MARRI LAXMAN REDDY GROUP OF INSTITUTIONS

MLR INSTITUTE OF TECHNOLOGY

(UGC AUTONOMOUS)

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Laxman Reddy Avenue, Hyderabad-500043, Telangana, India

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MAJOR PROJECT REPORT

ON

SELF DRIVING CAR

Submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

MECHANICAL ENGINEERING

By

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This is to certify that the Major Project report entitled "**SELF DRIVING CAR"** is the Bonafede work carried out and submitted by

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To the Department of Mechanical Engineering, MLR Institute of Technology Hyderabad, In Partial fulfilment for the award of **BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING** during the academic year 2021-2022.

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ABSTRACT

Self-driving cars have received a lot of attention in recent years and many stakeholders like Google, Uber, Tesla, and so forth have invested a lot in this area and developed their own autonomous driving car platforms. The challenge to make an autonomous car is not only the stringent performance but also the safety of the passengers and pedestrians. Even with the development of technologies, autonomous driving is still an active research area and still requires a lot of experimentations and making architecture entirely autonomous. The intriguing area of self-driving cars motivates us to build an autonomous driving platform. In this document, we discuss the architecture of the self-driving car and its software components that include localization, detection, motion planning and mission planning. We also highlight the hardware modules that are responsible for controlling the car. Autonomous driving is running state-of-the-art algorithms used in localization, detection, mission and motion planning.

An autonomous car is a self-driving vehicle that can perceive the surrounding environment and navigate itself without human intervention. For autonomous driving, complex autonomous driving algorithms, including perception, localization, planning, and control, are required with many heterogeneous sensors, actuators, and computers. To manage the complexity of the driving algorithms and the heterogeneity of the system components, this document applies distributed system architecture to the autonomous driving system and proposes a development process and a system platform for the distributed system of an autonomous car. This document introduces different levels of automated driving functions according to the SAE standard and derives requirements

on sensor technologies. Subsequently, state of the art technologies for object detection and identification as well as systems under development are introduced, discussed and evaluated given their suitability for automotive applications.

Overview

The overview of this project is to implement a driverless car, which is an autonomous vehicle that can drive itself from one point to another point without any assistance from the driver. One of the main impetuses behind the call for driverless cars is for safety. An autonomous vehicle is fundamentally defined as a passenger vehicle. An autonomous vehicle is also referred to as an autopilot driverless car or AGV most prototypes that have been built so far perform automated steering that was based on sensing the painted lines in the road or magnetic monorails which are embedded in the road.

Purpose

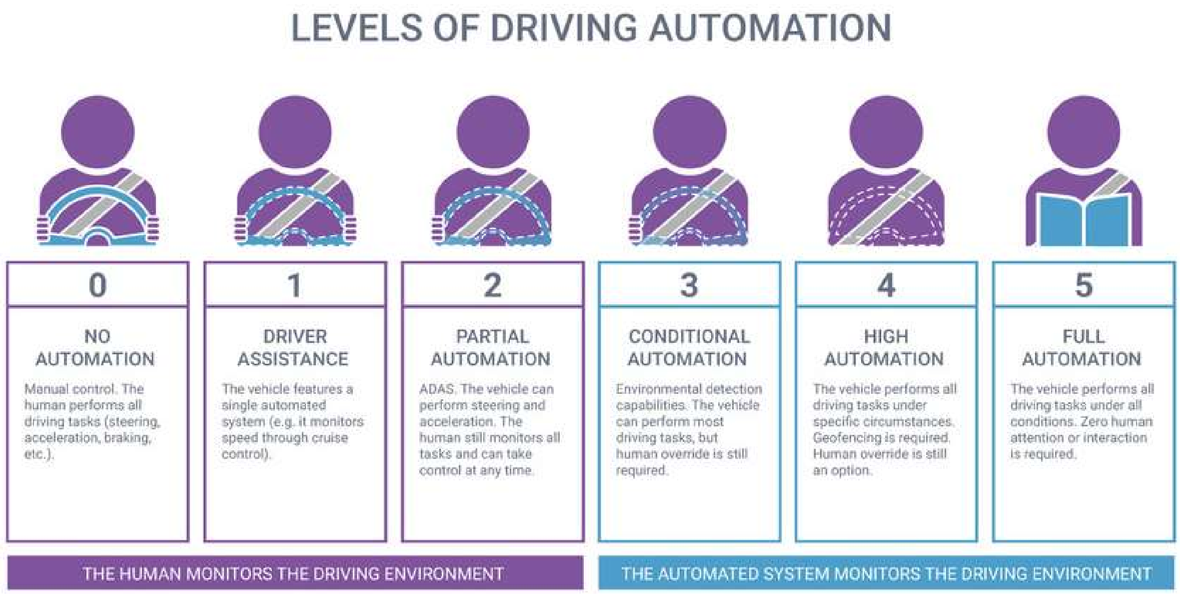
The purpose of the current work is to study and analyse driverless car technology. This mobility is usually taken for granted by most people and they realize that transportation forms the basis of our civilization. The need for a more efficient, balanced and safer transportation system is obvious. This need can be best met by the implementation of an autonomous transportation system.

Chapter 1: INTRODUCTION

1.1 What is an autonomous car?

An autonomous car is a vehicle capable of sensing its environment and operating without human involvement. A human passenger is not required to take control of the vehicle at any time, nor is a human passenger required to be present in the vehicle at all. An autonomous car can go anywhere traditional cargoes and do everything that an experienced human driver does.

The Society of Automotive Engineers (SAE) currently defines 6 levels of driving automation ranging from Level 0 (fully manual) to Level 5 (fully autonomous). These levels have been adopted by the U.S. Department of Transportation.

