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Methods for Time to Time Control of Self-Driving Cars: A Review

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***Abstract*—**In this paper, researcher explain different methods used for autonomous cars or self-driving cars are explained such as Lane detection, Path planning, computer vision and Sensors. In India there are lots road accidents due to human errors. Self-driving cars can reduce the amount of road accidents, but the majority of people cannot afford costly cars, so keeping that in mind self-driving car should be made at low cost. Sensors cost less among all other methods discussed in this paper, so in India using Sensor technology for self-driving cars can be the best method.

Keywords*-Self-Driving **Car**;Path Planning; Edge Detection; Lane Detection*

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I. INTRODUCTION

According to a survey in last year total numbers of road accidents in India were 4, 80, 652. In that 1, 50, 785 had lost their lives and 4, 94, 624 were seriously injured. The reasons for so many accidents are mainly because of drink and drive, overtaking a car, rash driving and breaking traffic rules. So, to avoid these problems Self-Driving cars will be the exact solution. Self-Driving car is useful to reduce accidents rate, it helps to decrease traffic as rules are followed, physical disable or elderly persons can travel alone along with this it maintains speed limit on road.

Basically, Self-driving car is driver-less or robotic car which uses navigation and sensors without human interruption. It uses multiple technologies like Radar, Lidar, GPS, computer vision, Convolutional Neural Network (CNN), Artificial Intelligence(AI), Lane Detection, Vehicle Detection and Infra Sensing. To develop a system for automatic driving car image recognition with machine learning and neural network technologies are applied. Generally, computer vision, sensor fusion, deep learning, path planning, actuator and localization are the concepts used for self-driving car [9].

A. Control Mechanism

Automatic functioning of self-driving car is based on six major concepts; the block diagram of it is show in figure 1.1.The block diagram includes computer Vision: focuses on how computers can understand human vision from digital images or videos at high-level, Sensor Fusion: collects images and videos from two or more cameras and combines two dimensional images and videos and calculate depth information, Deep Learning: a part of machine learning method based on learning data representations, Path Planning: is most important part of self-driving car system to find a shortest or optimal path between two points. It reduces amount of time by identifying amount of turning and breaking, Actuator system: a part of machine which moves or controls a system, Localization: determines the robots ability to identify its own position and plan a path towards the destination [9].

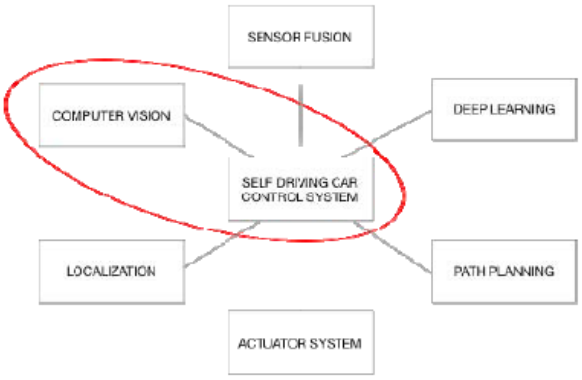

Figure 1.1 Block diagram of self-driving car
[Source adapted from [9]]

II. LITERATURE REVIEW

for self-driving car sensing technique is one of the important technique. Sensors are embedded into robots and its performance is checked. For detecting object coming in its travel way, sensing techniques are used. Sensors are mostly used in detection because installation is simple, they cost less and consume less energy. Sensing techniques are useful in

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measuring short distance obstacles and not much effective in measuring long distance objects.

In sensing technique model Raspberry pi operating system is used. Time-division multiplexing technique is used in this embedded system. For processing the data from sensor is collected and is stored in memory. The software is coded in Python 2.7 for IR sensing system. This technique allows sensor to maintain and detect further vehicle smoothly and follows ahead vehicle at maintained distance. Less than 5% errors are maintained in following distance. These techniques are used in major companies like Tesla, Mercedes-Benz, etc.

Sensor techniques are using in self-driving car, data collection is necessary. To identify objects coming in travel way data collection is necessary. But Data collection can consume a lot of time as each data has to be taken again, so to avoid this datasets method is used.

All sensors unstructured data are inserted in a disk. This saved is used for testing algorithms. For testing purpose mostly, data sets are used.

Path planning is also one of important method or concept in autonomous cars. In changing environment algorithms which work faster in execution. Heuristic searching, artificial intelligence and model-based methods are different path planning methods.

Most efficient method in this is model based method. Online trajectory generation and selection are the algorithms based on model method which is useful in dynamic or changing environment.

In Path detection or planning there might be lots of obstacles which are called as threat probability area. So, detection of vehicle state and threat probability is necessary. From the length of obstacle threat can be predicted. Obstacle size is based on width of rectangle. Rectangle is enlarged as velocity is increased. Trajectory evaluation is done by calculating threat probability area and distance from centerline. Selection is done on low total cost. Collision occurrence is based on time when car and obstacle are parallel at same time. To avoid collision obstacle is detected quickly and path is planned again with algorithms.

The importance of computer vision in the self-driving car is the computer vision is developing and progressing at high level. In this process human behavior is taken into consideration, due to these objects and relationships are detected to make right decisions at a proper time. Through human behavior visions can be implemented in realistic way. Perception-driven method and end-to-end method are vision concepts used now-a-days.

Perception-driven method takes the realistic views from human consideration to get traffic scenes, lane boundaries, pedestrians, cars, traffic signals and sign boards. This method lacks self-learning, plans are needed to be worked manually.

