AUTONOMOUS CARS USING RASPBERRY Pi

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Abstract: *It is for an online comprehensive solution to manage internet banking. Autonomous cars are the future smart cars anticipated to be efficient and crash avoiding ideal urban car of the future. The purpose of the project is to build up a car which can move with any driver. It just need a command from the user and then it will start moving towards the destination. The project aims to build a autonomous car prototype using Raspberry Pi processor. Sensor interfacing is used to provide necessary data from the real world to the car. The car is capable of reaching the given destination safely and intelligently thus avoiding the risk of human errors. Many existing algorithms like traffic light detection, obstacle detection and speed control are combined together to provide the necessary control to the car. The technology that autonomous cars and "connected vehicles" use would allow the vehicles to communicate with roadside infrastructure like traffic lights and road congestion, and then use this information to curtail fuel consumption and emissions significantly.*

Key Words: Connected vehicles, Navigation system, Obstacle detection, Path planning, Sensors

1. INTRODUCTION

An autonomous car refers to a computer-controlled car that can guide itself, familiarize itself with surroundings, make decisions, and fully operate without any human interaction. The primary drivers behind the emergence of autonomous cars include: the need for driver and driving safety, growth in population, expanding infrastructure, increase in the number of vehicles, the need for efficient time management, and resource utilization and optimization.

The evolution and emergence of autonomous cars are the result of remarkable research results coming from the fields of wireless communication, embedded systems, navigation, sensor and ad hoc network technologies, data acquisition and dissemination, and data analytics.

The idea of autonomous cars started with "phantom autos" in the 1920s, where the car was controlled through a remote control device. In the 1980s, we witnessed the emergence of self-sufficient and self-managed autonomous cars. A major contributor to the autonomous car field was the NavLab at Carnegie Mellon University, where researchers developed the Autonomous Land Vehicle (ALV). In the same decade, the "Prometheus project," sponsored by Mercedes in 1987, achieved a major result with the design of their first robotic car to track lane markings and other vehicles. In the 21st century, the increasing interest in autonomous cars has been fueled primarily by low-cost, high-performance technologies in various areas.

As the human population grows and the number of cars increases, this creates a stressful impact on our transportation infrastructure, ranging from roads and parking spaces to fuel stations (for fuel engines vehicles) and charging stations (for electric and hybrid vehicles). In the past few decades, governments have taken serious measures for road safety, with many introducing both static and dynamic technologies such as closed-circuit television (CCTV) cameras, road sensors, and more.

However, despite these efforts, in the United States alone, road accidents caused more than 32,000 fatalities in 2014. The number of fatalities increased to more than 35,000 in 2015, demonstrating that despite the use of existing technologies, human errors still occur.

The traffic conditions in developing countries, like India, are more complex owing to varied road conditions, a heterogeneous mix of vehicles and chaotic traffic. Since India is a developing country there is a constant requirement for good quality transportation, infrastructure, and services.

Roads in India normally have speed breakers so that the vehicle's speed can be controlled to avoid accidents, because of our system we also have undefined potholes (formed due to heavy rains and movement of heavy vehicles) which created immediately after of completion of the road. It is a major reason for traumatic accidents and loss of human lives.

To minimize human errors and reduce life-threatening situations on the road, alternative technologies such as connected cars and autonomous cars are being explored.

2. LITERATURE SURVEY

2.1 Autonomous Cars: Research Results, Issues, and Future Challenges- Rasheed Hussain ;Sherali Zeadally [1]

Throughout the last century, the automobile industry achieved remarkable milestones in manufacturing reliable, safe, and affordable vehicles. Because of significant recent advances in computation and communication technologies, autonomous cars are becoming a reality. Already autonomous car prototype models have covered millions of miles in test driving. Leading technical companies and car manufacturers have invested a staggering amount of resources in autonomous car technology, as they prepare for autonomous cars' full commercialization in the coming years. However, to achieve this goal, several technical and nontechnical issues remain: software complexity, real-time data analytics, and testing and verification are among the greater technical challenges; and consumer stimulation, insurance management, and ethical/moral concerns rank high among the nontechnical issues.[1] Finally, to enable cost-effective, safe, and efficient autonomous cars, we discuss several challenges that must be addressed (and provide helpful suggestions for adoption) by designers, implementers, policymakers, regulatory organizations, and car manufacturers.

