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Smart Automobile for Indian Roads

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Abstract

Objective: To propose a system design for an autonomous vehicle in order to tackle the rising road accidents and vehicle safety issues. **Method:** A detail study of the various intelligent systems used by the existing manufacturers of autonomous vehicles and drawing out a statistical data of where these systems lack to adapt to certain situations. An attempt to discover new findings which can tackle these issues of dynamic adaptation, unguided self-training and adaptability to roads in India. **Findings:** Stereoscopic vision is used to get input from environment on which image processing algorithms are applied to obtain the improved response time for autonomous vehicle. Using ANMLP (Artificial Neural Network for Multi Language Processing) algorithms to train and guide the system to learn and understand behavior patterns dynamically. **Improvements:** The Autonomous Vehicle shows greater adaptability to dynamic environments compared to previous versions. This in turn helps it to drive on roads where there might be unorganized traffic scenarios like in some rural parts of India.

Keywords: Automobile, Autonomous, Obstacle Detection, Self-Driving, Ultrasonic Sensors

1. Introduction

The smart automobile/ the autonomous car is one step towards smart city and is applicable for all the handicap people especially blind people and is suitable for all day to day transport activities. The motive behind the whole concept of the driverless car was to avoid accidents that take place now days in large numbers. According to the statistics of 2014, the[1] death rate of people due to accidents in the US was around 32,000 each year. In India itself, the count was around 13,976. Use of these Smart Automobiles on the roads could reduce at least half of these accidents; it could save up to 16,000 lives each year. Also, the handicapped and older public can avail to long distance transport without relying on a third person say, a driver. All they would have to do is set the destination on the GPS and the car will take them to that destination.

With the continuous progress and evolution in information technology and rising demands of safe travel, it is necessary to find better and innovative systems to aid the human life and make it easier. There has been a tremendous growth in the technologies involving self-driving cars including LIDAR (Light Detection and Ranging) to Image Processing techniques which has led self-driving car to become a reality in 2016.

Self-Driving cars are applicable in a lot of areas including Industrial transport, Public transport, Military ammunition supply and Ambulances. The industrial applications include all the conveyer activities being done in industries for goods transportation in intra infrastructure of the industries. Public transport for intra cities such as cabs can be replaced with Smart Cabs which will help increase strict obedience of traffic rules and decrease the number of accidents taking place in India especially due to cabs and also

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ensure safety and security of passengers travelling in night especially females.Self-driving ambulances may help focus paramedicson treating patients in an emergency

It would help enforce many of the constraints for efficient and reliable road transport such as:

Fuel conservation can be done at maximum by efficient driving techniques and speed limits

Strict obedience of traffic rules especially in India as many of the human drivers ignore and neglect the traffic rules such as not following of traffic signal lights, improper lane keeping, not following of speed limits especially in city areas, blowing horns in horn restricted areas such as near educational institutes and organizations etc.

Efficient use of parking space can be achieved using autonomous cars as they include automated parking algorithms and sensors to avoid collision with other parked vehicles which will in turn increase space for parking.

There is an increased demand for these cars in India itself. This is due to the careless attitude of drivers (in the city, as well as on highways and mountain passing). As of 2014, [1]deaths due to speeding reached a count of 57,844 while that due to overloaded trucks on highways totalled up to 36,543 deaths. Hence, introduction of these self-governing and self-driving smart automobiles in India will help reduce this death toll as well as aid in day to day activities like long distance goods transport, disciplined driving and so on. Autonomous cars will soon be a reality; the only question is how quickly, as the number of technologies involved for its implementation is growing day by day.

Autonomous cars have been said to be the next big innovation in coming years in India, it is supposed to have a massive social impact in all kind of fields.

According to[1], who is a specialist in transportation and urban growth at the University of South California[1] say that for approximately every two generations, they would reconstruct the transportation infrastructure in their cities in a way that will shape the vitality of the neighborhoods; the settlement patterns of our cities and countryside; and our economy, society and culture" and as everyone believes self-driving cars are the new big change everyone is talking about. It will not only impact environment such as by improvement in fuel economy. It would help decrease the fuel consumption by 20% to 30% approx.

In paper titled [2] "How Google's self-driving car works" stated the key functions or objectives for the self-driving vehicles. This included the implementation of LIDAR systems for 360% image production and mapping, obstacle detection systems to avoid collisions with other cars. It also explained the parking assistance systems and most importantly the lane keeping management which is carried out by the self-driving car itself without human interference. Guizzo's research findings also showed a couple of backdrops like the high cost of LIDAR systems which in turn increases the cost of vehicles implementing LIDAR sensors and the self-driving car's inefficiency in adapting to dynamically changing environments. Most of the time the environment and infrastructure like roads, speed breakers, traffic signal lights, and addition of new lanes makes it difficult to adapt itself to changing environments as it requires prior knowledge of the roads and its infrastructure for autonomous driving.

