Active Suspension System

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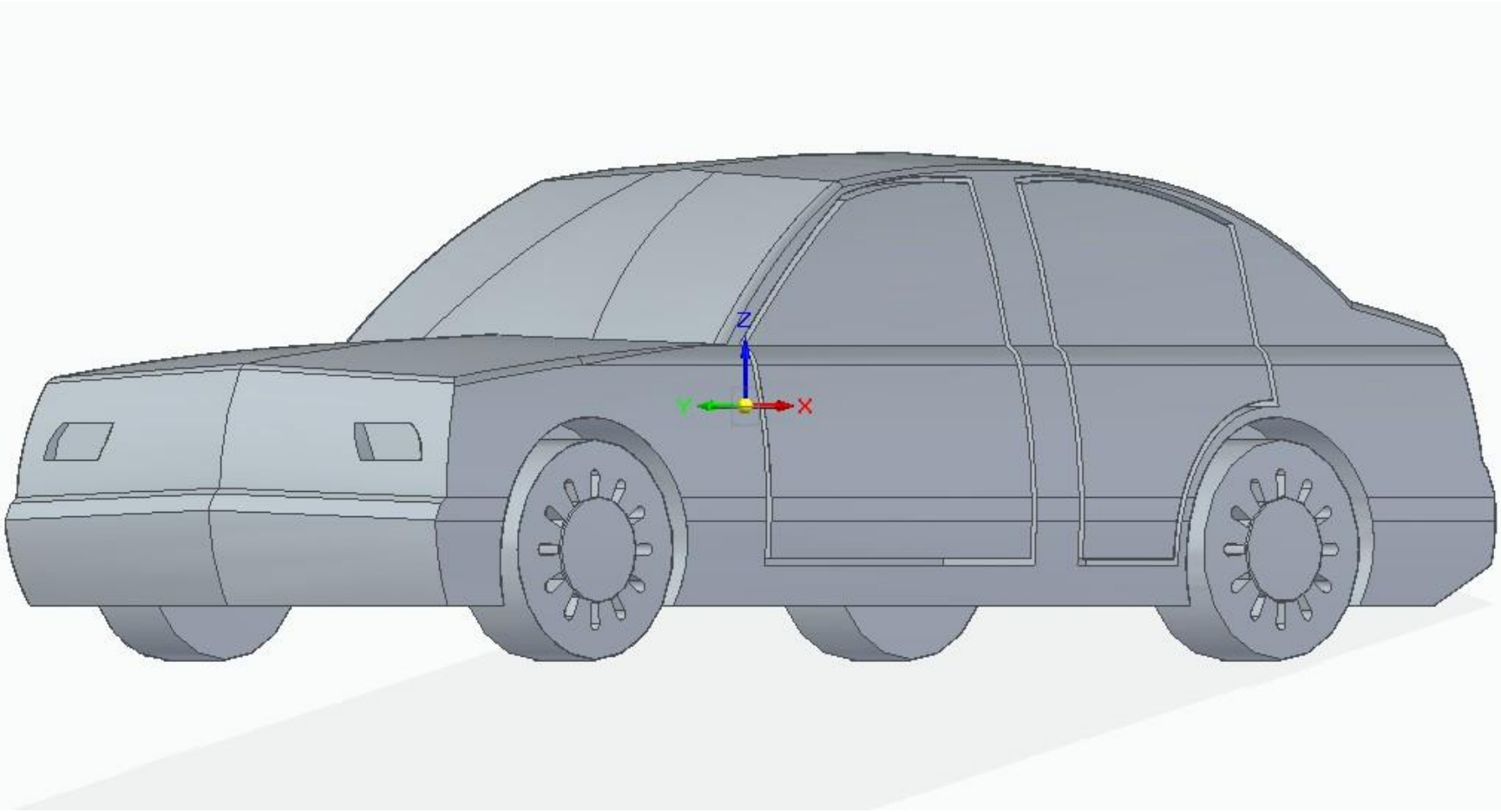
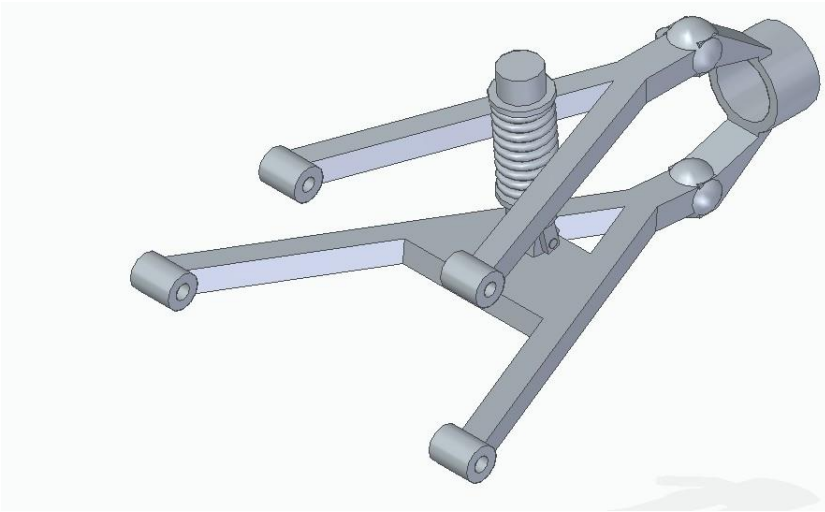
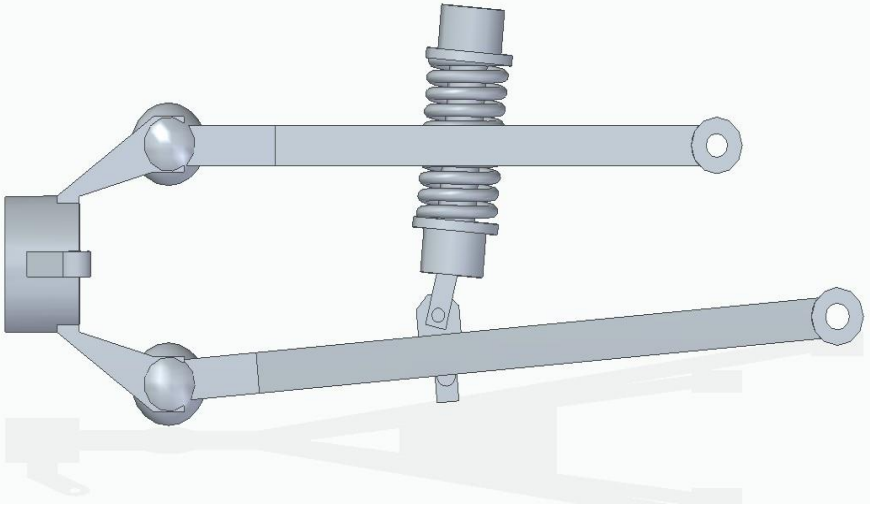