2.2 An Autonomous Driving System for Unknown Environments Using a Unified Map -Inwook Shim; Jongwon Choi; Seunghak Shin [2]

There have been significant advances in self-driving cars, which will play key roles in future intelligent transportation systems. In order for these cars to be successfully deployed on real roads, they must be able to autonomously drive along collision-free paths while obeying traffic laws. In contrast to many existing approaches that use prebuilt maps of roads and traffic signals, we propose algorithms and systems using unified map built with various onboard sensors to detect obstacles, other cars, traffic signs, and pedestrians. The proposed map contains not only the information on real obstacles nearby but also traffic signs and pedestrians as virtual obstacles.[2]Using this map, the path planner can efficiently find paths free from collisions while obeying traffic laws. The proposed algorithms were implemented on a commercial vehicle and successfully validated in various environments, including the 2012 hyundai autonomous ground vehicle competition.

2.3 Short Term Traffic Prediction for Edge Computing Enhanced Autonomous and Connected Cars- Shun-Ren Yang ; Yu-Ju Su ; Yao-Yuan Chang ; Hui-Nien Hung [3]

Autonomous and connected cars (ACCs), together with edge computing (EC), have been recognized as a promising solution to achieve green intelligent transportation for smart cities. This paper aims to address short-term traffic prediction, a fundamental enabler for the success of ACC applications, under the European Telecommunications Standards Institute multi-access EC (MEC) architecture that exhibits constraints different from conventional cloud computing. First, a data-centric experiment platform is designed and implemented to facilitate traffic prediction algorithm development. This paper further proposes a novel short-term traffic prediction model that integrates a traffic light model and a vehicle velocity model, considering limited computing resources of MEC servers. We note that the effects of traffic lights are complicated and have not been rigorously examined in most, if not all, of the related work. This work models the queueing time when a driver arrives at a road intersection and faces a red light. Moreover, to forecast the vehicle velocity, we propose a novel low-complexity semiparametric prediction model considering periodic features and spatial/temporal correlations of dynamic road events. The experiment results demonstrate that our vehicle-velocity prediction model achieves almost equivalent accuracy to the well-known Long Short-Term Memory Neural Network model, requiring much lower computational complexity. [3]

2.4 Road profile recognition for autonomous car navigation and Navstar GPS support- W. Holzapfel; M. Sofsky; U. Neuschaefer-Rube [4]

Autonomous car navigation based on updating dead reckoning (DR) by road profile recognition (RPR). The navigation system requires sensors to detect changes in altitude and driving direction which are installed in modern cars for different purposes (e.g. ABS sensors).[4]The layout of the navigation system is discussed and simulations are carried out over driving distances of approximately 150 km on the basis of realistic road data and ordinary sensor accuracies. Positioning errors of lower than 10 m (standard deviation) are observed. To achieve this accuracy the synchronization error between measured and mapped data must be continually estimated. The introduced navigation method is ideal to complete present commercial car navigation systems using Navstar GPS.

2.5 RFID-based autonomous mobile car- Jen-Hao Teng; Kuo-Yi Hsiao; Shang-Wen Luan [5]

Radio Frequency Identification (RFID) system is looked upon as one of the top ten important technologies in the 20 th century. Industrial automation application is one of the key issues in developing RFID. Therefore, this paper designs and implements a RFID-based autonomous mobile car for more extensively application of RFID systems. The microcontroller of Microchip PIC18F4550 is used to control the autonomous mobile car and to communicate with RFID reader.[5] By storing the moving control commands such as turn right, turn left, speed up and speed down etc. into the RFID tags beforehand and sticking the tags on the tracks, the autonomous mobile car can then read the moving control commands from the tags and accomplish the proper actions. Due to the convenience and non-contact characteristic of RFID systems, the proposed mobile car has great potential to be used for industrial automation, goods transportation, data transmission, and unmanned medical nursing etc. in the future.

