CMPE 258 Short Story assignment

Autonomous Vehicles and its challenges.

Agenda

- Introduction to autonomous vehicles, autonomous driving and how it works.
- Current situation of technology in autonomous vehicles.
- Challenges in the system.
- Exploring possible solutions.

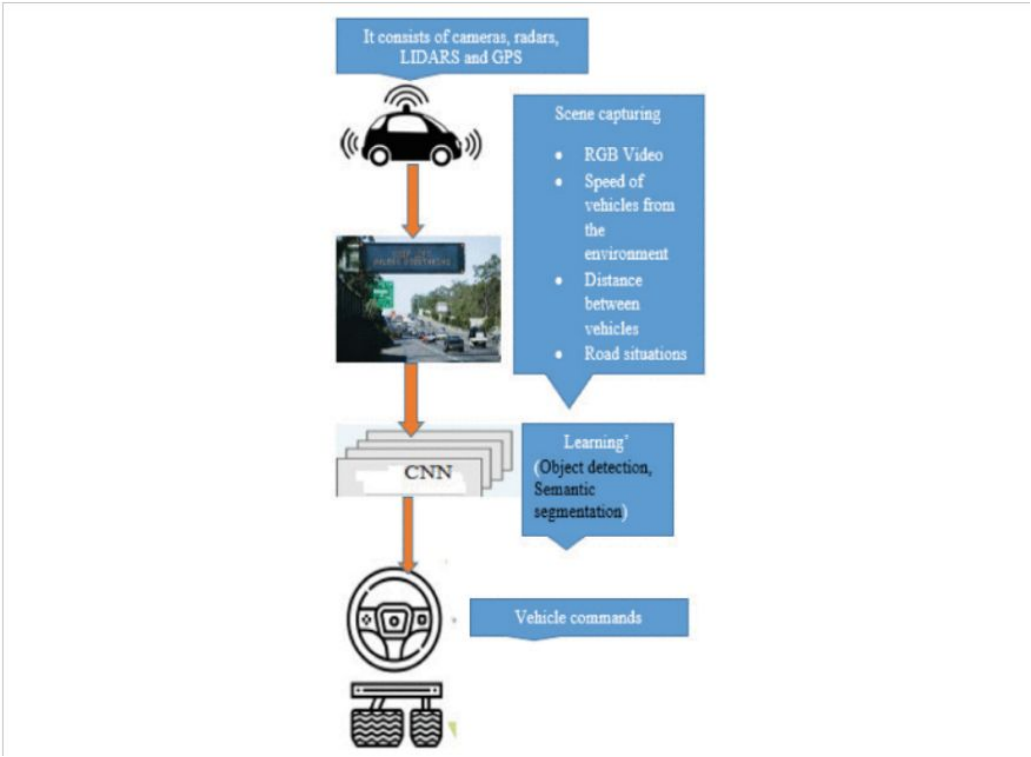
Introduction to Autonomous Driving

- A vehicle capable of driving by itself is called as an autonomous vehicle. And the method to achieve this called as autonomous driving.
- Autonomous driving involves using a lot of state of the art technology like various aspects of computer vision, fast and reliable decision making and state of the art control systems.
- Computer vision is of particular interest in autonomous vehicles.
- It is used for object detection, path tracking.
- Analogous to a human seeing the road and the objects around it like traffic signs, pedestrians, other vehicles and obstacles.

Introduction to Autonomous Driving

- In an autonomous vehicle, a lot of the decisions are based on the data gathered from cameras.
- Some of the systems that use the data are,
  - Collision avoidance systems.
  - Auto-pilot/self drive systems.
  - Obstacle avoidance systems
- We will explore the current standards of the commercially available autonomous vehicles, its challenges and discuss some of the solutions to overcome those challenges.

General overview of computer vision in Autonomous driving



Role of CNN(Convolutional Neural Networks)

- As most of the data is in the form of image/video, CNNs play an important role in the process of decision making.
- The CNN is trained using available data, and then used in real time to make decisions regarding the next action of the vehicle.
- Some of the tasks that are performed by CNN are
  - Obstacle detection
  - Road sign detection
  - Semantic Segmentation etc..

Current accomplishments of the system and shortcomings

- The actions performed by a AV is not solely based on the road. Just detecting objects and classifying them is not enough to build an intelligent system which is capable of driving. Some of the key areas of an intelligent system are as follows.
  - Collision avoidance
  - Human behavior prediction (other drivers and pedestrians)
  - Driver behavior detection
  - Ethical Decision making
- We will see the capability of each of these in the coming slides.

Collision avoidance

- The road is a dynamic environment where there are other vehicles, pedestrians traffic stops etc. With all of the above variables, there is a high possibility that an entity may react abnormally. This may lead to a collision.
- Eg : A car ahead sees an obstacle and breaks suddenly, the autonomous car that we are building should be able to recognize this and react accordingly to avoid a collision.
- Currently , autonomous cars are able to track the movement of other cars and in most cases avoid collisions. But there has been incidents where the car was not able to detect an object and respond to it

Human behavior prediction/modelling

- Lot of fatalities on the road are pedestrians. Nearly 20% of the total fatalities. This could be due to bad behavior on the car drivers and also due to bad behavior from the pedestrians.
- Currently the cars are capable of detecting pedestrians as objects and not humans. Which means that there is no behavior associated with the pedestrian.
- Cars need to be able to predict that a human is at the risk of obstructing the car and make a decision whether the human will actually obstruct the path or not.