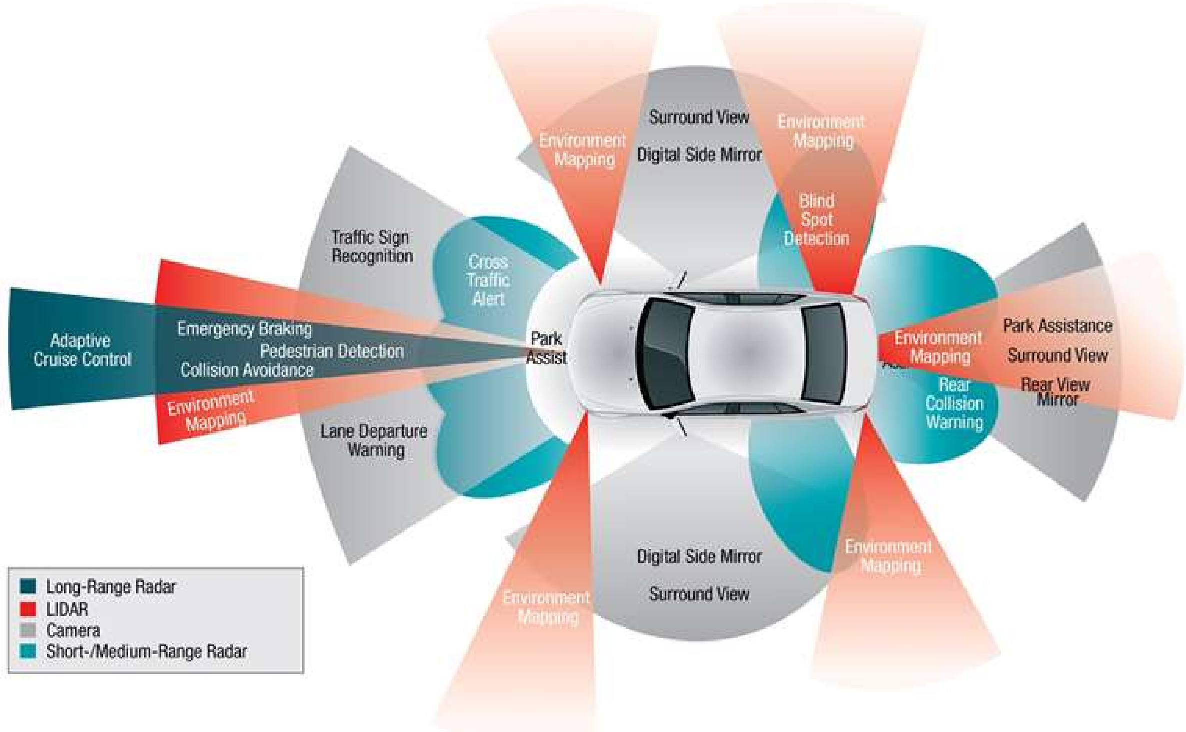


1.2 How does an autonomous car work?

Autonomous cars rely on sensors, actuators, complex algorithms, machine learning systems, and powerful processors to execute software.

Autonomous cars create and maintain a map of their surroundings based on a variety of sensors situated in different parts of the vehicle. Radar sensors monitor the position of nearby vehicles. Video cameras detect traffic lights, read road signs, track other vehicles, and look for pedestrians. Lidar (light detection and ranging) sensors bounce pulses of light off the car's surroundings to measure distances, detect road edges, and identify lane markings. Ultrasonic sensors in the wheels detect curbs and other vehicles when parking.

Sophisticated software then processes all this sensory input, plots a path, and sends instructions to the car's actuators, which control acceleration, braking, and steering. Hard-coded rules, obstacle avoidance algorithms, predictive modelling, and object recognition help the software follow traffic rules and navigate obstacles.



Chapter 2: LITERATURE SURVEY

1. Self-driving Car Researches from DARPA Urban Challenge 2007

One of the major milestones in the technology of self-driving cars in an urban environment was the DUC in 2007. The competition's purpose was to test the ability of vehicles to drive between checkpoints while respecting the California traffic code. This required exhibiting behavior, such as maintaining the lane, intersections priority, parking, queuing, merging, and passing or overtaking. Six teams completed the event which showed that fully autonomous urban driving was possible. The first winner of DUC was the Tartan Racing team from Carnegie Mellon University with an autonomous vehicle called "Boss". Tartan Racing team completed the DUC challenge in 4 hours 10 minutes. The CMU Boss vehicle used variational techniques for making local trajectories in structured environments and lattice graphs in 4-dimensional configuration space (including position, velocity, and orientation) together with Anytime D* to find obstacle-free paths in car parks. However, in the navigation strategy, Boss made two mistakes in determining that he needed to turn U, so the Boss had to travel an additional 3.2 km which was not needed . The second winner of DUC was the Stanford Racing team from Stanford University with an autonomous vehicle called "Junior". The Stanford team used a search strategy called Hybrid A* which, during the research, lazily built a tree of motion primitives by recursively applying a finite set of maneuvers. The search was guided by a carefully crafted heuristic and the sparsity of the tree was ensured by keeping only one node in a given region of the configuration space. The robot was able to demonstrate the merging, the management of the intersections, the navigation in the parking lots, the change of lane, and the autonomous half-turns The third winner of DUC was the VictorTango team from Virginia Tech with an autonomous vehicle called "Odin". The VictorTango team built a graph discretization of the possible maneuvers and searches the graph with the A* algorithm. During the competition, Odin was able to drive several hours without human intervention, negotiate intersections of stop signs, merge into and across traffic, pass through the parking lot, and maintain the speed of the road. The team that completed the DUC in the fourth position was the MIT team with an autonomous vehicle called "Talos". MIT used a variant of the RRT algorithm called RRT closed-loop with biased sampling. A key innovative aspect of the MIT system, compared to many other teams, was that autonomous decisions have been made based on locally sensed perception data, in preference to pre-specified map data where possible. Another innovative aspect was the use of a powerful and general-purpose RRT-based planning and control algorithm that meets the requirements of lane driving, three-point turns, parking, and maneuvering across fields of obstacles with a single unified approach. The other two teams that completed the DUC challenge were The Ben Franklin Racing Team from the University of Pennsylvania with an autonomous vehicle named "Little Ben" and a Cornell team from Cornell University with an autonomous vehicle named "Skynet". It was noted several incidents of collisions between vehicles on this DUC.