2.6 Autonomous parallel parking of a car-like mobile robot by a neuro-fuzzy behavior-based controller- M. Khoshnejad; K. Demirli [6]

The concept of sensor-based behavior is used to design a neuro-fuzzy control system for a car-like-mobile-robot. The problem addressed is the parallel parking in a rectangular constrained space with just one backward maneuver. To accomplish the autonomous fuzzy behavior control, the car-like-mobile-robot has trained to park in just 2 parking dimensions based on the training data obtained from sensor information generated offline by adopting a fifth-order polynomial as the reference trajectory. The proposed controller is an ANFIS architecture that generates turning angle as output. As long as the states (positions and orientations) of the robot are measurable at each discrete-time step during the control process, this controller can make the robot follow feasible trajectories by just knowing the initial configuration of the robot and park successfully at the prescribed goal position.[6]The simulation results which are based on real dimensions of a typical car demonstrate the feasibility and effectiveness of the proposed controller in practical car maneuvers.

2.7 Design of multifunctional autonomous car using ultrasonic and infrared sensors - Ayesha Iqbal; Syed Shaheryar Ahmed [7]

The daily routine problems that common man faces on roads while commuting are becoming a serious problem with each passing day. People get late and meet accidents. The model of autonomous car presented in this research paper aims to solve these issues by taking humans off the wheels, so that they do not have to drive anymore and the risk of accidents, getting late and traffic congestions can be reduced to a minimum. This car is able to follow the track, overtake other cars, detect obstacles, take sharp bends and turns, follow traffic signals and turn on its lights under low light conditions. [7]Circuit diagrams for performing all these functions have been presented and the mechanical model of the car has also been shown in the paper, which is practically implemented and successfully run by the authors.

3. METHODOLOGY

The four key technologies in self-driving car, namely, car navigation system, path planning, environment perception and car control, are addressed and surveyed. The automatic control, architecture, artificial intelligence, computer vision and many other technologies are integrated into the self-driving car, which is a product of the highly developed computer science, pattern recognition and intelligent control technology.

Car Navigation System-During self-driving, two issues, which are the current location of the car and how to go from the location to the destination, must be resolved. Certainly, the above two issues can be solved by a human's own knowledge in human driving. However, in self-driving, the car must be able to automatically and intelligently locate its position and perform the path planning to destination. For this objective, the on-board car navigation system is deployed on the self-driving car.

Location system-The main purpose of the location system is to determine the vehicle location, which generally can be classified into relative location, absolute location and hybrid location. For relative location, the current position of self-driving car is obtained by adding the moving distance and direction to the prior position.

Electronic map (em)-EM is used for digital map information storage, which mainly includes geographical characteristics, traffic information, building information, traffic signs, road facilities, etc. It is expected that special EMs for self-driving, such as automatic road sign recognition, car's driving information interacting among self-driving cars, will be developed in the future.

Global Path Planning-It is used to determine the optimal driving path between the start point and end point. Generally, the typical path planning algorithms, such as Dijkstra algorithm, Bellman-Ford algorithm, Floyd algorithm and heuristic algorithm (Seshan and Maitra, 2014) are employed to fuse the EM information and calculate the optimal path.