End-to-end method consists of convolutional neural networks (CNN) and GPU technology. It learns image features automatically and handles steering accurately. It maps images directly to control direction which is more effective. It learns from human behavior and only needs vision data. The idea is inspired from the human brain.

In object detection methodology the obstacles can occur in any shape and distance, to detect those objects Histogram Oriented Gradients (HOG) feature is used. These study focuses on detection of pedestrians for images, then further focuses to detect humans and then animals and vehicles. This method is implemented by cutting images into smaller parts called as cell. How to detect objects and how to trace performance of detected objects are the main problems in this method.[5]

End to end model is used to maintain the car in a proper lane using steering angle. To get the output of steering angle the convolution neural network (CNN) model is used with image frames as input.

A traditional way to self-driving causes problem such as lane detection, path planning and steering control whereas end to end model provides directly steering the vehicle using front view camera data after training. In short end to end learning is based on human vision data [10].

Lane detection algorithms are used to detect road whether it is straight, curve or turning. The process of lane detection is First captured the image then separate the color till the mask region and at end implement the canny edge detection using Hough transform for lane recognition.

Color Selection: In this phase work is based upon image the image will be separated into image captured then, color selection until the region masking

Region masking: Hough transformation is used to identify lines of image, position of arbitrary shapes after selection of region masking [9].

III. METHODOLOGY

There are many methodologies in self-driving car. In that mostly used methods are End-to-end learning, Path planning, Lane detection, IR Sensing. These methods are used by using latest technologies like Convolutional Neural Network (CNN), Artificial Intelligence (AI) and Embedded System.

End-to-end learning:

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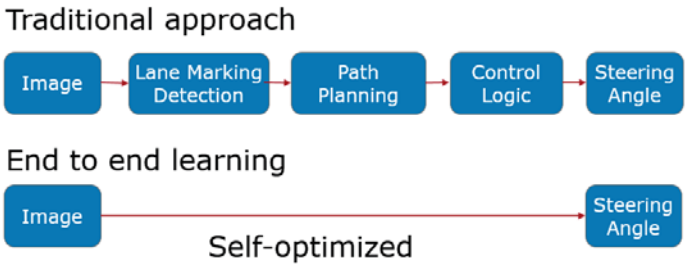
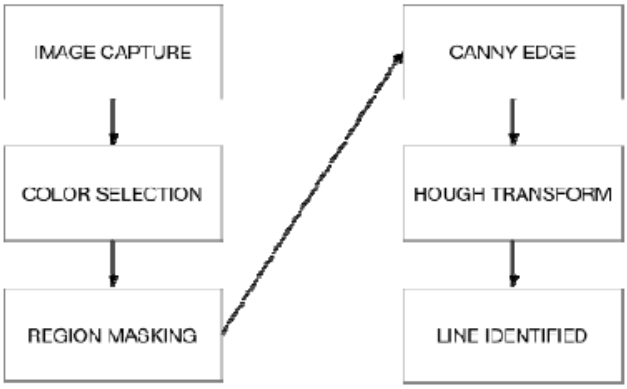


Figure 3.1 Comparison between the traditional approach and end-to-end learning
[Source adapted from [10]]

In End-to-end learning phases of traditional approach are skipped using convolutional neural network which makes lane detection faster and easy. End-to-end method connects image and steering angle directly. Raw image is taken as input and it gives output as control signal automatically. In this technique model has no defined rules manually and is self-optimized on training information.[10]

Lane Detection:



. 3. Flowchart image processing for lane detection

Figure 3.2 Flowchart image processing for lane detection
[Source adapted from [9]]

In Lane Detection method, image selection is one of the important phase which uses edge detection technique. For image processing, image analyzing, image pattern recognizing, and computer vision techniques edge detection is the most important step. After selection of image, color selection is necessary. Color selection is done till region is being masked. Through Hough transform technique image analysis, computer vision and digital image processing is done which helps in identifying lane or path.

Convolutional neural network (CNN) finds objects from images which helps in lane detection. Warping, filtering, detecting road lane and De-warping are the parts of road lane detector. [9]

IR Sensing method: For IR Sensing method embedded system is much important to store data objects. The embedded system is based on Raspberry Different sensor techniques are used for dynamic environments or in different lights such as day, night and fog.[5]

IV. Research Finding

Technologies like path detection, computer vision, End-to-end learning are developing rapidly and are progressing extensively in autonomous cars but the problem with this techniques is that they cost much, as high definition cameras, embedded systems and computer visions or robots are used. So, it is not much applicable in India as everyone can't afford. But this can be overcome with Sensing techniques which are cost efficient and easy to install. Sensing techniques doesn't cost much as data are already gathered through human vision and the technique works on human behaviors. Sensing technique can help a lot to make autonomous cars in India as it can be affordable. Other techniques are much efficient then sensing technique but this technique can be combined and enhanced in future like model-based planning which consists of path planning, selection, human vision and sensing technique.

V. Conclusion

IR Sensing technique can be the best among all as a target object is followed smoothly and obstacles are found easily and quickly maintaining a headway. There are less than 5% of errors with this technique in travel way. By comparing with other research papers, we can say that sensors are best because of its low cost and easy to install. Using of two or three sensors can also be done to achieve great results. Enhancement needs to be done for real time environment such as fog which will help it to use sensors in any weather condition. Model based Path planning is also a technique which is much useful in path re-planning if any collision occurs. By implementing some techniques together greater results can be achieved. Major companies like Mercedes-Benz, Ford, etc are trying to launch autonomous cars by 2021. And this autonomous car could reduce lots of accidents which will be very useful in India, as now-a-days rate in car accidents have been increased due to human errors.

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