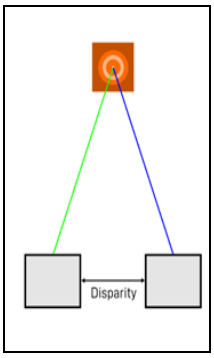
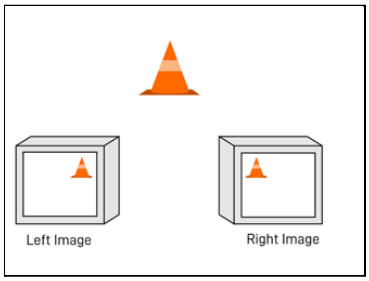
SENSORS IN AUTONOMOUS DRIVING

1. **STEREO CAMERA** :- Stereo cameras are used to mimic the working of a human eye. The need of a stereo camera over a single lens camera is its ability to provide depth perception . It achieves this by using two sensors that are set apart by some distance to triangulate pixels from a 2D plane. Stereo cameras use visible light and are cheaper compared to a LIDAR.





NOTE: **DISPARITY ∝ angular offset**

So more disparity implies more will be the 3D depth information. But proper calibration needs to be done before deploying our stereo camera. Advantage is that its cost effective and can help in detecting signs and lanes which can't be done by a LIDAR.

2. **GPS** :- Global Positioning system is a satellite based navigation system that uses radio signals. GPS helps self driving cars to geo locate themselves using lat long values. They can also navigate using GPS and other digital maps (like google maps). GPS data often varies around a five-meter radius. To compensate for imprecise GPS data, self-driving cars can use unique data-processing techniques like **particle filtering**(1) to improve location accuracy

3. **LIDAR** :- LIGHT DETECTION AND RANGING

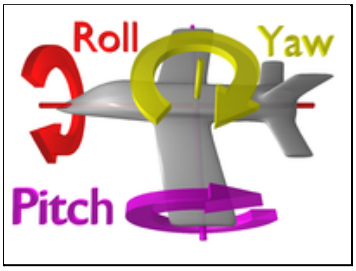
LiDAR is considered a key technology for achieving higher levels of autonomy. GIS and GPS in addition with INS are used for navigation . But in most developing countries GIS info is not available (especially in rural areas). Here Lidar plays a key role in path detection using Radio or Ultrasonic waves. It emits about one million lasers per sec and gets reflected by an object and hits the photodetector .It helps in identifying obstacles and navigate safely. Some applications of it are adaptive cruise control obstacle detection . Compared to a Stereo camera its costlier but its effective because it can work even in regions with dull lighting. Disadvantage is that it can spot obstacles but won't be able to classify them

4. **Radar**:- These also have similar working as that of Lidar . The only difference is the wavelength of the wave used is larger and the information obtained is not as detailed as that obtained from LIDAR . Now we need to decide b/w (data+safety) and cost .

5. **IMU**-

IMU is composed of 3 main sensors:

a. Accelerometer:- Helps to measure linear acceleration
b. Gyroscope :- Helps to measure angular velocity along pitch roll yaw (i.e X,Y and Z axes respectively). It helps in identifying the orientation in a 3d space
c. Magnetometer:-Estimates magnetic fluctuation at the sensor in a sensor and helps to identify the heading when fused with accelerometer and gyroscope values.



6. **Sensor Fusion**
Sensor fusion is a method in which Radar LiDAR stereo camera ultrasonic sensors Radar information is all used to collectively interpret environmental conditions with a high certainty. It is not possible for all these sensors to work independently. Sensor fusion has a great advantage i.e it suppresses the weakness of other sensors.

Sensor fusion is done within the IMU sensor itself , where we try to use acceleration, angular velocity and magnetic field to determine motion orientation and heading. Gyroscope has no initial point reference only when data is fused with accelerometer it has a meaning and helps us to measure angular position

1.What is **Particle Filtering**: (used to improve GPS positioning)
The vehicle is able to measure its distance from these objects: trees, buildings, humans, other vehicles and so on and paint a picture of the surroundings. Using high-precision measurements, as evidence, the vehicle is able to improve its localization within the GPS spot. As the vehicle moves, so does the GPS spot and the vehicle has to repeat the process of sensing, gathering evidence and improving upon the new prior.