In study done by[3] ideas and possibilities of autonomous vehicles being able to detect and avoid obstacles and analyze and estimate the nearby objects or obstacles. The major problem with this finding was the unreliability of the complete system due to its sole dependence on only RADAR sensors. It makes it inefficient as sole reliance on a single system may cause collision with other vehicles if it fails to detect an object.

According to[4] enlightened 2 new advancements in the driverless vehicle's capacity to sense and navigate the environment and also manipulate the car's speed using a 'Wheel Speed Sensor' and Radar sensors along with a navigation system built to strongly support the autonomous behavior or the driverless car. This research will help coping with the speeds of other non-autonomous vehicles to avoid collision with each other in heavy road traffic areas. The wheel speed sensor works on an image processing algorithm along with radar sensors.

On the other hand, city traffic can be a problem for the self-driving vehicles and safety is a major issue of the current era. This has always been a big concern for the developers of the driverless car, on how to make the car safer for city travel. In[5] presented ideas on using VANET systems for intra-vehicular and inter-vehicular communications in their research paper[5].Their research showed great potential as networking of autonomous vehicles will help self-learning which can be used by other vehicles in similar situations, intra-vehicular communication will help increase safety and security of the vehicle by automatic checking and communication between all the modules used for autonomous vehicles implementation, although it was only applicable in areas where sensors and VANET (Vehicular network) systems were deployed.

In the research by[6], how the driverless car can perform computerized or automatic lane-keeping and make suitable decisions while running on high speeds on highways. This survey also showed the system's dependency on semi-automated cars only, which can evolve to support the fully-automated systems too.

It was stated in the research paper on that the[7] driverless vehicles need an efficient and fail proof framework to handle and govern the control unit and statistical analysis of surroundings and obstacles. The car needs to perform auto computation of any obstacles that might occur and perform actions accordingly while the control framework which handles all the self-governing capability of the driverless car.

In research done by 1998 to showcase their ideas and developments on [8]making the driverless cars truly driverless by proposing auto steering of the passenger vehicle using magnetic sensors while, it also showed research on how the car will be controlled while turning on corners with accuracy just like any human driver.

While we all know that GOOGLE is the current leading manufacturer of autonomous vehicles, they have experimented it in a limited area before deploying the autonomous self-driving vehicle in a campus where these machines or say cars are trained to recognize and understand road signs, road markings, etc. This test was conducted and the vehicle travelled approximately 140,000 miles[9].

Thus, from all these research findings and ideas it can be derived that the motivation behind smart automobiles has been going on since a long time, and it is not just a myth but a promising vision. Autonomous vehicles will soon be a future of India and help to tackle many concerns related to road traffic infrastructure such as avoidance of accidents, not following of traffic rules etc.

Autonomous Vehicles developed till date do not possess dynamicity and are not capable of successful deployments in Indian traffic road infrastructure. But given the available human resource and rapidly evolving technology we can hope to see Autonomous Vehicles running on Indian Roads either as Public Transport such as Cabs, buses, autorickshaws etc., as Industrial conveyer transport vehicles and inventory supplying trucks, or as an aid to the specially abled people and as Paramedic Vehicles etc.

2. Proposed System Architecture

The proposed system architecture for the autonomous vehicle contains the following elements are shown in Figure 1:

- **Obstacle Analyzer**: This module analyzes the obstacles to avoid collision using Radar, ultrasonic, IR, sensors and image processing techniques the output of the block is sent as an input to Steer Control and Management block.
- **Location Mapper:** The location mapper takes GPS and DGPS as an input. GPS serves as a location for long distance and DGPS serves as a differential factor for analyzing small turns and curves of the roads helping the vehicle smoothly taking turns and keeping lanes.
- **Park Assist:** The parking assistance module is used to compute data using sensors such as ultrasonic and IR sensors and generate a way to park a vehicle the efficiently using lesser space for parking.
- **Steer Control and Management:** It serves as control unit for decision making and driving the vehicle considering inputs from various modules such as park assistance, image processing, location mapper etc.
- Once the car begins moving, the front facing cameras capture and forwards all the images of the path, lanes, road signs, pedestrians, etc. to the Image processing module to be analyzed and steering the car accordingly.
- The radars monitor for any obstacles and other cars to avoid collision and efficient traffic management.
- The ultrasonic sensors aid the car during park assist and overtaking.
- All this data is sent to the Control Unit which will analyze and send out signals for performing approriate actions to the car, accordingly.
- The control unit/ automation software of the smart automobile initially gathers information of the source and destination to map a path between them which the car can follow. This is achieved using the GPS and DGPS module.

