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Auto Cruise System Modelling and Disturbance Reduction Using Control System Techniques

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Abstract: Designed the first principle mathematical modelling of the car model. Applied the newton second law of force for the car model and obtaining the mathematical parameter of the car. Convert the mathematical model into the transfer function. In this project, we were introducing the disturbance to the car model and reducing the disturbance control the speed of the system using PID controller. Air drag and rolling resistance was two disturbance introduced in this project.

INTRODUCTION

This project tested open-loop and closed-loop systems. For the open-loop test, inputs are a force and output is a velocity general meaning force introduce in a system makes the car move at a particular velocity. In the closed-loop test, velocity is input and velocity is output. For instance, the user starts placing the leg in the accelerator and monitoring the speed in the speedometer. In this case, the user gives the desired velocity and the car has to move the expected velocity. Two disturbances were applied to the system rolling resistance and air drag. In this project, we had introduced the disturbance and reduce the disturbance using the PID controller.

Air drag and rolling resistance

Due to the hard surface friction that occurs in a car wheel is a rolling resistance and it follows hysteresis in tire material. Tire rolling resistance energy is applied to the car so the car has to maintain a consistent speed. Fuel loss happens due to energy loss occurs in the tire. For additional information department of energy United States state that a low rolling resistance tire gives benefits to save 10 % fuel.

The resistance that happens while traveling in a car at a particular speed air drag or air resistance would occur. This force also knows as air drag. Shape drag will happen due to the design and shape of the car. Two pressures occur in a car 1) High pressure 2) Low pressure. High pressure occurs in front of the car opposes its movement by pushing. Low pressure occurs rear of the car opposes its motion pulling it backward.