4. BLOCK DIAGRAM

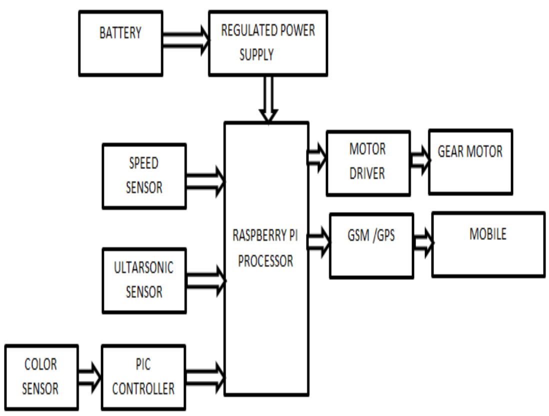


Fig 4.1 Block Diagram of Autonomous Cars

WORKING PRINCIPLE

Block diagram for Autonomous cars is shown in fig 4. The proposed system is prototype function of autonomous car with multiple objective, like potholes detection, traffic light detection and speed regulation in school zone. For the above functions are implemented with Raspberry pi processor and various sensors. The robot arrangement is implemented for the car setup with Gear motor. Ultrasonic sensor is used to detect the humps and potholes. Color sensor is to detect the traffic lights. For example, when it detects the red light, the car stops. This speed sensor indicates the speed at which the car is actually travelling. It is used to control certain handling systems, as well as certain braking systems. It is controlled by a signal generator that is spun, and makes an electrical pulse that is then sent to the vehicle's computer. Zigbee communication is used to identify the school zone. So the car slows down at the schools. Gsm sends the message through the mobile phone to concerned person.

4.1 Raspberry Pi Proccessor:

The Raspberry Pi is a credit card-sized single-board computer. There are currently five Raspberry Pi models in market i.e. the Model B+, the Model A+, the Model B, the Model A, and the Compute Module (currently only available as part of the Compute Module development kit). All models use the same SoC (System on Chip - combined CPU & GPU), the BCM2835, but other hardware features differ. The A and B use the same PCB, whilst the B+ and A+ are a new design but of very similar form factor. The Compute Module is an entirely different form factor and cannot be used standalone. The project aims to build a monocular vision autonomous car prototype using Raspberry Pi as a processing chip. In this project, we have used the model B Rev 2. It comprises of a 512 MB RAM model with two USB ports and a 10/100 Ethernet controller. It is powered by USB and the video output can be hooked up to a traditional RCA TV set, a more modern monitor, or even a TV using the HDMI port. This gives you all of the basic abilities of a normal computer. It also has an extremely low power consumption of about 3 watts.

4.2 PIC microcontrollers

They are a family of specialized microcontroller chips produced by Microchip Technology in Chandler, Arizona. The acronym PIC stands for "peripheral interface controller," although that term is rarely used nowadays. A typical microcontroller includes a processor, memory, and peripherals. PIC microcontrollers are the worlds smallest microcontrollers that can be programmed to carry out a huge range of tasks. These microcontrollers are found in many electronic devices such as phones, computer control systems, alarm systems, embedded systems, etc. Various types of microcontrollers exist, even though the best are found in the GENIE range of programmable microcontrollers. These microcontrollers are programmed and simulated by a circuit-wizard software. Every PIC microcontroller architecture consists of some registers and stack where registers function as Random Access Memory(RAM) and stack saves the return addresses.

4.3 ULTRASONIC SENSORS

Ultrasonic sensors (also known as transceivers when they both send and receive, but more generally called transducers) evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. In this project, they are used to detect the distance of obstacles from the car. It has been used in vehicles to support drivers with their driving tasks like parking.

4.4 SPEED SENSORS

The wheel speed sensor was initially used to replace the mechanical linkage from the road wheels to the speedometer, eliminating cable breakage and simplifying the gauge construction (elimination all moving parts except for the needle/spring assembly). With the advent of automated driving aid, such as electronic ABS, the sensor also provided wheel speed data to the controllers to assist the operator in maintaining control of the vehicle. The vehicle Speed sensor is also used for the proper shifting up of gears for the vehicle maintenance.

4.5 COLOR SENSOR

Color can be a useful feature in autonomous vehicle systems that are based on machine vision, for tasks such as obstacle detection, lane/road following, and recognition of miscellaneous scene objects. Unfortunately, few existing autonomous vehicle systems use colour to its full l extent, largely because colour-based recognition in outdoor scenes is complicated, and existing colour machine vision techniques have not been shown to be effective in realistic outdoor images.

4.6 GEAR MOTOR

The DC geared motor is used here to control the movement of the robot and help in carrying the robot to the desired area. The gear assembly helps in increasing the torque and reducing the speed of the shaft. It can operates on 24.0 volt, 250mA with no load condition at speed of 150rpm.

4.7 MOTOR DRIVER

Motor drivers acts as an interface between the motors and the control circuits. Motor require high amount of current whereas the controller circuit works on low current signals. So the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor.

