Vehicle Dynamics
Vehicle-Driver Model

Group A

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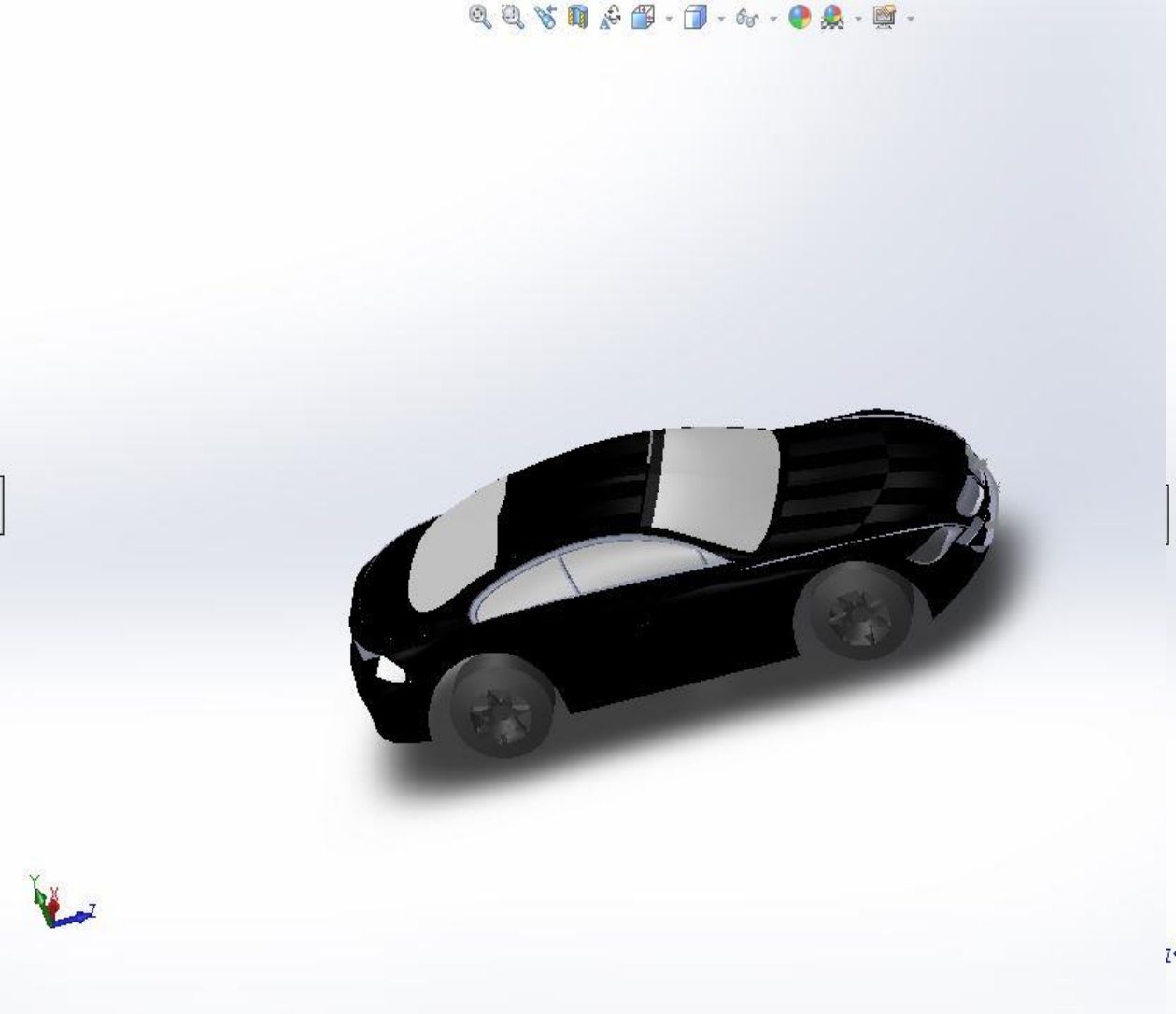
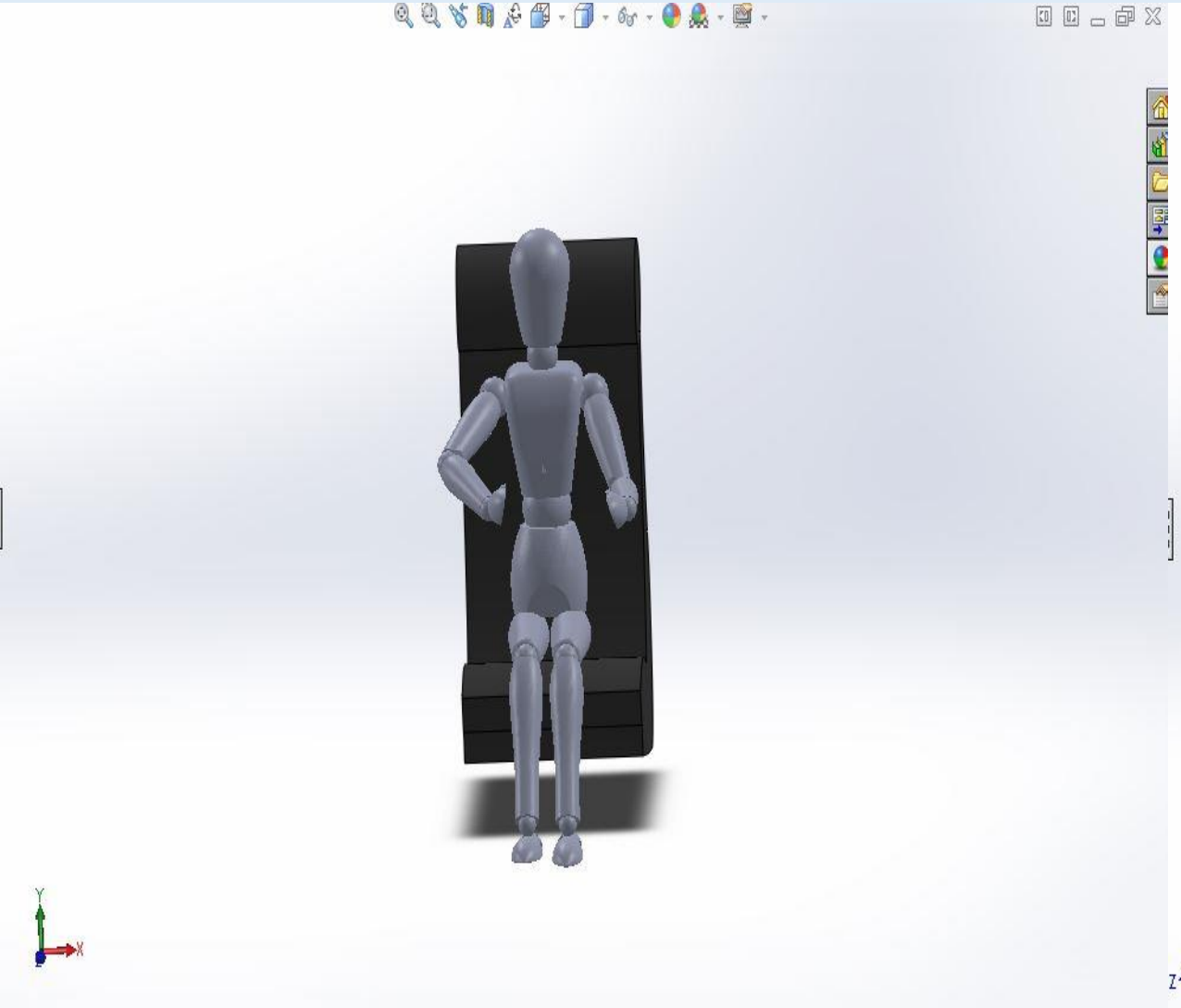