Z
Y
X

Types of Suspensions

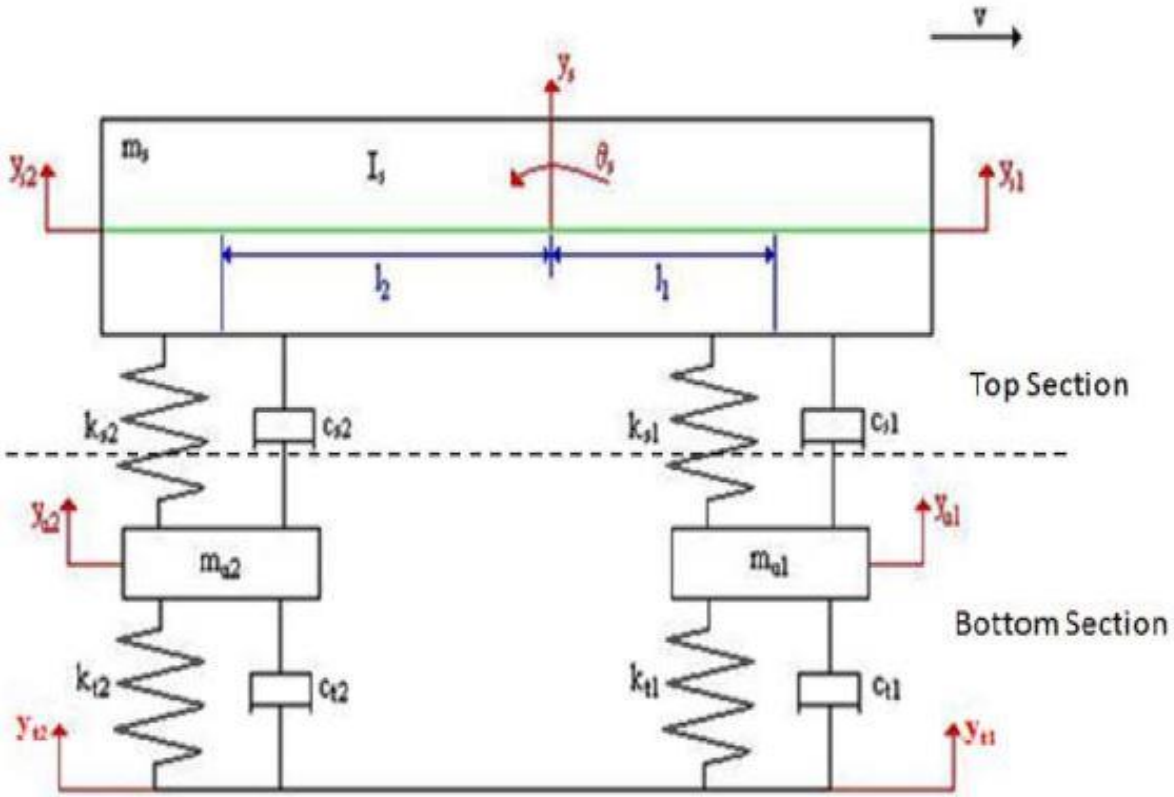
- Passive suspension system
  - Not flexible to different operating conditions
  - Low cost
- Semi active suspension system
  - In between to passive and active suspension system in flexibility and cost
- Active suspension system
  - Flexible to different operating conditions
  - High cost