2. Self-driving Car-Research from Google

Google is the most famous in the autonomous domain. Autonomous car technology research by Google began in 2005. In 2008, Google AV with Pribot from Levandowski was able to deliver pizzas across the California Bay Bridge to San Francisco-Oakland. In 2009, Google's autonomous vehicle project was led by Sebastian Thrun, who also led the Stanford University team and won the 2005 DARPA Grand Challenge with his "Stanley" car. Google's autonomous car has become an independent company called Waymo. Waymo's autonomous car uses a RADAR to detect distant objects and their speed, a LIDAR to create a detailed map of the world around the car, and high-resolution cameras to acquire visual information, such as the red or green traffic signal. Google’s autonomous car first driving license was issued in Nevada, the USA in May 2012. By the end of 2014, the eight-car Google’s autonomous project was tested over 700,000 kms covered an urban road, a highway, a mountain road, various roads, and no proactive accidents occurred.

3. Self-driving Car-Research from Vislab

In July 2013, an autonomous car developed by the Artificial Vision and Intelligent Systems Laboratory (VisLab) of the Parma University, Italy, drove around the old district of the city of Parma without any human participation. The autonomous car successfully passed the roundabout, the single two-lane, recognized the pedestrians crossing the road, recognized the traffic lights, and so on. In 2010, a driverless van made the longest journey approximately 13,000 kilometers within three months, which began in Italy and ended in China. In 2013, a driverless test program called PROUD-Car Test was organized by Vislab. It can be seen that a car with no one in the driver's seat can move successfully on a mixed traffic route (rural, highway, and urban) open to public traffic. In 2014, a new driverless vehicle called Deeva was designed with a similar appearance to that of a normal vehicle.

4. Self-driving Car Researches from Tesla

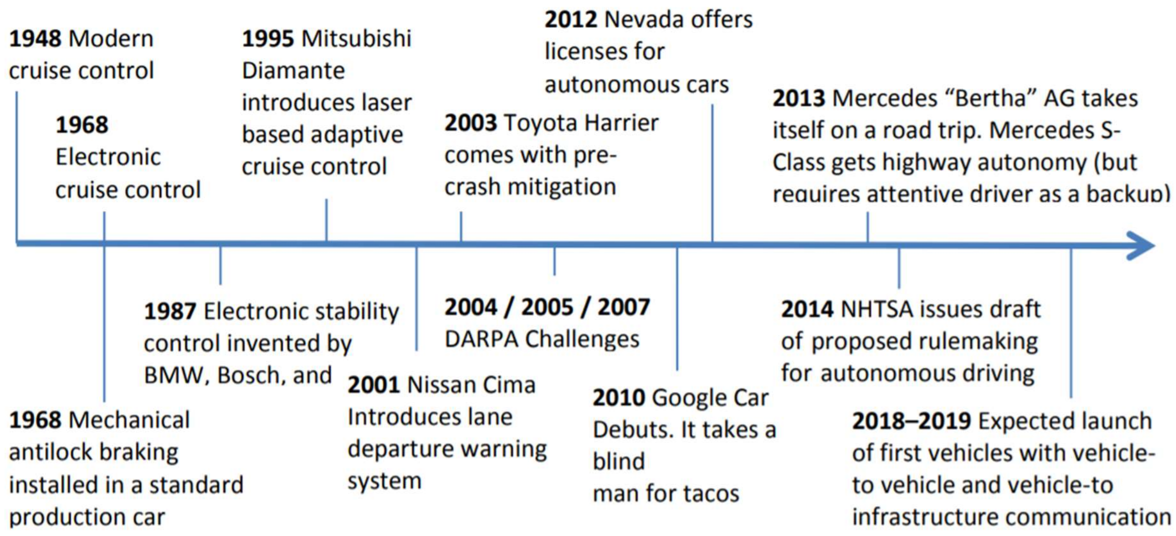
In 2015, Tesla Autopilot introduced: freeway driving, in a ramp to off-ramp, and Tesla summon released. In 2016, all Tesla models were built with appropriate hardware for SAE level 5 capabilities: steering and acceleration/ deceleration, monitor environment, fallback performance, capability in all driving modes. Tesla plans 90% autonomous cars for the public which is expected to have an 'autopilot' feature which would make the '90% autonomous' travel possible. INCITEST 2019 IOP Conf. Series: Materials Science and Engineering 662 (2019) 042006 IOP Publishing doi:10.1088/1757-899X/662/4/042006 4

5. Self-driving Car-Research from NuTonomy

One autonomous vehicle that has been socialized to the public is an autonomous economy. Taxi cars NuTonomy operates in a 6 km area on Singapore's One-North technology business district. NuTonomy car provides three main buttons, namely "Manual", "Pause" and "Autonomous". Singapore's One-North technology business district has a challenging complexity for autonomous cars. There are many pedestrians and although traffic tends to be stable, sometimes there are dangerous traffic situations. All of them provide opportunities for autonomous cars to learn about environmental conditions. Navigation priority from nuTonomy uses three priority sequences. The priority is "do not hit pedestrians", the second priority is "do not hit other vehicles", the third priority is "do not hit objects". Things that are not prioritized are like "not crossing the center line", or "giving a comfortable trip". NuTonomy cars will try to follow all traffic rules at all times but are allowed to violate less important rules. This autonomous car uses the RRT* path planning algorithm to evaluate many potential path alternatives based on data from other cameras and sensors. The decision-making algorithm will evaluate each of these pathways and choose the path that best matches the priority of the rules above. Most autonomous car companies use machine learning. Machine learning algorithms have been used successfully for many autonomous cars. Indeed, NuTonomy uses machine learning algorithms to interpret sensor data, but not in decision making. This is so that the reason for making choices made by the machine can be known. If using machine learning as a decision-maker, it is feared that it cannot be believed what decision-making behaviour will be carried out because machine learning is like a black box. The ability to explain what an autonomous car will do will greatly help the trust of users and the government in permitting them to operate autonomous cars nuTonomy.