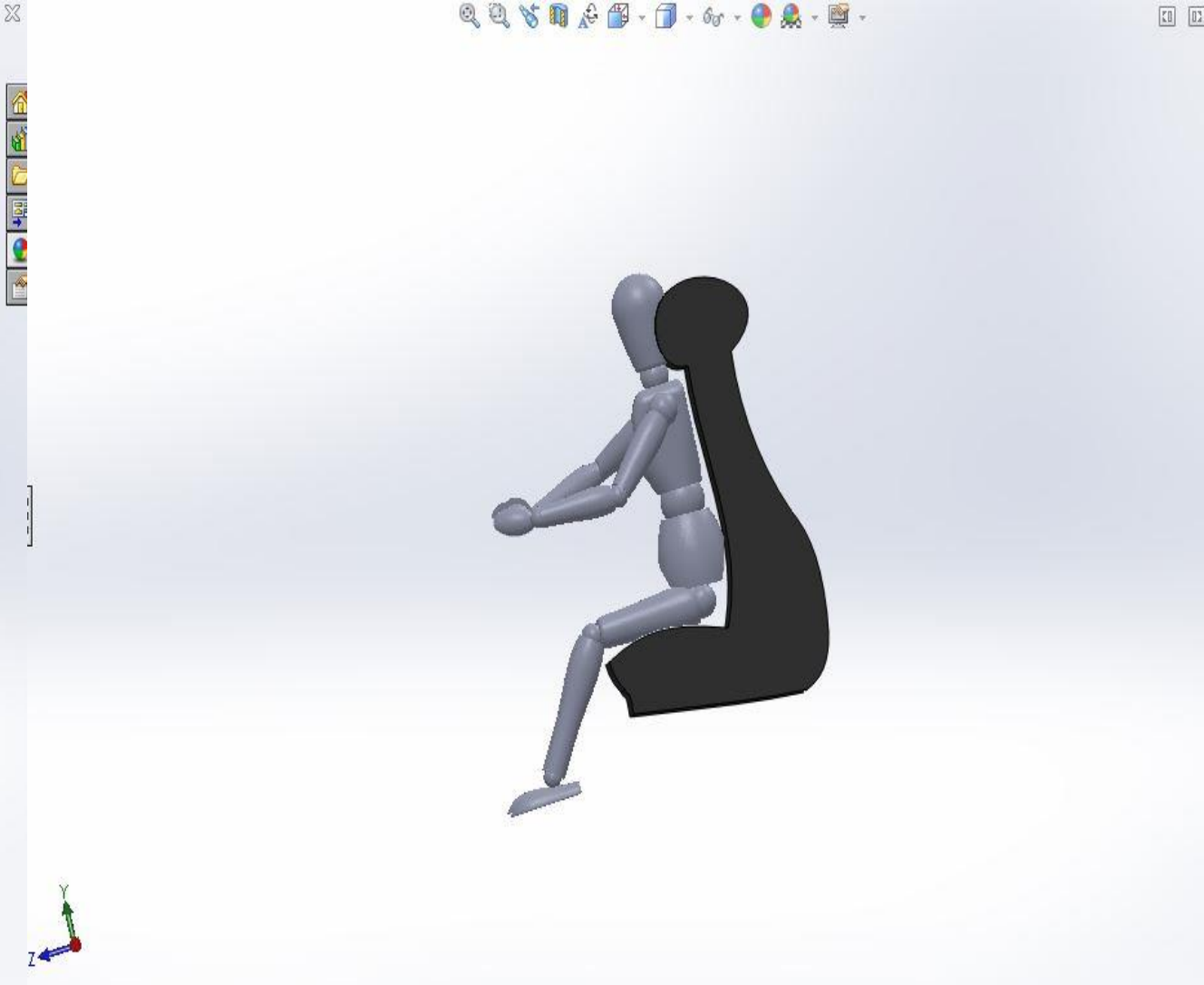
Car Model-BMW(M6)