Suspension system





Passive suspension



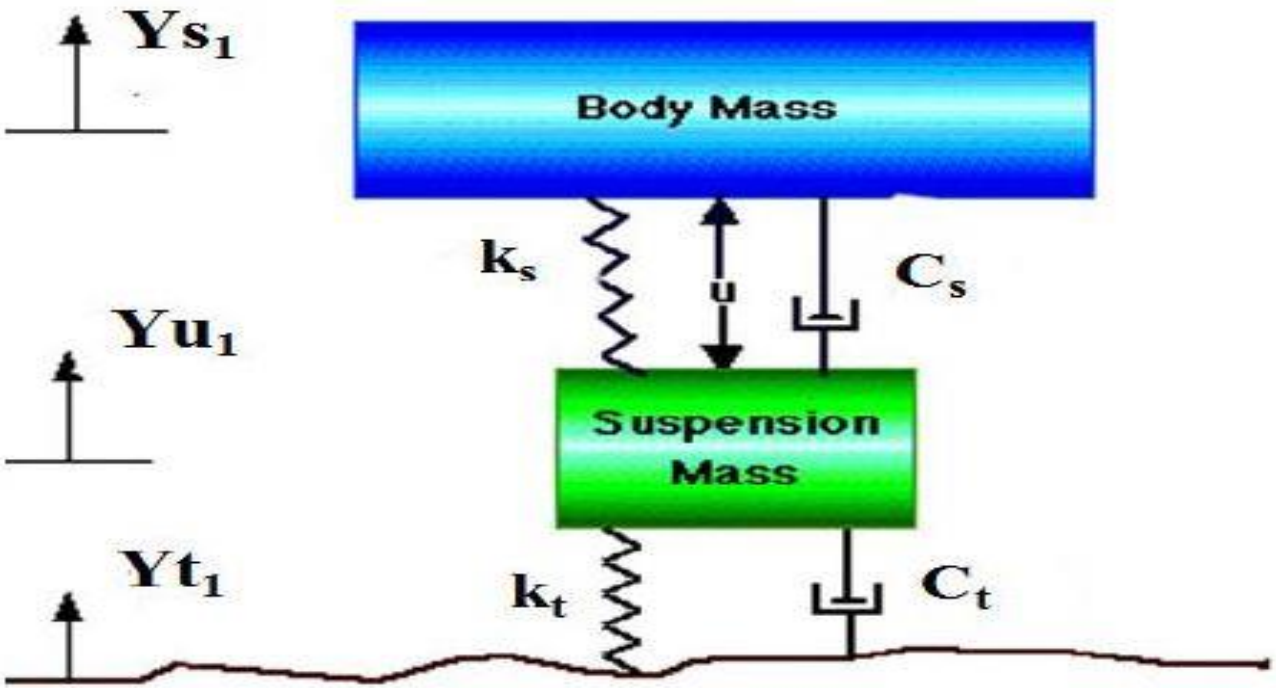
$$\ddot{y}_s = -\frac{(y_{s_1} - y_{u_1}).k_{s_1} + (\dot{y}_{s_1} - \dot{y}_{u_1}).c_{s_1} + (y_{s_2} - y_{u_2}).k_{s_2} + (\dot{y}_{s_2} - \dot{y}_{u_2}).c_{s_2}}{m_s}$$

$$\ddot{\theta}_s = -\frac{l_1[(y_{s_1} - y_{u_1}).k_{s_1} + (\dot{y}_{s_1} - \dot{y}_{u_1}).c_{s_1}] - l_2[(y_{s_2} - y_{u_2}).k_{s_2} + (\dot{y}_{s_2} - \dot{y}_{u_2}).c_{s_2}]}{I_s}$$

$$\ddot{y}_{u_1} = \frac{(y_{s_1} - y_{u_1}).k_{s_1} + (\dot{y}_{s_1} - \dot{y}_{u_1}).c_{s_1} - (y_{u_1} - y_{t_1}).k_{t_1} - (\dot{y}_{u_1} - \dot{y}_{t_1}).c_{t_1}}{m_{u_1}}$$

$$\ddot{y}_{u_2} = \frac{(y_{s_2} - y_{u_2}).k_{s_2} + (\dot{y}_{s_2} - \dot{y}_{u_2}).c_{s_2} - (y_{u_2} - y_{t_2}).k_{t_2} - (\dot{y}_{u_2} - \dot{y}_{t_2}).c_{t_2}}{m_{u_2}}$$