6. Self-driving Car-Research use Deep Reinforcement Learning

While the traditional approach of planning and control is the current mainstream in the autonomous vehicle system, learning-based approaches have emerged and have attracted increased interest from researchers. In practice, these optimization-based approaches work quite well. Kendall demonstrates the first application of deep reinforcement learning for a self-driving car. From randomly initialized parameters, the model can learn the path strategy using a single input monocular image. The general reward setting is the distance travelled by a vehicle without the human driver taking control.



Chapter 3: PROJECT OVERVIEW

- Detect highway lane lines on a video stream.
- Use OpenCV image analysis techniques to identify lines, including Hough Transforms and Canny edge detection.
- Build and train a deep neural network to classify traffic signs, using TensorFlow.
- Experiment with different network architectures.
- Perform image pre-processing and validation to guard against overfitting.
- Build and train a convolutional neural network for end-to-end driving in a simulator, using TensorFlow and Keras.
- Use optimization techniques such as regularization and dropout to generalize the network for driving on multiple tracks.

- Build an advanced lane-finding algorithm using distortion correction, image rectification, colour transforms, and gradient thresholding.
- Identify lane curvature and vehicle displacement.
- Overcome environmental challenges such as shadows and pavement changes.
- Create a vehicle detection and tracking pipeline with OpenCV, histogram of oriented gradients (HOG), and support vector machines (SVM).
- Implement the same pipeline using a deep network to perform detection.
- Optimize and evaluate the model on video data from an automotive camera taken during highway driving.
- Simulate lidar and radar measurements are used to detect a bicycle that travels around your vehicle.
- Use Kalman filter, lidar measurements and radar measurements to track the bicycle's position and velocity.

Chapter 4: MACHINE LEARNING

AI (ML) is the investigation of PC calculations that improve consequently through experience. It is viewed as a piece of man-made brainpower. AI calculations construct a model dependent on example information, known as "preparing information", to settle on forecasts or choices without being expressly customized to do so.AI calculations are utilized in a wide assortment of utilizations, for example, email sifting and PC vision, where it is troublesome or unworkable to create traditional calculations to play out the required undertakings.

A subset of AI is firmly identified with computational insights, which centres around making forecasts utilizing PCs; yet not all AI is measurable learning. The investigation of numerical advancement conveys techniques, hypotheses and application areas to the field of AI. Information mining is a connected field of study, zeroing in on exploratory information examination through unaided learning. In its application across business issues, AI is additionally alluded to as a prescient investigation.

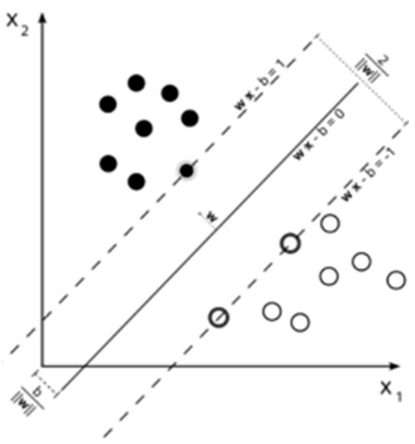
MACHINE LEARNING APPROACHES

AI approaches are generally partitioned into three general classifications, contingent upon the idea of the "sign" or "input" accessible to the learning framework:

SUPERVISED LEARNING

Supervised learning calculations assemble a numerical model of a bunch of information that contains both the sources of info and the ideal outputs. The information is known as preparing information and comprises a bunch of preparing models. Each preparation model has at least one data source and the ideal yield, otherwise called a supervisory sign.

In the numerical model, each preparation model is addressed by an exhibitor vector, now and then called an element vector, and the preparation information is addressed by a network. Through iterative advancement of a goal work, regulated learning calculations gain proficiency with a capacity that can be utilized to foresee the yield related to new inputs. An ideal capacity will permit the calculation to accurately decide the yield for inputs that were not a piece of the preparation information. A calculation that improves the exactness of its yields or expectations after some time is said to have figured out how to play out that task.



A support vector machine is a supervised learning model that divides the data into regions separated by a linear boundary. Here, the linear boundary divides the black circles from the white.

Kinds of supervised learning calculations incorporate dynamic learning, order and regression. Classification calculations are utilized when the yields are confined to a restricted arrangement of qualities, and relapse calculations are utilized when the yields may include any mathematical incentive inside a reach. For instance, for a characterization calculation that channels messages, the info would be an approaching email, and the yield would be the name of the organizer were to document the email.

Likeness learning is a region of managed AI firmly identified with relapse and grouping; however, the objective is to gain from models utilizing a similitude work that estimates how comparable or related two items are. It has applications in positioning, proposal frameworks, visual character following, face check, and speaker confirmation.

UNSUPERVISED LEARNING

Unsupervised learning calculations take a bunch of information that contains just data sources and discover structure in the information, such as gathering or grouping of information focuses. The calculations, hence, gain from test information that has not been marked, arranged or classified. Rather than reacting to criticism, unaided learning calculations recognize shared traits in the information and respond dependent on the presence or nonappearance of such shared characteristics in each new piece of information. A focal utilization of unaided learning is in the field of thickness assessment in insights, for example,

finding the likelihood thickness function.[41] Though unsupervised learning includes different spaces including summing up and clarifying information highlights.

Bunch examination is the task of a bunch of perceptions into subsets (called groups) so perceptions inside a similar group are comparative as per at least one predesignated model, while perceptions drawn from various groups are disparate. Diverse bunching methods make various suppositions on the design of the information, frequently characterized by some similitude metric and assessed, for instance, by inward smallness, or the closeness between individuals from a similar group, and partition, the contrast between bunches. Different strategies depend on assessed thickness and diagram network.