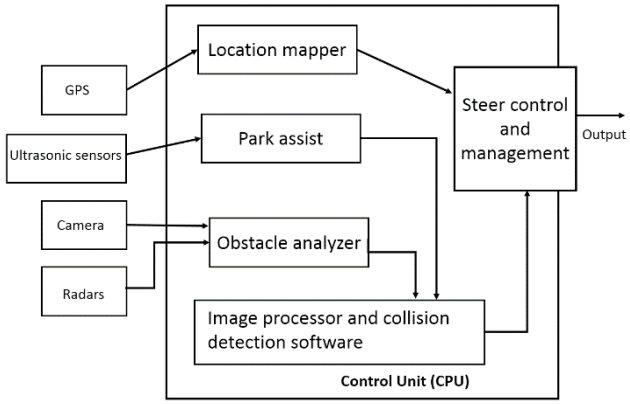

Figure 1. System Architecture.

2.1 Sequence Flow

The sequence of events that take place in the vehicle's lifetime while it travels from the source to the destination can be understood using the sequence diagram is shown in Figure 2.

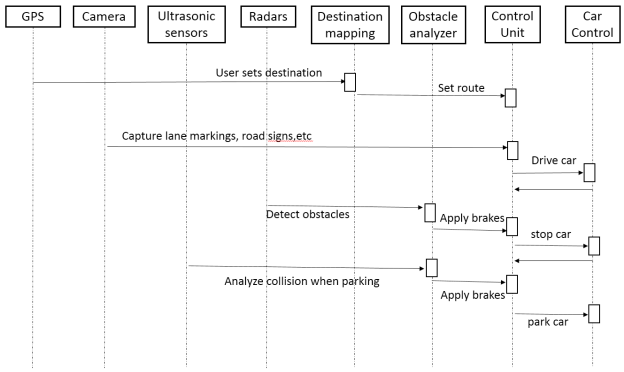

Figure 2. Sequence Diagram.

The sequence diagram depicts an approximate sequence of how exactly signals will be sent from every input module to the analyze and control software which in turn performs suitable operations like drive, stop or apply brakes and parking of the smart automobile.

3. Methodology

3.1 Mathematical Model

This mathematical model described using the set theory as a superset S which consists of 3 subsets namely:

Therefore, S= {I, O, F}

I = {set of inputs provided to or acquired by the system}, O = {set of outputs to state the corresponding response given by the various modules or the system as a whole}

F = {a set of functions or software modules used for acquisition, processing and generating suitable responses and/or corresponding actions of the proposed system}.

Consider a set T = {T1, T2…..Tn} that contains all the devices that provide data and signals to the processor.

Let set T1 = {images captured via camera}

Let set T2 = {object 1 detected via radars and sensors}

Similarly T2, T3…. Tn contain 'n' objects that are detected by the various collision detection modules.

Therefore T= T1 ∪ T2∪ T3 ∪ ….. ∪ Tn.

T= {T1, T2, T3…….. Tn}

Thus set T ⊆ I.

Let set Q be the set of signals generated from each element of set T.

Q = {captured sensor/radar inputs, pathway images, camera feed, source location, destination location}

Thus Q ⊆ T.

Hence input set I= {T, Q}.

Let a particular set D contain all the analyzed values after processing the inputs and generating corresponding actions say D1, D2….. up to Dn.

D= {collision prevention, computer generated and guided path from source to destination, hands free transportation, traffic awareness of vehicle while in motion, safe travel}

Therefore D ⊆ O.

A set E points to the control software that actually drives the car, makes it stop or perform other actions.

E= {move car (forward, reverse), turn (left/right), stop car, adjust velocity}

Hence the output set O= {D, E}.

Now, all the collected inputs that are to be processed and analyzed are to be performed via some user defined functions. The functions belong the set F = {F1, F2…. Fn} for n user defined functions.

Hence F= {image processing module, obstacle detection module, lane_keeping(), path_monitor(), collision avoidance module, self-drive module, location_mapper() }

Thus, the overall system follows the above mentioned subsets for its working and this is combines in one single superset that is set S={I,F,O}. Using these I/O and functionality models, the SMART Automobile is to be designed to achieve its objectives.

3.2 Algorithm

- User starts the car engine.
- Pre-initialization checks are performed on startup.
- Validate all the modules and sensors and wait for input from user.
- User sets source & destination data via GPS.
- The GPS sends this data to location mapper module.
- The control unit draws or maps a path to be followed by automobile.
- Pass data from steps 2, 3 and 4 to steer control and management software.
- Initialize traffic-awareness, obstacle detection module.
- Automobile should start moving accordingly.
- Camera constantly captures images of the road signs, lanes, street lights to image processor.

- Sensors and radars notify control unit about oncoming obstacles.
- Take suitable actions for lane-keeping, collision avoidance and safe driving.
- Notify driver on reaching destination.
- Initiate park assist module.
- Stop engine.

4. Conclusion

In conclusion, there are many strong socio-economic motivators for adopting the smart automobiles such as human safety, infrastructure efficiency, quality of life, physically challenged people as they can use self-driving car for their commuting. These are just a few of the key concerns that will help to make autonomous car a reality. With the rapid growth in technology the existing as well the emerging manufacturers of this automobile will ensure a reliable and quality performance. These features combined with strong economic motivators are sure to overcome such obstacles. The future will surely include autonomous vehicles in India too.

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