Active suspension

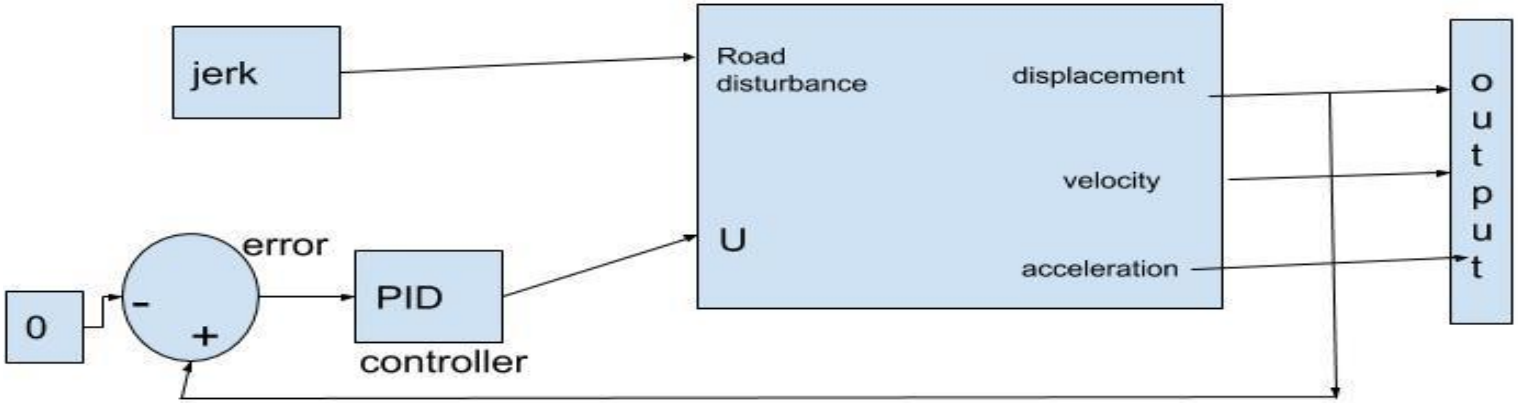


$$\ddot{y}_{u_1} = \frac{(y_{s_1} - y_{u_1}).k_{s_1} + (\dot{y}_{s_1} - \dot{y}_{u_1}).c_{s_1} - (y_{u_1} - y_{t_1}).k_{t_1} - (\dot{y}_{u_1} - \dot{y}_{t_1}).c_{t_1}}{m_{u_1}} - \frac{u}{m_{u_1}}$$

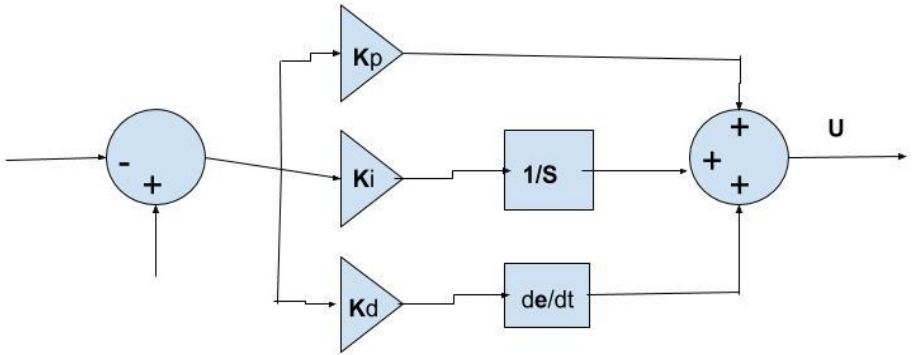
$$\ddot{y}_{u_2} = \frac{(y_{s_2} - y_{u_2}).k_{s_2} + (\dot{y}_{s_2} - \dot{y}_{u_2}).c_{s_2} - (y_{u_2} - y_{t_2}).k_{t_2} - (\dot{y}_{u_2} - \dot{y}_{t_2}).c_{t_2}}{m_{u_2}} - \frac{u}{m_{u_2}}$$