Chapter 5: COMPONENTS

LIDAR SENSOR

Fig: Lidar sensor

The LIDAR (Light Detection and Ranging) sensor is a scanner. It will rotate in the circle. It is fixed on the top of the car. The scanner contains the 64 lasers that are sending the surroundings of the car through the air. This laser is hits objects around the car and again comes back to it. By these known How far that objects are from the car and also it calculates the time to reach that object. These are can see in the monitor in a 3D object with the map. The monitor is fixed in the front seat. “The heart of the system generates a detailed 3D map of the environment (Velodyne 64- beam laser). The map is accessed from the GPRS connection.

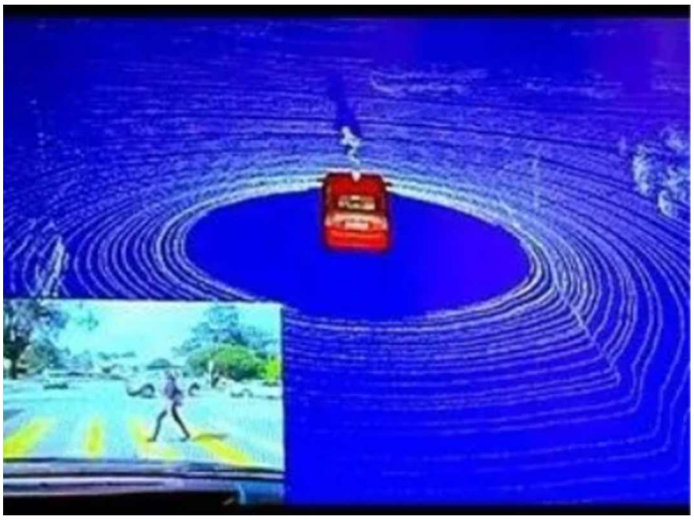


Fig: Road

RADAR SENSOR

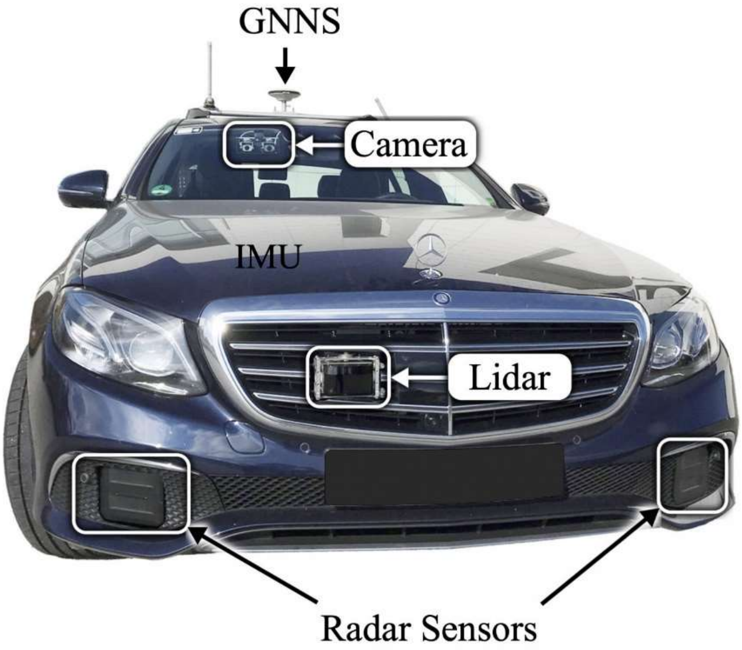


Fig: Radar Sensor

The three RADAR sensors were fixed in front of the bumper and one in the rear bumper. These will measure the distance to various obstacles and allow the systems to reduce the speed of the car. The backside of the sensor will locate the position of the car on the map.

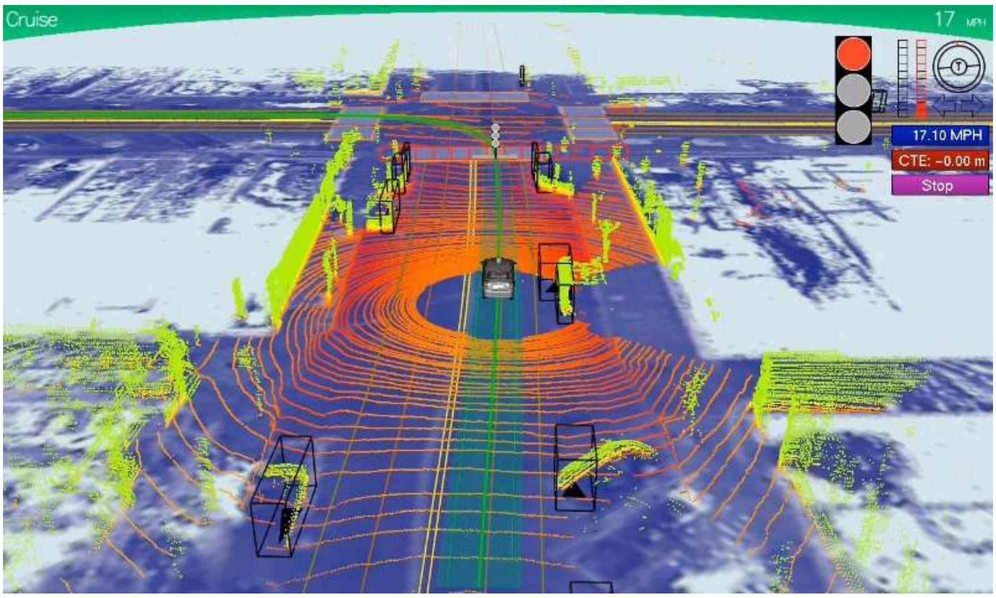


Fig: Front and backside of the road

For example, when the car was travelling on the road then RADAR sensor was projected on road from and backside of the car

VIDEO CAMERA

The video camera was fixed near the rear-view mirror. That will detect traffic lights and any moving objects in front of the car. For example, if any vehicles or traffic detected then the car will be slow down automatically, these all will be done by the artificial intelligence software only.