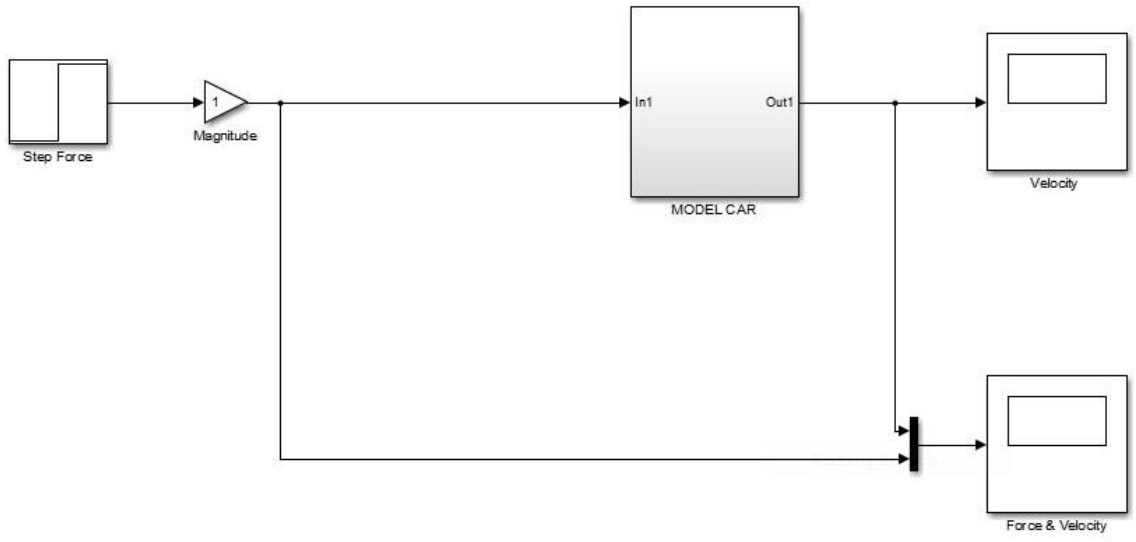

Figure: 1 Open Loop Force vs Velocity Circuit Diagram

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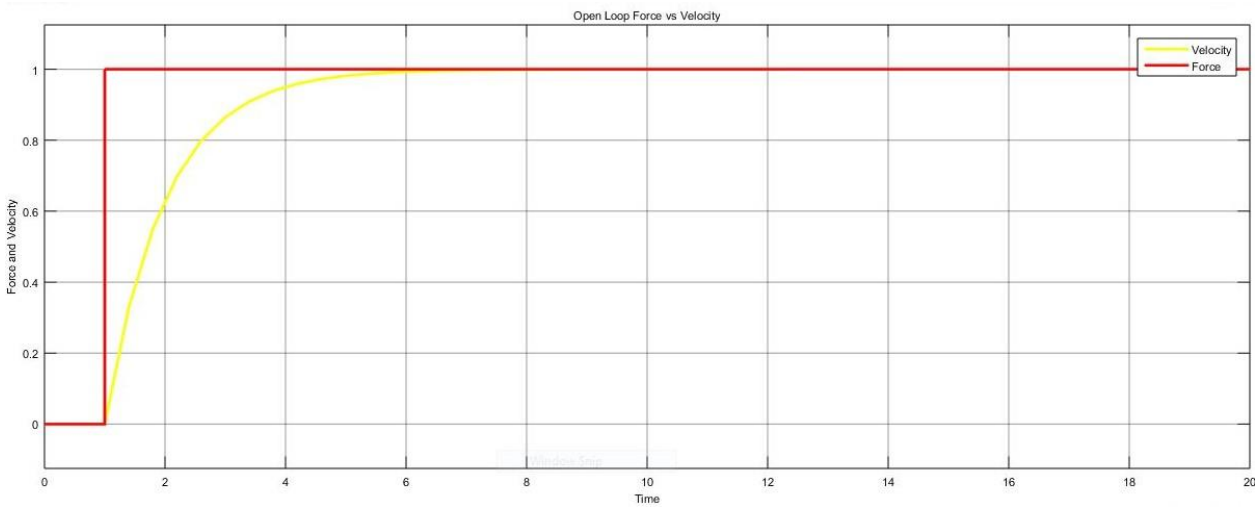