Simulink

The active suspension system modelling diagram



PID controller

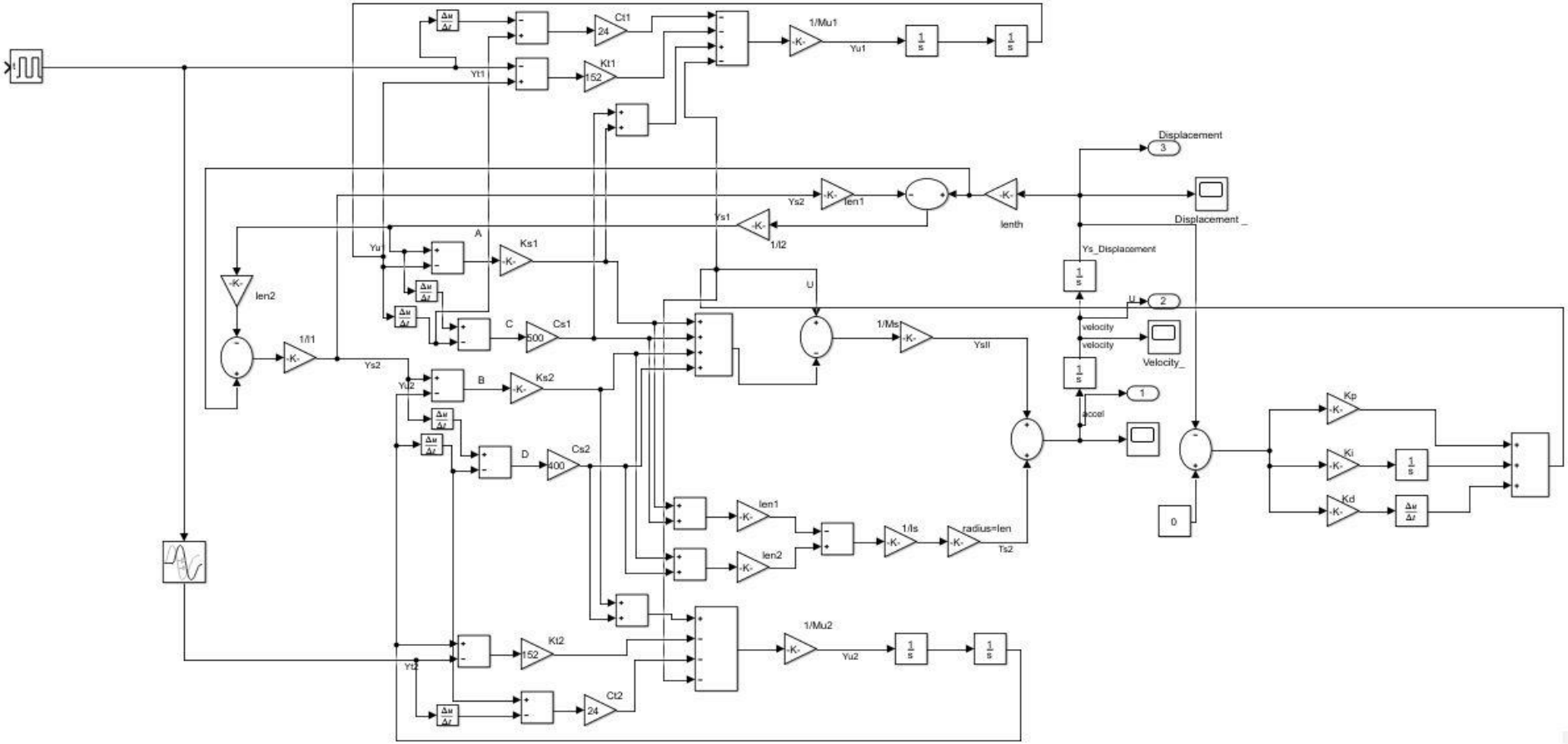


Kp = 3000

Ki = 5000

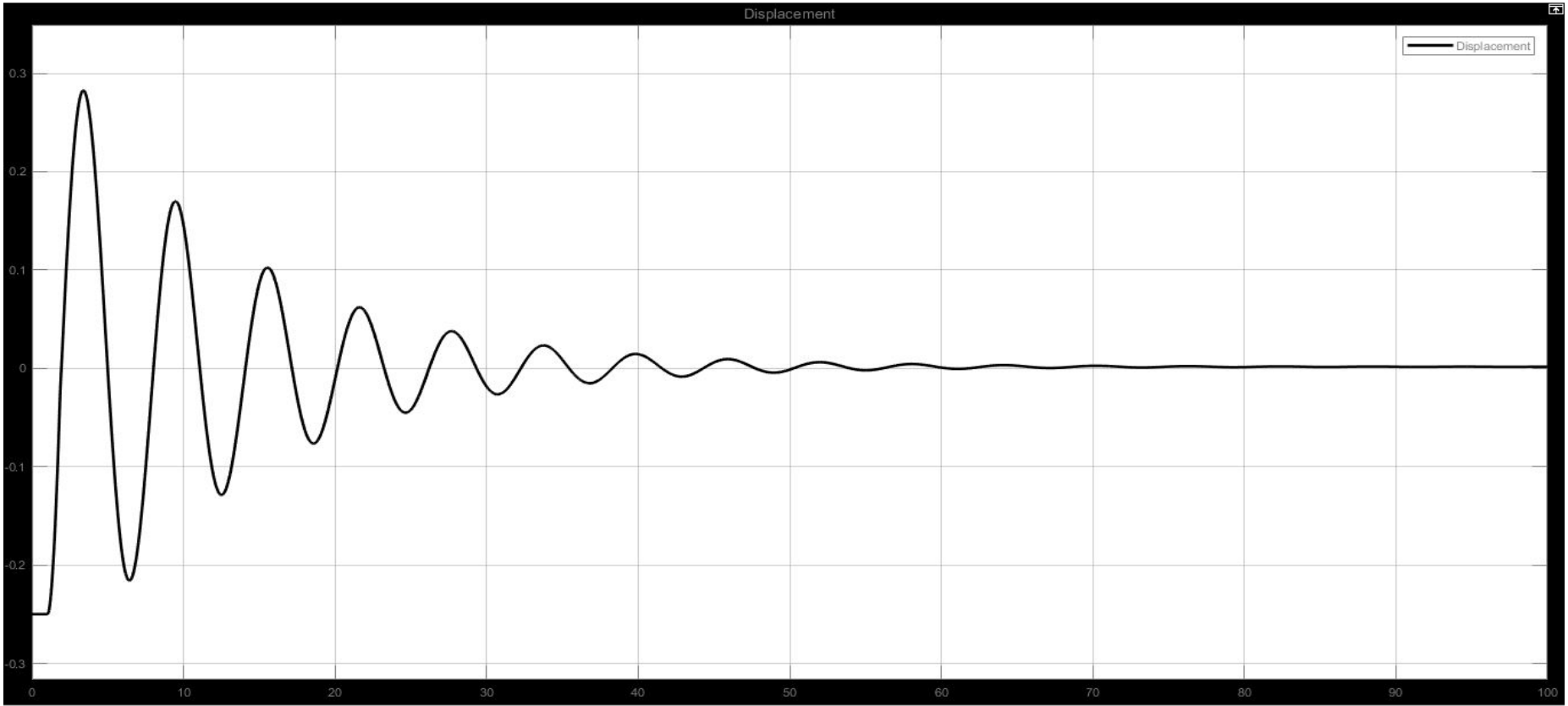
Kd = 20000

Simulink full block model



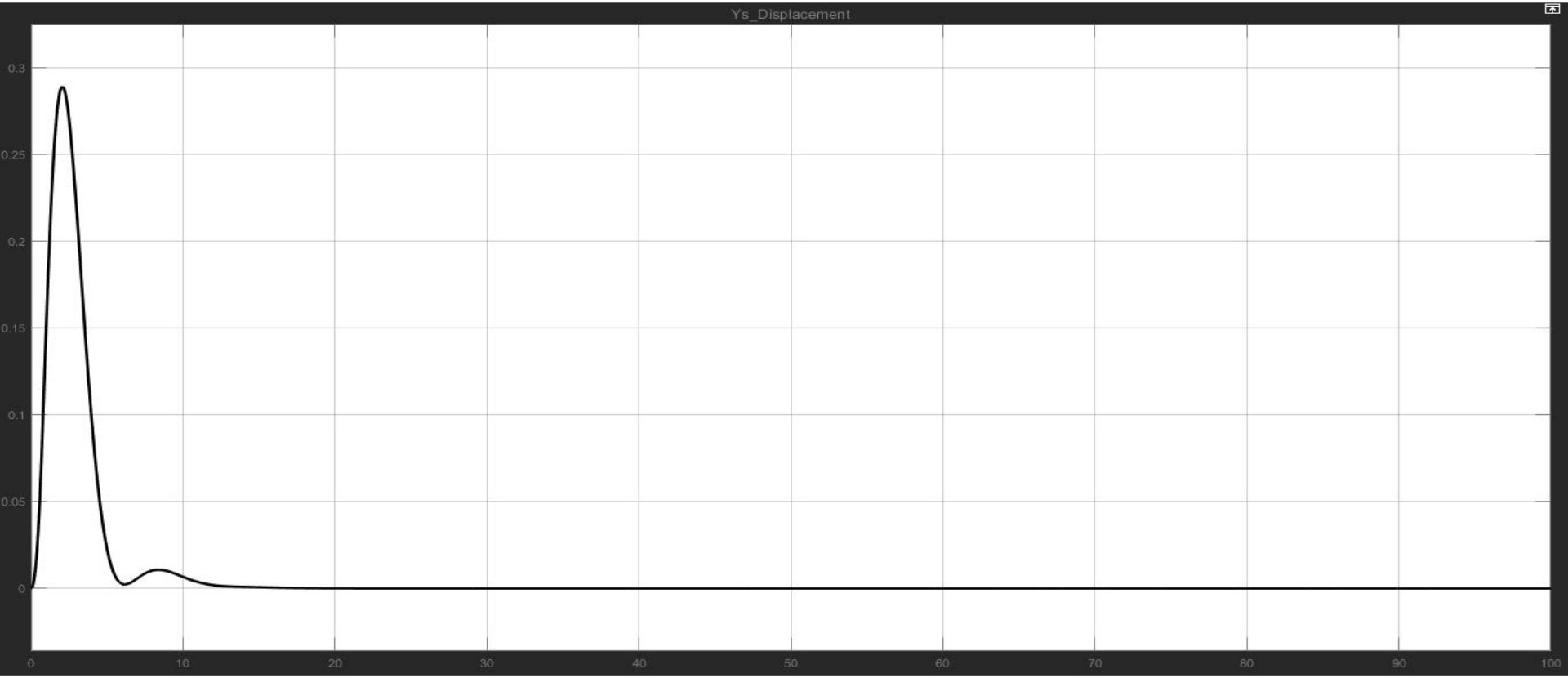
Passive suspension

Vertical displacement of sprung mass

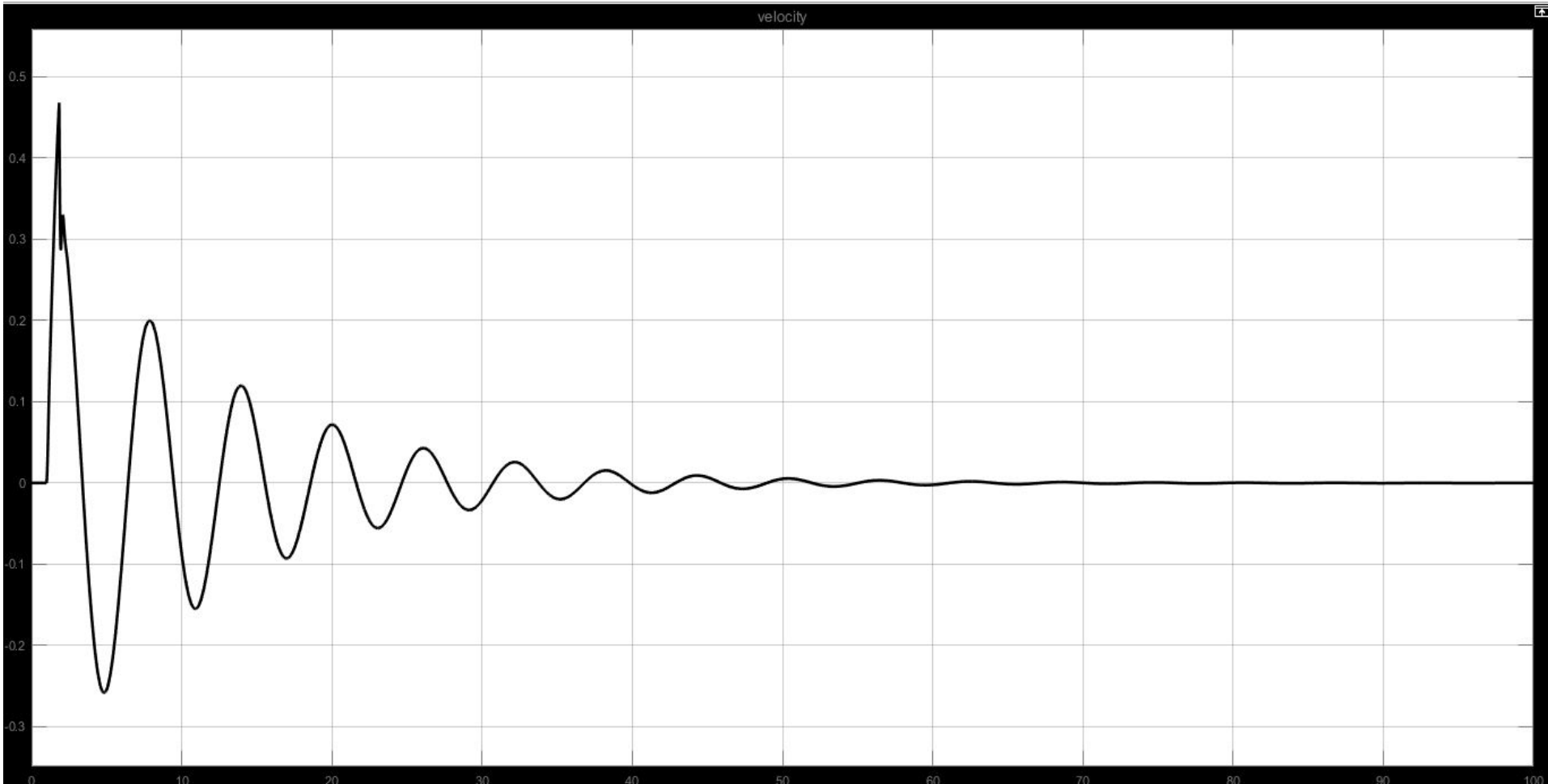


Active Suspension