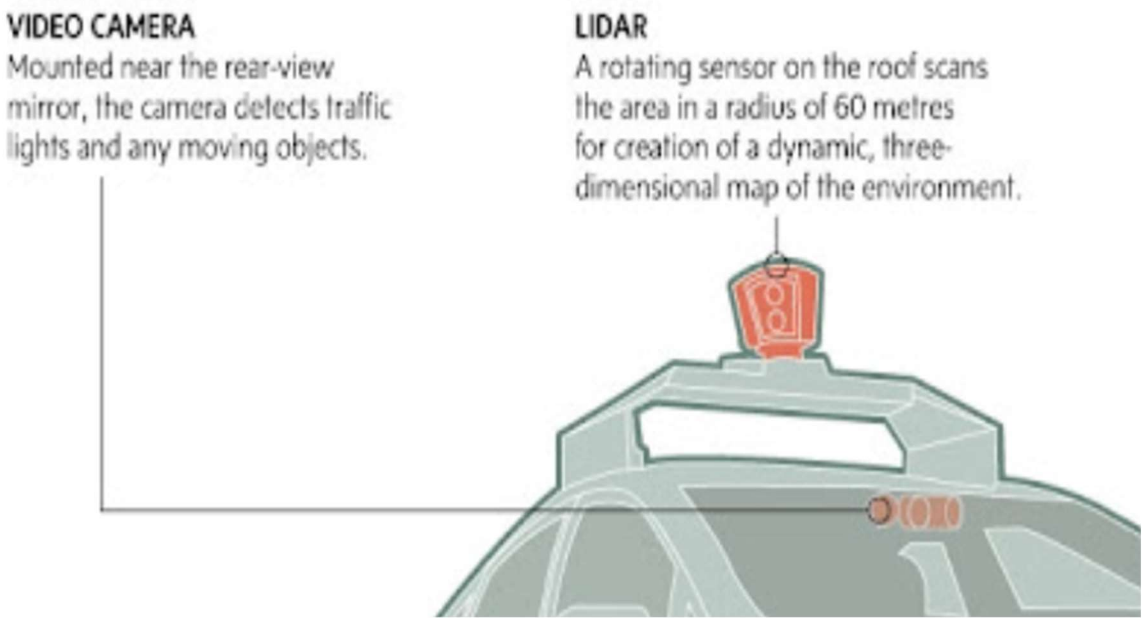


Fig: Video Camera

By that, the computer will recognize moving obstacles like pedestrians and bicycles. Its position on the map. The position of the car can be seen on the monitor.

