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Assignment 4
Vehicle Collision Avoidance Controller

Requirements for Collision Avoidance Controllers in Vehicles:

1. A test bed vehicle which can be either a car or a drone etc.
2. Sensors that can be integrated directly with the test bed vehicle:
    a. Motion Sensors- A device that that detects moving objects, particularly people. Hence it can be integrated in the vehicle which alerts the system about any object in motion around the vehicle (eg: GPS, GYRO, Odometry etc..).
    b. Video Sensors- A sensor that helps in digital image analysis. It helps to interpret scenes that are captured by a video camera. We require 6 video cameras, 3 cameras in front, one on top, two cameras looking on the side.
    c. LADAR's- sensors used to measure a distance to a target by illuminating the target with laser light.
    d. Rangefinder – A device that is mounted on top that helps in finding the curb if the test bed vehicle is a car.
3. A highly functioning processor with high accuracy time synchronization as time plays a major role in such critical systems.

The Signaling protocols are enlisted below as the following:

a) Signaling Protocol for Sensors:

I. The motion sensors are installed on all sides of the vehicle to detect multiple objects.
- Every object the motion sensors pick up the distance between the vehicle and the object.
- The distance is sent back to the controller where an algorithm checks the differences in the distances between the object and the vehicle.
- The controller then checks whether the distance of the object is too close or far away from the vehicle.
- The decision is then communicated to the other systems integrated with the controller to take appropriate actions.

II. The video sensors are nothing but cameras that are installed on the front, top and sides of the vehicle.
- The video sensors capture the environment of the vehicle in 360 degrees.
- Once the video is captured from all the angles, computer vison algorithms are used to determine the type of object that is near the vehicle.
- We use computer vision because it helps us classify the object the vehicle sees.

- The video cameras are also used to determine if the vehicle is taking the correct the path.
- This means that if the vehicle takes an incorrect path or is too close to an object of a specific type then this information is passed to the controller to take appropriate actions.

III. LADAR sensors are used in test bed vehicles that fire millions of light rays per second that help the vehicle to visualize the world as a 3D projection.
- The LADAR Sensors are placed on top of the vehicle.
- These sensors throw beams in 360 degrees from the vehicle and get 3D representation of all the objects from the surroundings.
- The reason we use the LADAR sensors is that It helps the vehicle to see objects way before the vehicle can intercept them.
- This allows the vehicle to make predictions and then adjust to the surroundings.

IV. The rangefinder is used to find the curb when the vehicle is on the road.
- We use the rangefinder because when the vehicle is on the road it is really important that the vehicle doesn't cross over from the curb to the other side.
- So the rangefinder detects the curb and gives the distance between the curb and the vehicle.
- if the vehicle is very close to the curb then the vehicle is moved away from it.
- if the vehicle is in self-parking mode then the curvature of the curb helps the car to turn in a specific direction.

b) **Signaling Protocol for Brakes:**

I. The sensors are integrated in all the directions of the vehicle that reads the data and sends this data to the controller to make the decision.
II. The sensors send the distance between the vehicle and the object and the controller compares the distances with those the controller was trained for.
III. if the object detected is very close to the vehicle then the controller will show this information as a warning of collision detection.
IV. The controller then takes counter measures either to stop the vehicle (bring it to a complete halt) or move the vehicle away from the object without coming too close to another object.

c) **Signaling Protocol for Steering:**

I. We know that there are a lot of sensors integrated on the vehicle to read the data.
II. So if the object is really close to the vehicle then the sensors detect the position
III. The steering of the vehicle is controlled when the data is read from the fron and the side sensors while ignoring the rear sensors.
IV. if the object is on the left and it is very close to the vehicle then the controller steers the vehicle on to the right.
V. if the object is on the right and very close to the vehicle then the controller steers the vehicle on to the left.
VI. If the object is in front of the vehicle then the controllers keeps the steering in the same position while sending signals to the brake system.

d) **Signaling Protocol for Engine:**
   I. The sensors read the signals from all the directions of the vehicle and try to estimate the how far the obstacle is from the vehicle.
   II. If the object is very close to the vehicle then the controller sends a warning or a danger signal displayed on the dashboard of the vehicle.
   III. To avoid the collision the system sends a signal that switches of the engine which leads to getting the vehicle to an immediate halt.

e) **Signaling Protocol for Controller:**
   I. The Controller is integrated with a lot of sensors and runs an algorithm with pre computed data that helps the controller to make the decision.
   II. The Sensors collect the data between the vehicle and the object based on the distance between them.
   III. The distance measured is computed against the precomputed data which the algorithm runs it can be seen under the following:
      i. If the object is too close in the front of the vehicle, the controller can send the signal to the brakes system for appropriate measures.
      ii. if the object is too close to the vehicle on either sides then the controller can send signals to the steering system.
   IV. The controller system is like the brain of the vehicle that allows to make counter measures if there is a chance of collision.

Pseudocode for the Controller

The assumption we make here is the sensors and the controller are directly interfaced with the vehicles engine system such that when the engine is turned on the power supply to the sensors and the controller is provided.

Pseducode:

```
while(EngineStart)
{
        start_controller = True
        start_sensors = True
        while(start_controller & start_sensors)
        {
                distance_data = fetch_data_from_sensors()
                obstacle_position= left or right
                vehicle_Speed = get_speed_of_vehicle()
                if (distance_data < safe_distance_from_vehicle() and vehicle_Speed<
safe_speed_of_vehicle())
                {
                        apply_brakes(True) //Send the signal to the brake system.
```

```
            }//brake system ends here
        if (distance_data < safe_distance_from_vehicle() and vehicle_Speed >
safe_speed_of_vehicle())
            {
                engine_system_OFF(True) // Cut the engine system OFF and
get the vehicle to a halt.

            }//engine system ends here

        if(obstacle_position ==right)
        {
            rotate_steeringToLeft(True)//rotate the steering system to the left
        }//steering condition one ends here.

        if(obstacle_position ==left)
        {
            rotate_steeringToRight(True)// rotate the steering system to the right
        }}//steering condition two ends here.

        }//sensor readings end here
} //engine system ends here
```

Failed Sensor Exception

```
if(sensor_data() == Null or undefined)
{
        send_OFF_signal_to_failed_sensor(True)
        display_Warning_Signal(True)
        if(sensorData is critical to the vehicle)
        {
            send_OFF_signal_to_Controller(True)
            send_OFF_signal_to_Engine(True)
        }
}
```