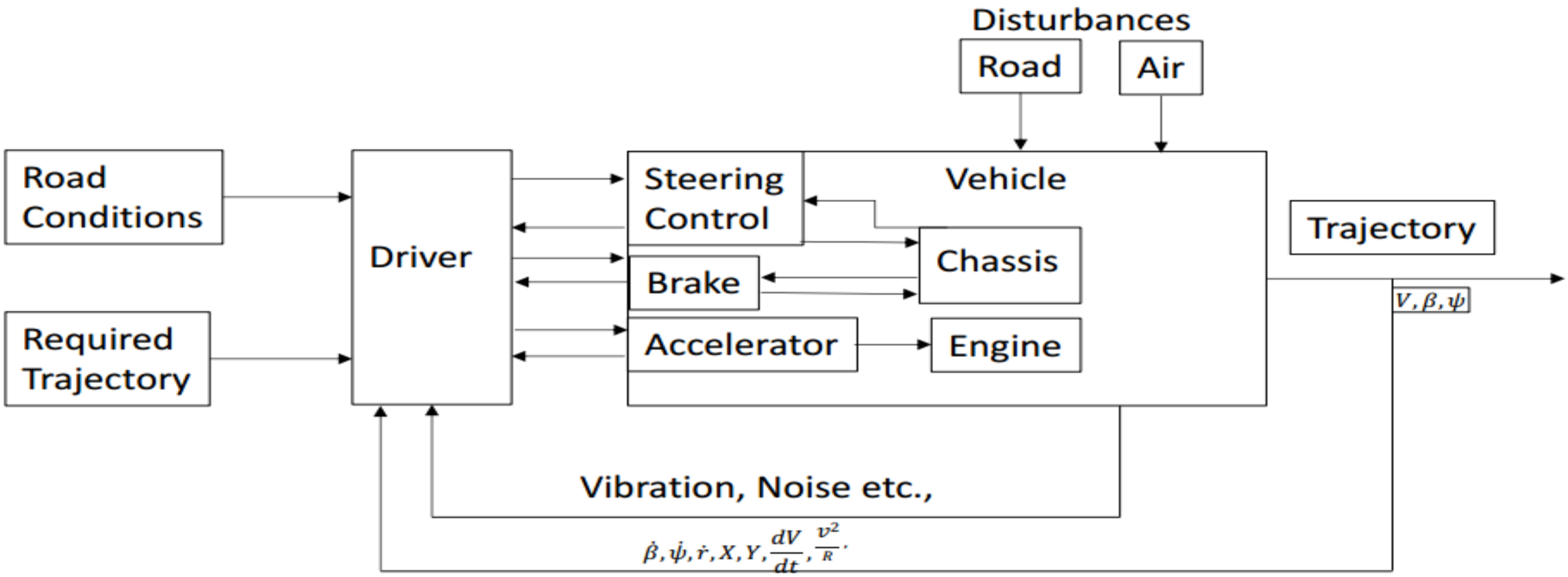
Part Specification





Introduction-Driver Model

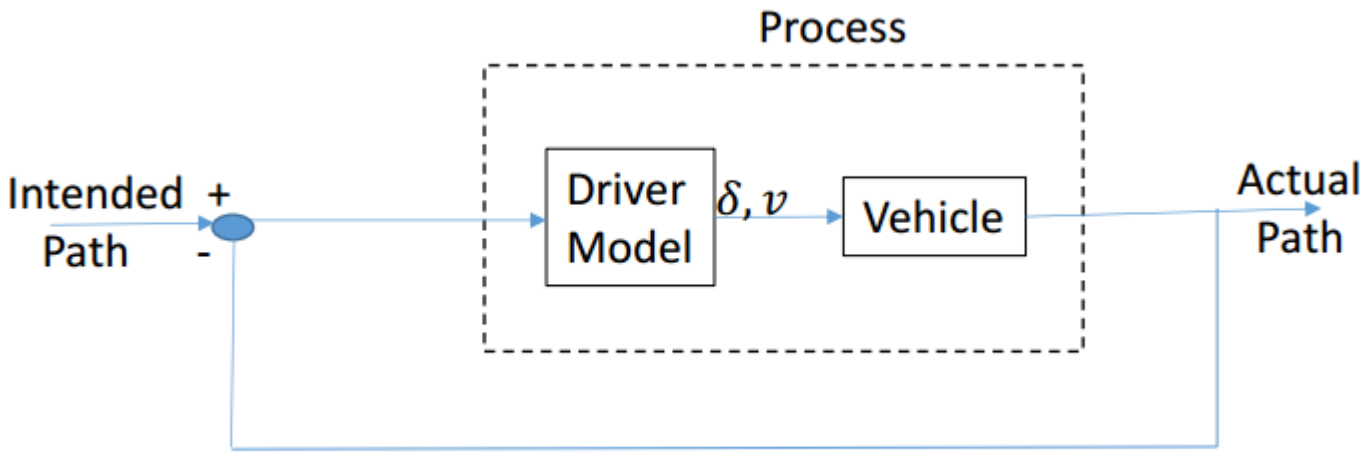
- A mathematical model which behaves similar to driver. Controlling, monitoring, stabilizing, proper maneuvering according to external disturbances.