4.8 GSM/GPS

GSM (Global System for Mobile communication) is a digital mobile network that is widely used by mobile phone users in all the parts of the world. GPS is a space-based satellite navigation system. It provides location and time information in all weather conditions, anywhere on or near the Earth. GPS receivers are popularly used for navigation, positioning, time dissemination and other research purposes. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection. A GSM modem can also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. GSM modem is usually preferable to mobiles.

4.9 POWER SUPPLY

A power supply is an electrical device that supplies electric power to an electrical load. The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power. Examples of the latter include power supplies found in desktop computers and consumer electronics devices.

Other functions that power supplies may perform include limiting the current drawn by the load to safe levels, shutting off the current in the event of an electrical fault, power conditioning to prevent electronic noise or voltage surges on the input from reaching the load, power-factor correction, and storing energy so it can continue to power the load in the event of a temporary interruption in the source power.

4.10 Battery

Battery is used for required power supply needed for operating the different components in the robot. Here we used a 12v dry cell Re-chargeable battery for the purpose. Lithium-Polymer (Li-Po) Battery, 3 Cell (3S) 11.1V2200MAH, Very small in size and weight, Connector Plug:XT60 connector, Discharge Current: 25*2200maH=55Amp.

5. FLOWCHART

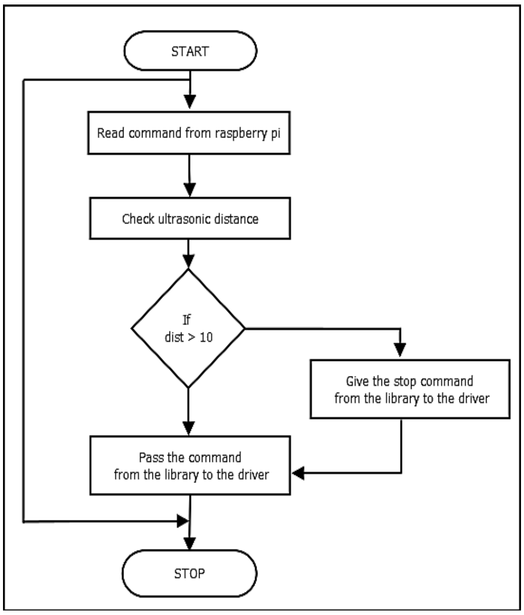
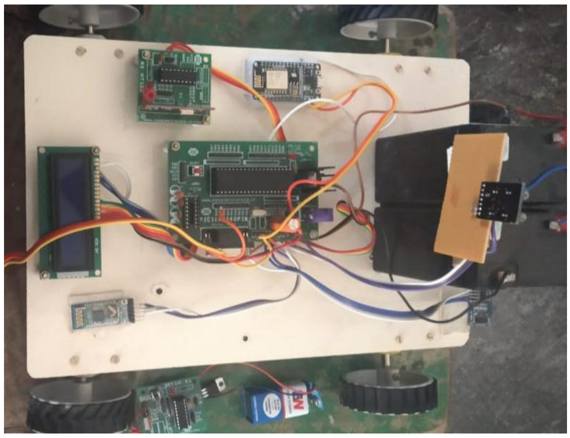


Fig 5.1 Flow Diagram for Autonomous car

6. RESULT



7. CONCLUSION

In this paper, a method to make a self driving car is presented. The different hardware components and their assembly are clearly described. Driverless car revolution which aims at the development of autonomous vehicles for easy transportation without a driver. For the economy, society and individual business this autonomous technology has brought many broad implications. Cars that drive themselves will improve road safety, fuel efficiency, increase productivity and accessibility; the driverless car technology helps to minimize loss of control by improving vehicle's stability as they are designed to minimize accidents by addressing one of the main causes of collisions: Driving error, distraction and drowsiness. The algorithm mention in this paper has been successfully implemented in prototype of Autonomous car.

8. FUTURE ENHANCEMENT

The work could be enhanced by improving the algorithm by adding advanced machine learning to it. Multi layered processors can be used for fast processing. The present obstacle detection algorithm just detects the obstacle and stops, but in future it can be improved by the avoiding the obstacle, and go through another way using advanced obstacle detection algorithm.

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