain minimal speed in automated vehicles by incorporating this intelligence in them. This paper mainly concentrates on building an autonomous vehicle incorporating features of swarm intelligence. This paper also cites the future scope in Unmanned aerial and underwater vehicles.

In [2], the end product is a generic model of an autonomous car which travels through a destined path by using web-based controls and voice commands. In this system, path planning is decided with the help of a Raspberry-Pi controller which takes important decisions like choosing a suitable path and checking for obstacles if any. Additionally, the car makes use of a microphone for voice control and other extra sensors to aid more accuracy in obstacle detection. Initially, the path is estimated and then traversed to find the shortest route between the start and end point. This prototype provides additional information about the car control from video streaming which assists in movement of the vehicle.

In [3], a working model of autonomous car which was tested in different tracks like straight tracks, curved tracks and curved tracks followed by straight tracks. First, Pi cam collects the information from its surrounding and then it is been fed into the Conventional neural algorithm. The processed data is given to Arduino to take decisions accordingly. Corresponding signals are activated and this results in motion of the vehicle. The working model had few serious issues while dealing with curved paths. Behaviour of the car whilst moving in a curved path was unpredictable. In few cases it glided smoothly and in few other cases the car crossed the lane which is a serious threat in real time system.

In [4], they presented the development process of an autonomous car by using Digital image processing and mainly they concentrated about computer vision. Their main aim was to develop a software which can be used to collect the samples and train the machine accordingly by using convolutional neural networks. They had greater emphasis on behavioural cloning using algorithms pertaining to neural networks. Further, the remote autonomous car was controlled by using an app specifically designed to instruct about the direction to be followed. This system was quite unstable due to many factors. Error in alignment was solved by using a closed loop control system. Here they have used a PID controller for more efficient and smooth movement of vehicle. According to the survey conducted, they found that the car was 80% accurate and it was very easy to implement.

In [5], they proposed that according to their experiment the prototype vehicle will use google maps and it will be linked to the front vehicle with same destination and the prototype vehicle is made to follow the front vehicle. The model is found out to be 90% accurate in terms of their accuracy and working. This prototype used an active network configuration where each base station continuously communicates with the main system.

In [6], the research was based on developing an autonomous car using Robot operating system. In their experiment they were able to perform the basic operations of autonomous car by using a one-tenth size model car which has very basic electronic functions using Raspberry-Pi and additionally it was an open-source prototype. The model uniquely consisted of mother board and daughter board which performed the tasks simultaneously and produced better outcomes when compared to other models. Angle detection using inertial sensors was successfully implemented and left and right movements traversed by the car was very neat and smooth.

In [7], the paper discusses about the designing and implementation of smart autonomous vehicle midst of a group of vehicles which is commonly called as Platoon. This car was planned to be implemented on a platoon of other autonomous vehicles and by this they were able to infer more about the autonomous car and its performance in real time system. They also developed different algorithms which helped in controlling the speed of the autonomous vehicle. This system was specifically designed to avoid collisions effectively and also it helped in maintaining a decent distance between other cars. Different kind of sensors were used in this prototype. Distance sensor was used to maintain appreciable distance in

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 05, May-2021

between the cars in real time system. Line tracker sensor in this prototype was used to follow the white lines and speed sensor was used to track the velocity of the car.

In [8], they have conducted many test case scenarios to obtain the course and the shortest distance between any two points in the setup along with GPS setup. Information about their respective latitudes and longitudes was available which further improved the accuracy in current location of the vehicle when compared to the latter. They have discussed about waypoints and correction angle and how they can be used to navigate the car. And also, they have used various others GPS models like NEMA (National marine electronics association) etc. Minute errors were found out in GPS setup and there was noise interference in the compass. This led to inaccuracy in navigating the current location which further resulted in the remaining distance to never attain zero. And also, it was observed that it took more time to refresh the data when the car was moving in a fast pace.

In [9], they have discussed about navigation by using ABS(Anti-lock braking system) sensor with GPS which produced satisfactory results when the car traversed through a short distance. They have compared behaviour of vehicles at different instances and they have observed the vehicle movement in smooth surfaces, rough surface and smooth surface with and without obstacle**.** The end product was designed in a such a way that it had two IR modules to detect obstacles in the front and back. Further changes were made to the existing model such that the car honks twice and waits for few seconds if there is presence of any pedestrians/animals. Then again it checks if there are any obstructions and continues to move. But this prototype wasn't accurate enough in curved path motion and obstacle detection in curved path produced merely satisfactory results. They also suggested the usage of Radars to improvise detection of obstacles in curved paths.

In [10], the goal was to develop a prototype using laser sensors combined with Infrared cameras which works well in all the weather conditions. They tested with different sensors and inferred about their performance, advantages and disadvantages Lidar sensor detects the distance from the obstacle using light. Radar can be used in case of detecting obstacles at long distance. Major drawback of using Radar is that when multiple objects are present in an area it is difficult to distinguish between each object correctly. They have observed that usage of Lidar and RADAR wasn't effective in obstacle detection in bad weather. It also uses heat sensors which is used to track the temperature of humans/animals/obstacles present in the path and it takes decisions accordingly. All these sensors are used to improvise working of an autonomous car. They also have observed a noticeable disadvantage in working of lidar when there's huge reflection from any another light source in the vicinity of the car.