Simplified scheme of the simplified vehicle-Driver System

Proposed Different Types of Vehicle Driver Model

- <u>Driver- Vehicle 1D Model</u>



- The properties of driver used to sign appropriate transfer function for the open loop and closed loop control. Includes path prediction ,reaction time.
- <u>PID controller</u>

1. Linearized Driver model
2. Path following Driver model-minimize lateral deviation, increase stability.

Car Following Models

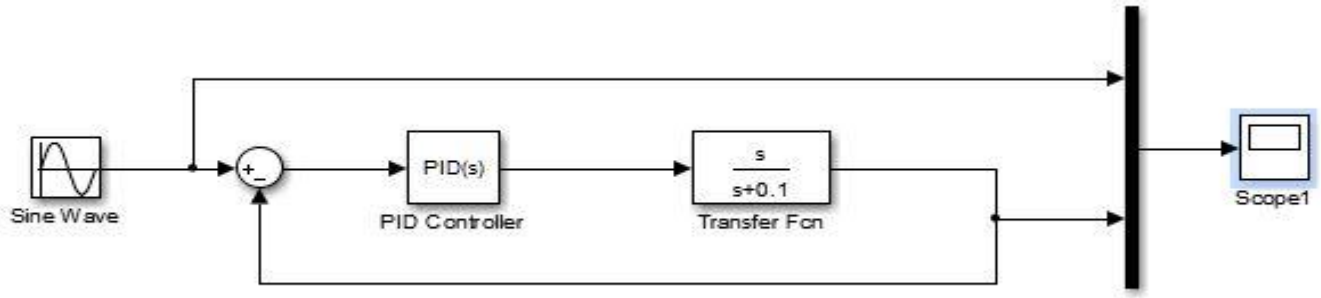
- Longitudinal spacing of vehicles are of particular importance from the points of view of safety, capacity and level of service. The longitudinal space occupied by a vehicle depend on the physical dimensions of the vehicles as well as the gaps between vehicles.
- Car following theories describe how one vehicle follows another vehicle in an uninterrupted flow. Various models were formulated to represent how a driver reacts to the changes in the relative positions of the vehicle ahead.
- **Pipe's model:**
  -- The basic assumption of this model is "A good rule for following another vehicle at a safe distance is to allow yourself at least the length of a car between your vehicle and the vehicle ahead for every ten miles per hour of speed at which you are traveling".
  -- According to Pipe's car-following model, the minimum safe distance headway increases linearly with speed. A disadvantage of this model is that at low speeds, the minimum headways proposed by the theory are considerably less than the corresponding field measurements.