POSITION ESTIMATOR

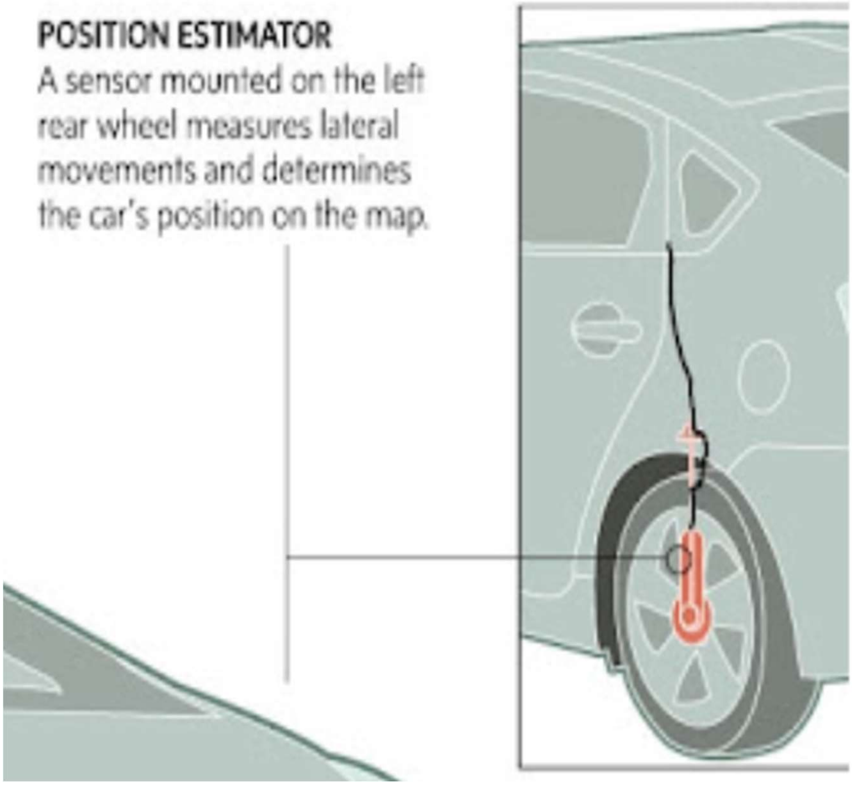


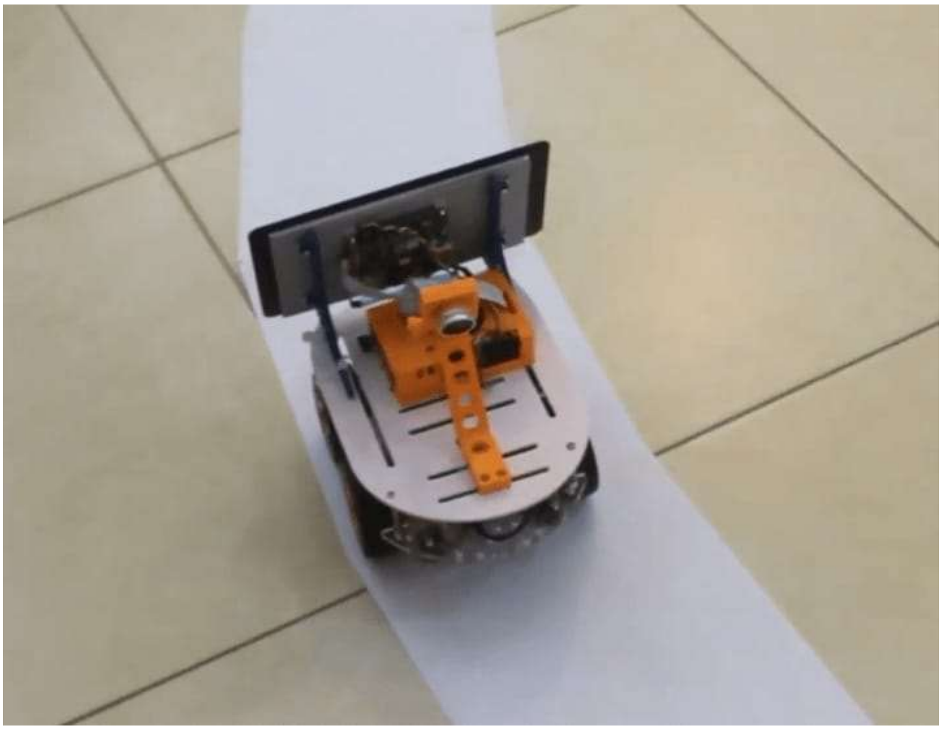
Fig: Position Estimator

A sensor is mounted on the left rear wheel. By these sensors only measures small movements made by the car and help to accurately locate its position on the map. The position of the car can be seen in the mirror.

Chapter 6: PROJECT ELEMENTS

Lane finding:

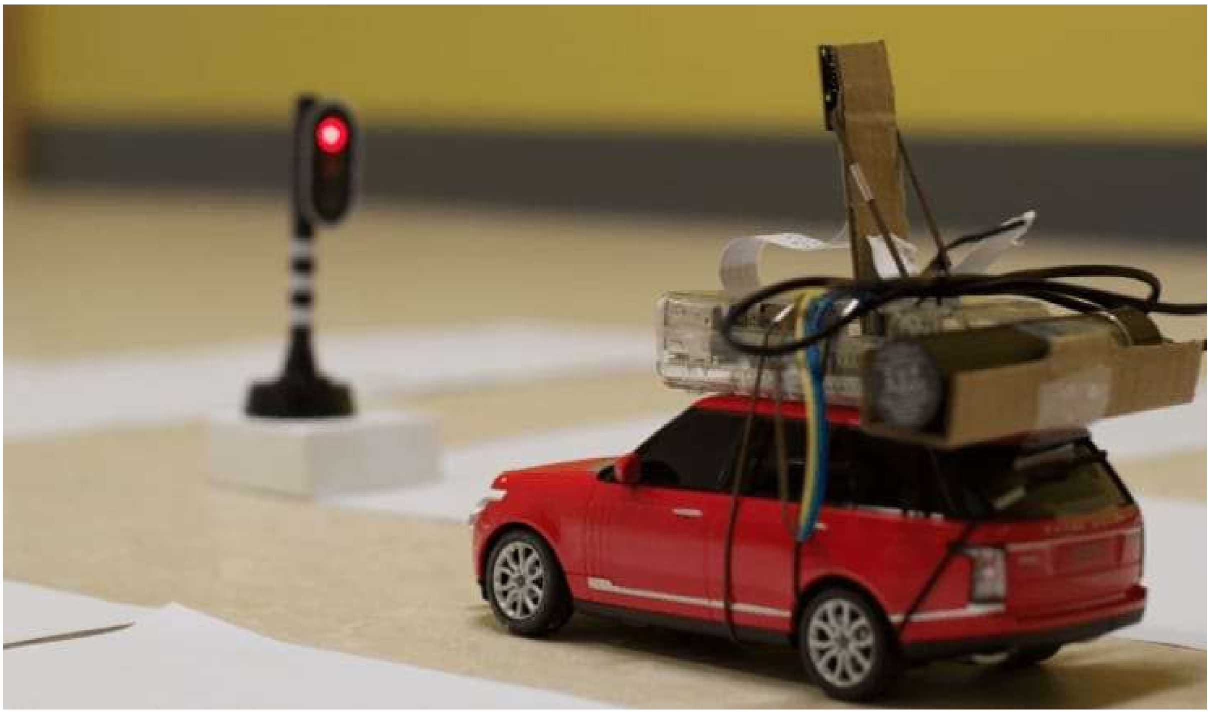
The goal of this project element was to create a simple pipeline to detect road lines in a frame taken from a roof-mounted camera.



Increasing safety and reducing road accidents, thereby saving lives is one of great interest in the context of Advanced Driver Assistance Systems. Apparently, among the complex and challenging tasks of future road vehicles is road lane detection or road boundaries detection. It is based on lane detection (which includes the localization of the road, the determination of the relative position between vehicle and road, and the analysis of the vehicle Silas heading direction). One of the principal approaches to detect road boundaries and lanes using a vision system on the vehicle. However, lane detection is a difficult problem because of the varying road conditions that one can encounter while driving. In this paper, a vision-based lane detection approach capable of reaching real-time operation with robustness to lighting change and shadows is presented. The system acquires the front view using a camera mounted on the vehicle then applies a few processes to detect the lanes. Using a pair of hyperbolas that are fitting to the edges of the lane, those lanes are extracted using Hough transform. The proposed lane detection system can be applied on both painted and unpainted roads as well as curved and straight roads in different weather conditions. This approach was tested and the experimental results show that the proposed scheme was robust and fast enough for real-time requirements. Eventually, a critical overview of the methods was discussed, their potential for future deployment was assisted.