In [11], they have developed a prototype which collects information from the surrounding environment solely using camera. Usage of four cameras i.e., front facing, rear facing and wide-angle camera coupled with stereo cameras on either side of the car aids in 360° view. Cameras are oriented in Image processing is performed using computer vision which helps in identifying obstacles and sign boards. Stereo vision helps in depth calculation and it also aids in effective steering of the vehicle. Usage of Lidar sensors are not appreciable because of their cost. Even though they are effective enough in tracking down the obstacles they cannot be commonly used because they are very costly. They have additionally inferred that coping with pictures captured in cameras is far hard for the vehicle to function optimally in negative climate conditions.

In [12], they have experimented in different traffic scenario where the distant obstacles can be detected by the radar sensors alone. Radars have an added advantage of securing rich data. This developed model was successful in long range detection and it also gave accurate results in diverse weather conditions despite of having a noisy data. Main reason for noise is because the information collected from the environment by the sensors are in raw form. In order to remove this noise an innovative technique called as clustering technique was opted. They have also inferred that radar sensors can offer only a limited resolution which turned out to be major drawback of the system. These sensors produced images which were blurry and it was not able to differentiate between colours of the object. This led to problem in taking decisions pertaining to the movement of the vehicle.

III. BASIC REQUIREMENTS TO DESIGN A CAR

After detailed study about autonomous vehicle, technology and other components required for this protocol to be developed are identified. This paper aims to create a protocol that specifies how autonomous car can share their sensor data and use information to collaboratively optimize traffic and increase overall safety. The tests for the protocol will be performed on a simulated environment. The below mentioned block diagram gives the overall description of the project to be developed.

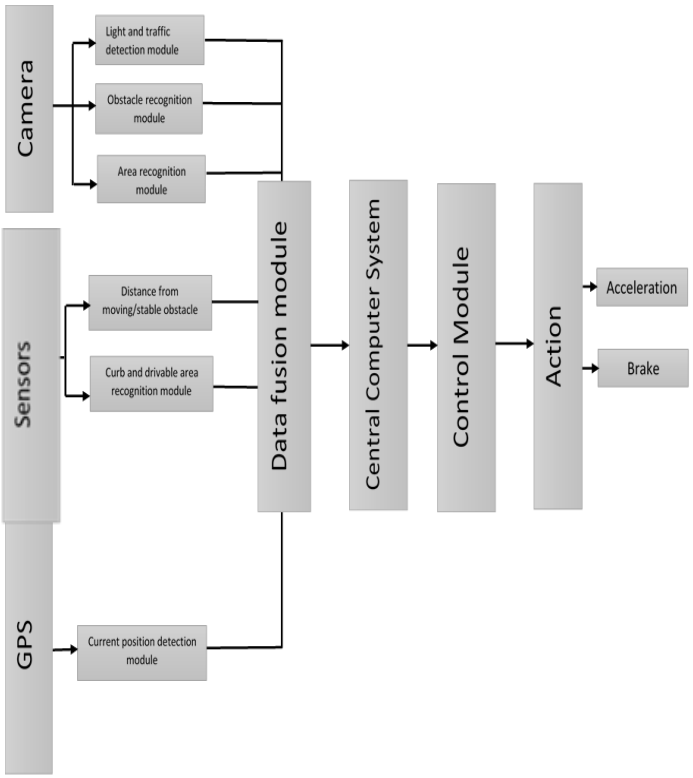

Fig. 1. Block diagram of Autonomous Car.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 05, May-2021

Figure 1 can be explained as follows

- The system will be designed in such a way that it starts from a position A and reaches the destination i.e., position B, by traversing through the destined path and also by checking various other conditions.
- Raw information collected from pi-camera, sensors and GPS is used to choose the correct route to reach the destination.
- Data fusion module is used to integrate all the information collected from individual source.
- Central computer system consists of Raspberry-Pi and Arduino UNO which is capable of exchanging data with sensors and fast enough for calculating millions of data per second. Few gear motors are used to control the car and these motors can be controlled Arduino UNO.
- The control module changes the processed information in a way such that the bot can understand.
- It is further connected to action module which further helps in actuating the robot efficiently.

IV. CONCLUSION

There is an immense scope in the field of autonomous cars in the future. Numerous automobile companies are improvising the model and design of autonomous car by rapidly making more and more changes to the present model to make them further accurate and secured. All the papers cited above explains about the proposed solution will help us to route the map accurately such that it should travel from start position to end position without any hassle by performing operations such as plane detection, traffic control, speed control, obstacle recognition etc. The protype is implemented by using Raspberry Pi 3b+.

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