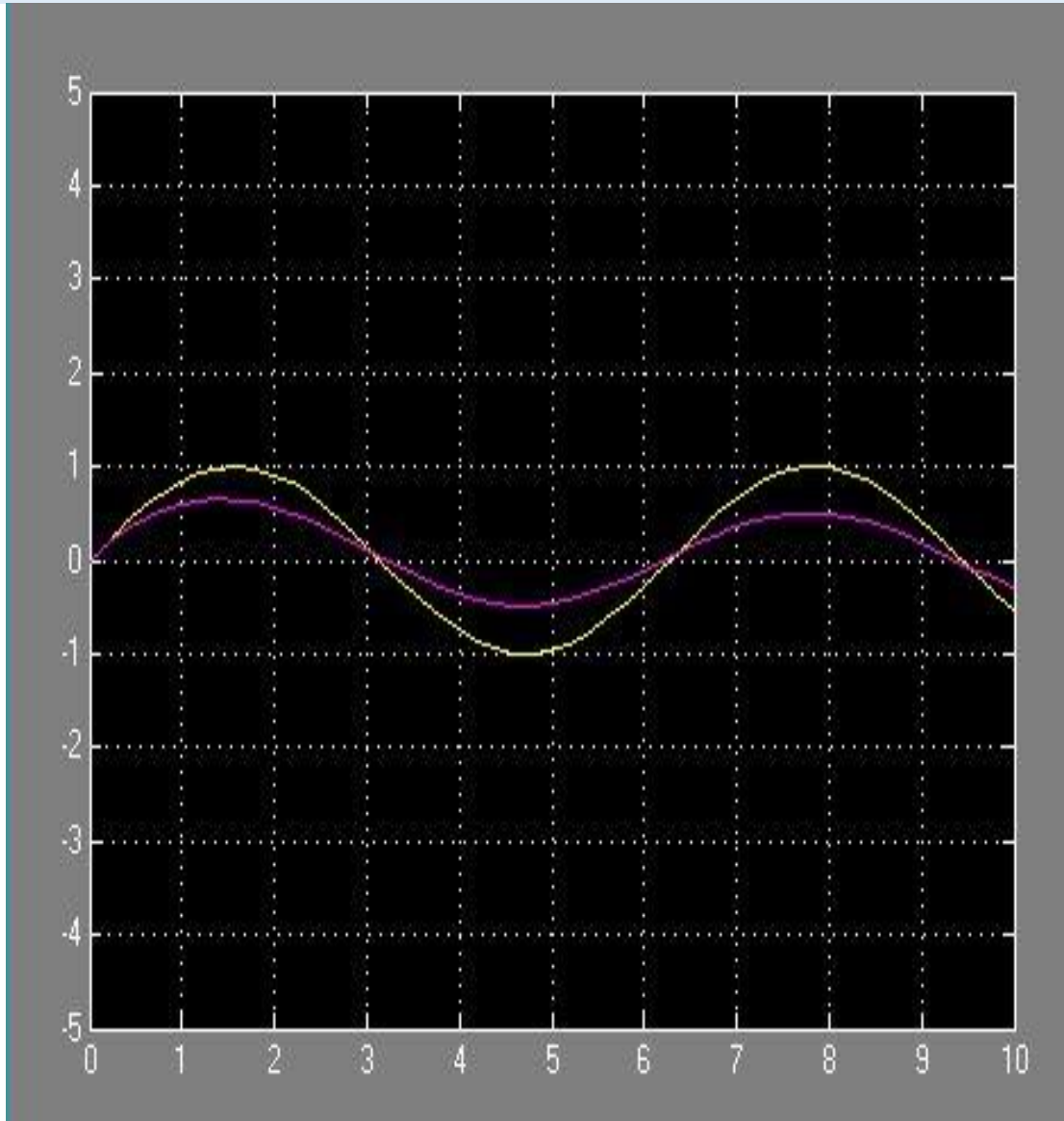
Car Following Models

- **<u>Forbe's Model:</u>**
  -- The time gap between the rear of the leader and the front of the follower should always be equal to or greater than the reaction time. Therefore, the minimum time headway is equal to the reaction time (minimum time gap) and the time required for the lead vehicle to traverse a distance equivalent to its length.
  -- A disadvantage of this model is that, similar to Pipe's model, there is a wide difference in the minimum distance headway at low and high speeds.

- **<u>Optimal Velocity Model:</u>**
  -- The concept of this model is that each driver tries to achieve an optimal velocity based on the distance to the preceding vehicle and the speed difference between the vehicles. This was an alternative possibility explored recently in car-following models.
  1. Car will keep the maximum speed with enough distance to the next car,
  2. Car tries to run with optimal velocity determined by the distance to the next car.