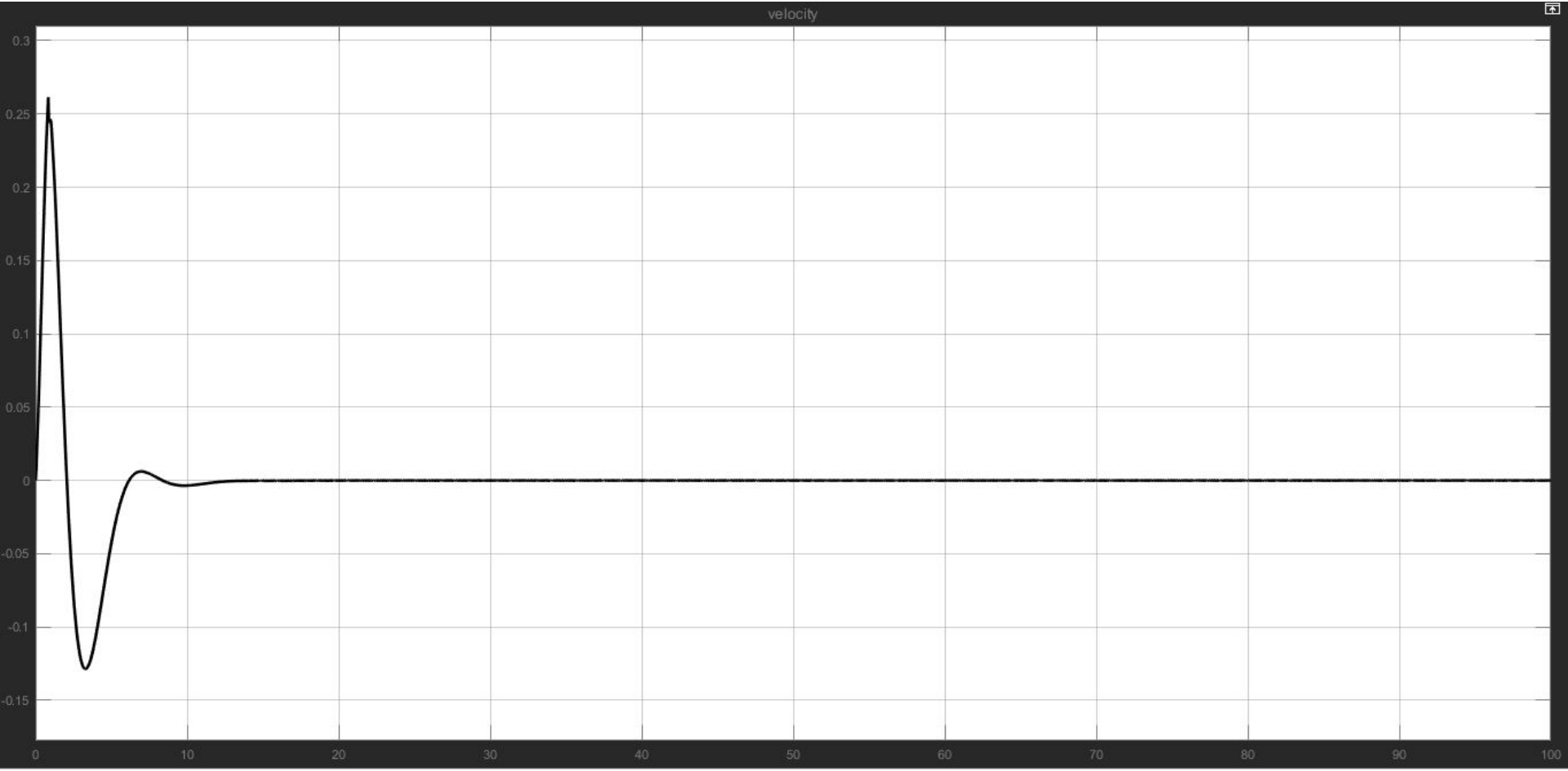
Vertical displacement of sprung mass



Velocity of sprung mass - passive suspension



Velocity of sprung mass - Active suspension



comparison

	Passive	Active	Improvement (%)
Displacement	0.29	0.24	18.00
Velocity	0.47	0.26	44.68
Settling time	80	20	75.00

Conclusion

- The proposed PID control gives percentage reduction in body vertical displacement, velocity and settling time.
- The comparison between active and passive suspension system is made and dynamic characteristics are compared. It has been observed that performance is improved in the form of vertical displacement and settling time by 18% and 75% respectively which will increase the passenger comfort and stability of vehicle.
- The observation drawn from the analysis is carried out with the help of software, the practical simulation may differ which can be further supported by control logics.

Future work

- Rolling action during cornering can be considered for accurate simulation

References

- Automotive suspension and steering system 5th edition – Don Knowles
- Modelling Simulation and Control of active suspension system in Matlab Simulink environment - Mohd. Avesh and Rajeev Srivastava

Thank you