Figure: 2 Open Loop Force vs Velocity Output

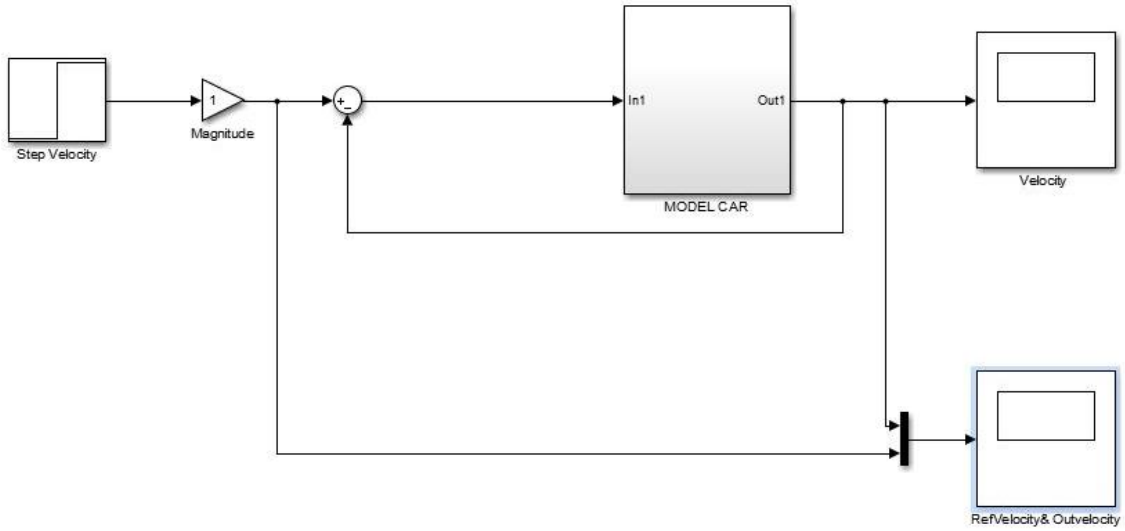

Figure: 3 Closed Loop Reference Velocity vs Output Velocity Circuit Diagram

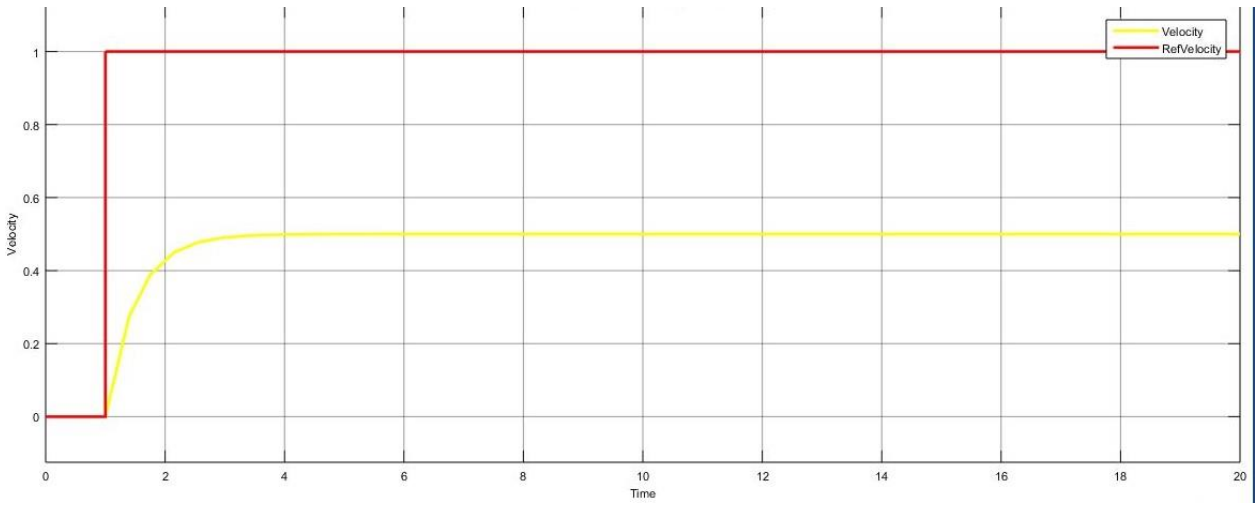

Figure: 4 Closed Loop Reference Velocity vs Output Velocity Output

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Model Performance

Open-loop Force input and velocity had obtained from the car model. The car model had designed from the newton second law of motion and converts the mathematical model into Laplace transform. One newton force applied to the model car it should give 1 meter per second velocity or speed output due to the disturbance it takes time to reach the settling point. In closed-loop velocity inputs applied to the model, it gives velocity output but in this project, velocity reached half of the expected velocity to overcome from this problem model had tuned using PID controller and reduced the error. Most of the projects talk about vehicle models but we were introducing disturbance to control the speed of the system. Disturbance plays a vital role in this project, the reason is an external factor like disturbance ruin the speed of the model regulating the speed makes the system comfortable

