In most autonomous vehicles, the combination of cameras, LiDAR, and RADAR form the primary set of sensors that provide imaging, detection, ranging, tracking, and sensing of the drive location for a seamless ride.

CAMERA SENSOR:-

Advantages:-

- Autonomous cars have cameras in order to see and interpret the objects in the road
- By equipping cars with these cameras at every angle, the vehicles are capable of maintaining a 360° view of their external environment, providing a broader picture of the traffic conditions around them
- 3D camera sensors automatically detect objects, classify them, and determine the distances between them and the vehicle. For example, the cameras can easily identify other cars, pedestrians, cyclists, traffic signs and signals, road markings, bridges, and guardrails.

Disadvantages:-

- Poor weather conditions such as rain, fog, or snow can prevent cameras from clearly seeing the obstacles in the roadway, which can increase the likelihood of accidents
- There are often situations where the images from the cameras simply aren't good enough for a computer to make a good decision about what the car should do

LiDAR:-

Advantages:-

- Apart from measuring the distances to various objects on the road, lidar allows creating 3D images of the detected objects and mapping the surroundings
- Moreover, lidar can be configured to create a full 360-degree map around the vehicle rather than relying on a narrow field of view.
- lidar is that it is economical
- it is more precise than other remote sensing methods such as sonar and radar.
- It is capable of collecting elevation data in dense forests.
- It is also not affected by geometric distortions such as angular landscapes.
- Another advantage of lidar is that most of the underlying processes are automated, thus minimizing human dependence
- Light detection and ranging is compatible with other surveying methods and imaging techniques. It can be used alongside sonar or radar systems to

address its limitations and complement one another. The data generated by this technology can also be integrated with other data sources for more in-depth analyses.

Disadvantages:-

- Even though LiDAR can catch the position, shape, size, and depth of an obstacle, they can get glitched by fake echoes showing far objects as near objects and vice versa.
- LiDAR fails to distinguish between multiple copies of laser signals and shows non-existent obstacles to autonomous vehicles.
- LiDAR does not function well in rain, snow, or fog
- Another drawback of lidar is that it has a low operating altitude of between 500 meters and 2000 meters. The pulses it emits will not be effective at higher altitudes.
- Because lidar can cover a wider surface area at a faster rate, it tends to generate too much data. An organization might not be suitably equipped to process and interpret large amounts of data they will be collecting.

RADAR:-

Advantages:-

- Radar (radio detection and ranging) is a detection system that uses radio waves to determine the distance (ranging), and radial velocity of objects relative to the site. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain.
- The radar sensor is independent of different weather conditions
- Bears excessive cold & heat
- It can work in bad lighting conditions or dark
- Its maintenance is free
- This sensor is used for indoor & outdoor purposes

- Unlike camera sensors, radar systems typically have no trouble at all when identifying objects during fog or rain

Disadvantages:-

- The pedestrian recognition algorithm needs a lot of improvement, the automotive radar sensors used in today's vehicles only correctly identify between 90% and 95% of pedestrians, which is hardly enough to ensure safety on the road
- As well, the still widely-used 2D radars are not able to determine accurately an object's height, as the sensors only scan horizontally, which can cause a variety of problems when driving under bridges or road signs
- It cannot differentiate & resolve numerous targets which are extremely close like our eye.
- It cannot identify the color of the objects.
- It cannot observe objects which are too deep and in the water.

Sensor fusion:-

Sensor fusion is the process of merging data from multiple sensors to create a more accurate conceptualization of the target scene or object. The idea behind it is that each individual sensor has both strengths and weaknesses; the goal is to leverage the strengths of each and reduce any uncertainty to obtain a precise model of the environment being studied. Sensor fusion maximizes the safety of autonomous vehicles.

Some other sensors are-

- **Inertial navigation systems**- It is a navigation device that uses a computer, motion sensors (accelerometers) and rotation sensors (gyroscopes) to continuously calculate by dead reckoning the position, the orientation, and the velocity of a moving object without the need for external references
- **Global positioning system**- can use GPS to geolocate with numerical coordinates (e.g. latitude, longitude) representing their physical locations in space. They can also navigate by combining real-time GPS coordinates with other digital map data
- **Sonar**:- Self-driving cars can use sonar to detect large objects made of solid materials (e.g. metal, ceramic) at short distances.
- **Tactile sensors**- senses if some force is applied or vehicle touched something
- **Acceleration sensor** - accelerometer; to measure acceleration