Simulink- Sine wave path following model





Car Sim –Sine path follow

Simple Driver Model

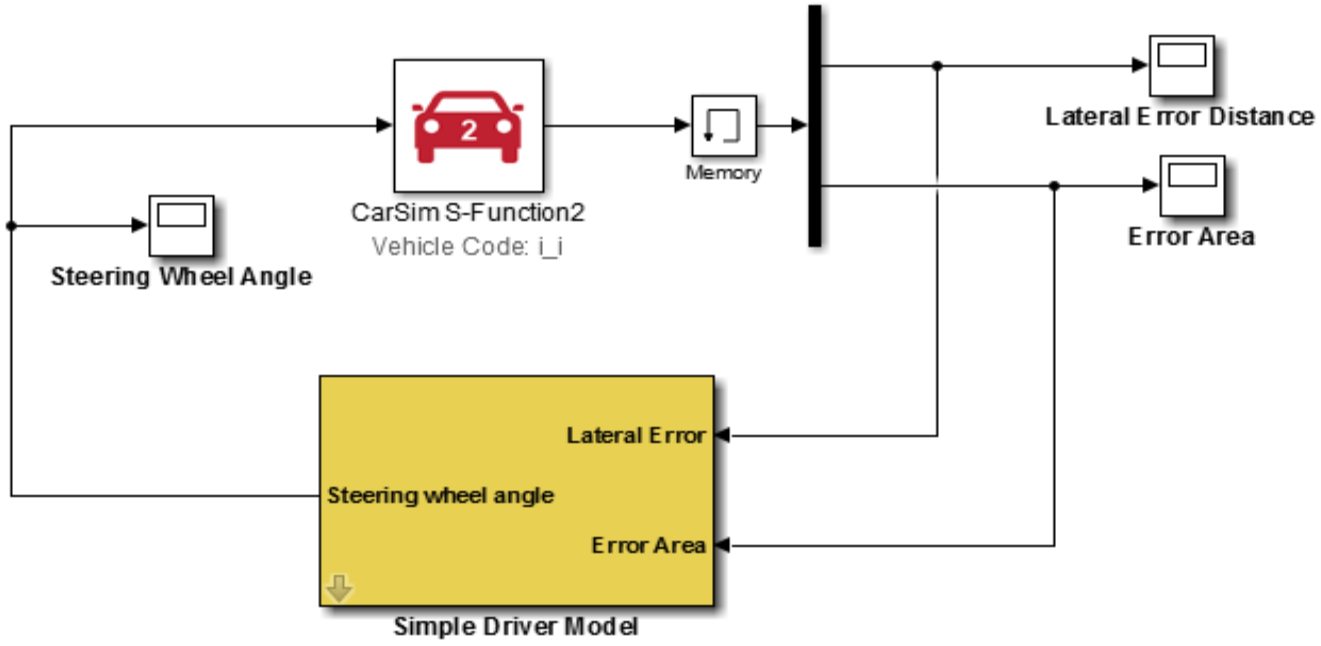
- Vehicle Model-the vehicle is modelled as a rigid body, free to move in six degrees of freedom under the influence of tire and nominal drag forces on a flat road
- Vehicle position and orientation in global coordinates are calculated using yaw rate r, and forward and lateral speeds u, v:

$$\dot{\gamma} = r$$

$$\begin{pmatrix} \dot{X} \\ \dot{Y} \end{pmatrix}_G = \begin{bmatrix} \cos\gamma & -\sin\gamma \\ \sin\gamma & \cos\gamma \end{bmatrix} \begin{pmatrix} u \\ v \end{pmatrix}$$

Driver Model

- For straight line driving, simple lateral correction process and when the vehicle is taking turn in on a fixed radius curve.
- Forward position based on current steer angle; the driver is only expected to have developed an appreciation of what radius a given steer angle will deliver.



Conclusion

- There are different Driver Models and it’s still diverse area of research. We implemented the simplest model but complexities increases as we include more properties of Driver into driver model.
- Google implemented autonomous **car** and many more companies tried to implement driverless car which is based on driver model concept.
- Govt. also trying to implement this idea into different area such as driverless metro to get rid of accidents happening regularly. Its also ecofriendly as its run on optimal condition.

Tools and References

- Simulink
- CarSim
- XBoX
- Publish By Korean Society of Automotive Engineers and the Society of Automotive Engineers Of Japan Inc.-A simplest realistic Driver Model
- Car following models-Lecture By NPTEL IITB