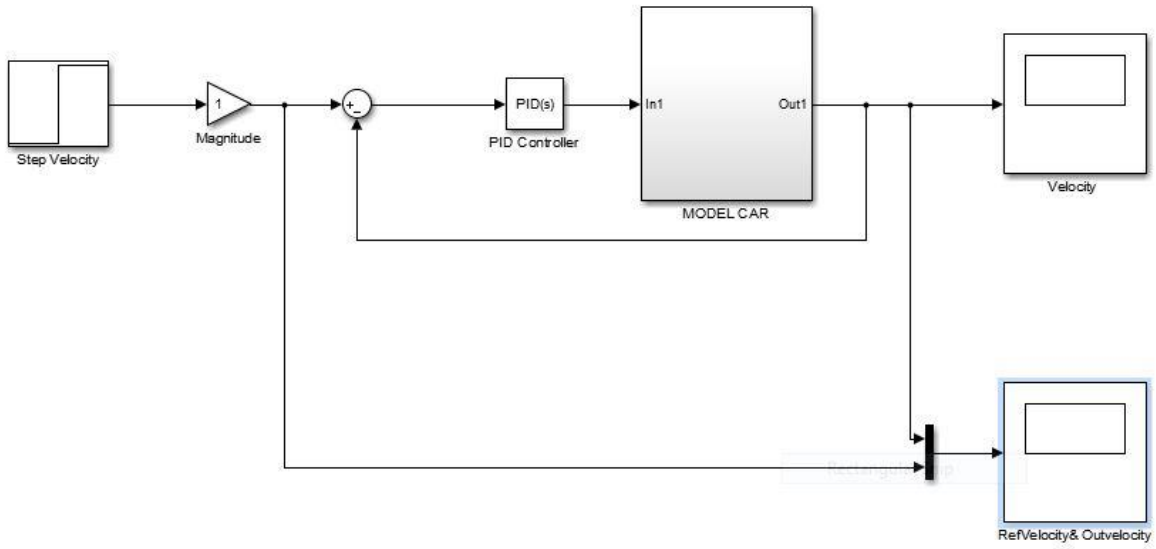

Figure: 5 PID Controller Closed Loop Reference Velocity vs Output Velocity Circuit Diagram

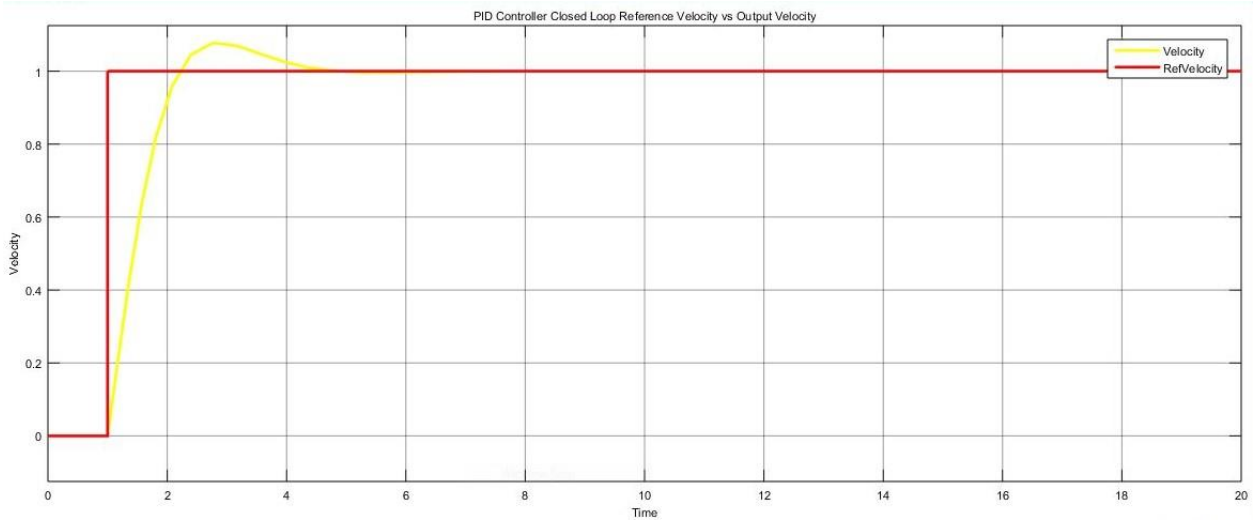

Figure: 6 PID Controller Closed Loop Reference Velocity vs Output Velocity Output

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CONCLUSION

The auto cruise system model is helpful to control the speed of the system. To control the speed by applying throttle maintain a steady speed. Mathematical modelling of the system is a lesser order and applying disturbance to the car model controlling the speed of the vehicle. Disturbance like rolling resistance and air drag are had introduced and reduced the disturbance. In this project, the disturbance had reduced and improved the car model performance in addition to improving the closed-loop model PID controller tuning model successfully executed.

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