Traffic Sign Classifier:

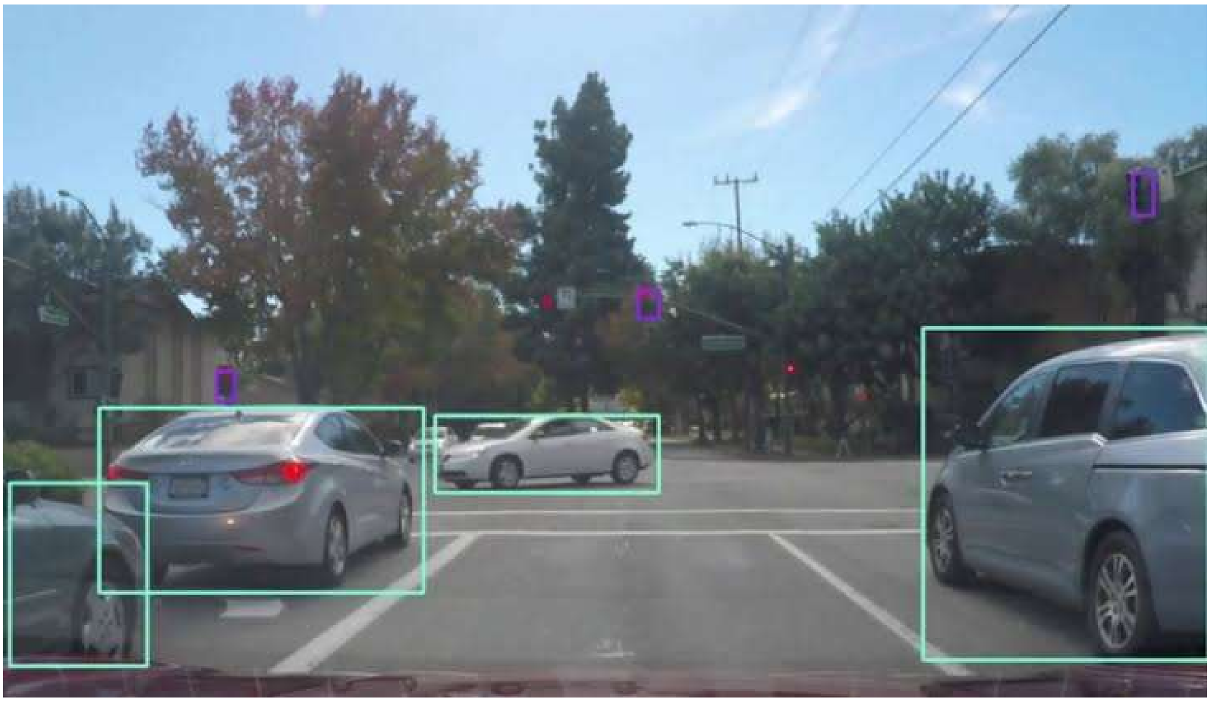
The goal of this project element was to build a CNN in TensorFlow to classify traffic sign images from the Traffic Sign Dataset.



traffic sign recognition system for autonomous vehicles using convolutional neural network (CNN). With the growing population and increased traffic on roads, the number of accidents has significantly increased over the last decade. Self-driving vehicles seem to be an efficient way to tackle this issue. Traffic signs play a very important role in maintaining the smoothness of traffic flow. Shape and colour are the 2 major factors that distinguish traffic signs from the rest of the objects. The system that has been proposed in this paper involves 4 stages: 1) Pre-processing stage which uses algorithms like gamma correction, geometric transformation and histogram equalization. 2) Colour segmentation and object filtering stage to remove unwanted noises from the images and normalize the dataset. 3) Training stage which uses CNN paired with a linear classifier. Training data needs to be scaled, normalized, extended and augmented. 4) Validation and testing stage in which traffic signs are recognized and accuracy is calculated. From the results, we conclude that our system achieved higher accuracy due to architectural optimization of the neural network for traffic sign recognition and due to the different types of techniques that we used for pre-processing of images. The techniques used by us made our system achieve better accuracy under variable lighting conditions. Our proposed system performed significantly better on partially occluded and blurred images. The dataset our system uses for training the model is GTSRB (German traffic sign recognition benchmark) dataset.

Vehicle Detection:

The goal of the project element was to develop a pipeline to reliably detect cars given a video from a roof-mounted camera.



Road accidents have been very common in the present world with the prime cause being careless driving. The necessity to check this has been very essential and different methods have been used so far. However, with the advancement in technology, different governing bodies are demanding some sort of computerized technology to control this problem of over speed driving. In this scenario, we are proposing a system to detect the vehicle which is being driven above the given maximum speed limit that the respective roads or highway limits. The overall project is divided into three categories; speed detection, image acquisition and transfer and image processing. Speed detecting device works on the principle of Doppler Effect using microwave Doppler radar sensor. The speed is compared with the preset threshold and the camera is triggered if the speed limit exceeds. Acquisition and transfer of images are done by an HD camera interfaced with raspberry pi. Raspberry pi is connected to the server via the internet. The server runs an Image processing program that isolates the license plate from the picture frame. The characters in the number plate are digitized and sent to the authority residing in the next station where the vehicle is heading.

APPLICATIONS AND LIMITATIONS

APPLICATIONS:

- The greater precision of an automatic system could improve traffic flow.
- It would eliminate accidents caused by driver error. Increasing roadway capacity by reducing the distances between cars.
- The current location of the vehicle can be determined using a global positioning system (G.P.S).
- Dramatically increases highway capacity and reduce or eliminate traffic jams.
- Time will be saved in the traffic
- . • The car itself park in the parking area. No license will be needed for the driver because he is a self-driver.

LIMITATIONS:

- If the vehicle is using the internet which has less security then from the hacker's point of view in some cases the vehicle can be switched off on the roads in rare cases).
- Hackers can change the route which is plotted in the system (in rare cases). In case of failure of the main sensor and backup sensors, the vehicle can create a chance of an accident.
- The cost of the car is high. By coming driverless cars into the market so many taxi drivers can lose their jobs.

CONCLUSION

It is so useful for humans when driving a car. By the Google driverless car can avoid the accidents on the roads and can reduce the traffic time at the traffic signals, can prevent the drinking driving on the roads. The car itself can be a driver at night times also. At the same time, so many taxi drivers can lose their jobs.

The driverless car's technologies improve vehicles stability helps to minimize loss of control. Driverless cars are designed to minimize accidents by addressing the main causes of collisions:

- Driving error
- Distraction
- Drowsiness

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