Driver behavior

- As with predicting pedestrian behavior, the system needs to be capable of predicting the behavior of other drivers on the road. Further it needs to be able to predict the person sitting in the driver seat of the autonomous vehicle too.
- This is important so as to be prepared with any type of emergency scenario. Some examples would be a rash driver, intoxication or drowsiness.
- Currently the system is able to detect the drowsiness or attention deficiency or intoxication of its own driver. But it needs to be able to do that for other driver too based on the driving style so it can be cautious when being in proximity to that particular car.

Ethical Decision Making

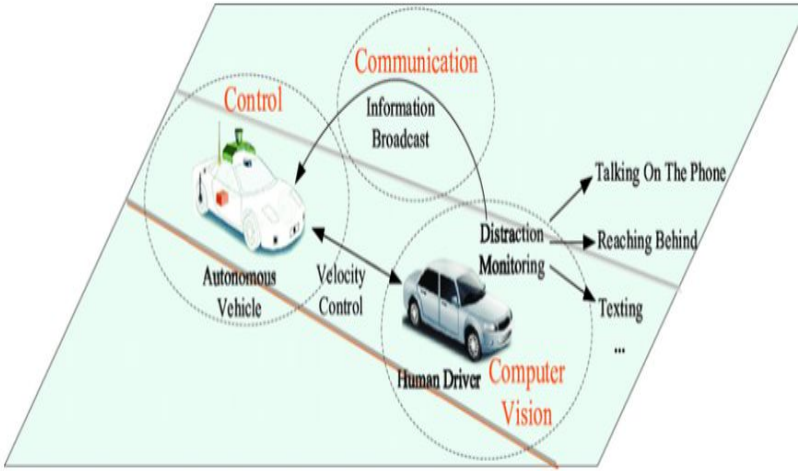
- When the driving system is challenged with a scenario where none of the outcomes are favorable, it needs to pick the option where there is least damage.
- This can be explained by the trolley problem.
- Currently the system is not capable of making these types of decisions. It can just detect obstacles but does not work well when there no good path.

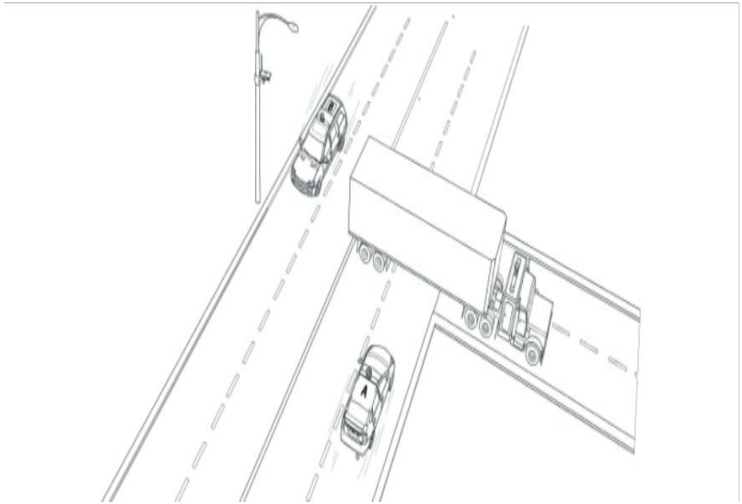
Some Solutions

Collaborative Autonomous Driving

- Focuses on using data from other devices alongside the data gathered from traditional systems.
- The devices may be 3rd party sensors as part of AV infra, other AVs or suggestive inputs using devices or electronic signals to trigger the AV to expect a certain scenario.
- This can be generalized as a huge IOT system where each device is broadcasting details to AVs and hence can help the AV better understand the situation ahead.
- Some of the issues it solves is, object detection around a blind spot, low visibility, and can help vehicles approaching a collision to be cautious.
- This speeds up the decision making as the AV is aware of the situation ahead and does not have to wait until it detects the danger itself.

Collaborative Autonomous Driving





Human Behavior modelling and driver behavior modelling

- One of the research papers suggests use of hidden markov model where the behavior is distributed as states
- And the job of or AI is to predict the transition probabilities between the current state and possible states.
- This will help us predict what the human will do next and hence take appropriate actions based on the prediction.
- This will help in detecting abnormal behavior with drivers and pedestrians.
- Ultimately this system should be capable of predicting if a lingering pedestrian will abruptly present himself as an obstacle to the AV. It should also be capable of predicting the current state of the driver in terms of intoxication, rage, drowsiness and rash driving.

Ethical Decision Making

- One of the most successful approaches to solving this issue is by situation based training. It is based on the approach used by aviation industry where any accident is studied and the sequence of events which led to the decision of the pilot is analyzed.
- Using scenario based training approach where the training data is gathered from a simulation involving actual human drivers would eventually train the automation to come up with decisions which are the the most favorable of the worst.

Ethical decision making examples

- Eg : if the automation is forced to make a decision of which obstacle to crash when none of them are avoidable, then the most humanly decision would be to crash in such a way that it should minimize the damage caused to all of the vehicles involved.
- Further it is essential that the system takes some decision when it comes to this situation. If the system becomes unaware or just shuts off, it may cause more harm.

Conclusion

- We have made significant achievements when it comes to autonomous driving. The fact that it is commercially available supports this fact.
- But, considering the dangerous environment that these vehicles operate in, it is quintessential that there can be no lapse of safely as the lives of people are at stake.
- To achieve this level of perfection we need to come up with smarter and more intelligent systems.
- This is not far away. The past few years have been the years where AI/ML technology is progressing at breathtaking pace.