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Study of Effect of P, PI Controller on Car Cruise Control System and Security

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ABSTRACT: This research paper deals with the effect of P,PI& PID controller in conventional cruise control which was implemented on a passenger car. Conventional cruise control takes over the accelerator operation at speeds over 40 km/h (25 mph) when it is engaged. An accurate positioning motor, with power amplifier that accepts a low-power (almost no current) voltage signal, and moves the accelerator pedal in a manner proportional to the voltage signal. . This paper deals with the design, and estimation of the controllers for steady state behavior.

KEYWORDS: P, PI & PID controller ,Car Cruise Control, Power Amplifier.

I.INTRODUCTION

Cruise control system is system to maintain accurately the driver's desired speed by actuating the throttle-accelerator pedal linkage without any intervention from driver's side. Cruise control system takes over the control the speed of the car by maintaining the constant speed set by the driver. Therefore, this system can help in reducing driver's fatigue in driving a long road trip This technique of controlling the speed was used in automobile industries since 1910.

The driver can set the cruise control with cruise switches, ON, OFF, RESUME, Set/Accel that are located in the steering wheel spokes or on the edge of the hub (HondaCars) or on turn signal stalk(GM cars)The on/off button actually has no crucial role. But the Off button turns the cruise control off even if it is engaged .The Set/accel button tells the car to maintain the current speed. Holding down the Set/Accel but will accelerate the car. The brake pedal and the clutch pedal each have a switch that disengages the cruise control as soon as the pedal is pressed.

The cruise control system controls the speed of the car the same way by adjusting the throttle position. Actually cruise control actuates the throttle valve by a cable connected to an actuator instead of pressing the pedal.

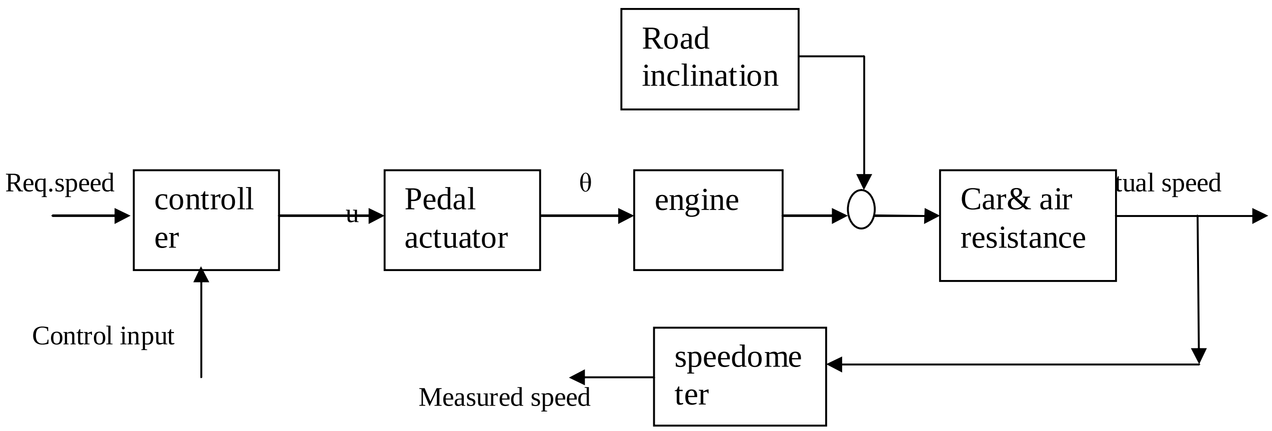

Fig.1 Simple car cruise block diagram

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II.SYSTEM MODEL AND ASSUMPTIONS

The purpose of cruise controls system is to maintain a constant vehicle speed despite having external disturbance like change of wind or road grade. It is accomplished by: measuring the vehicle speed and then comparing it with the reference/desired speed and then automatically adjusting the throttle according to control law.

In practise, the inertia of the wheels of the car is ignored. Assuming the friction of the car is obtained by the friction caused by the motion of the car. A physical model of the cruise control system is illustrated as shown in Fig. 1. The "m" indicated as the mass of a car

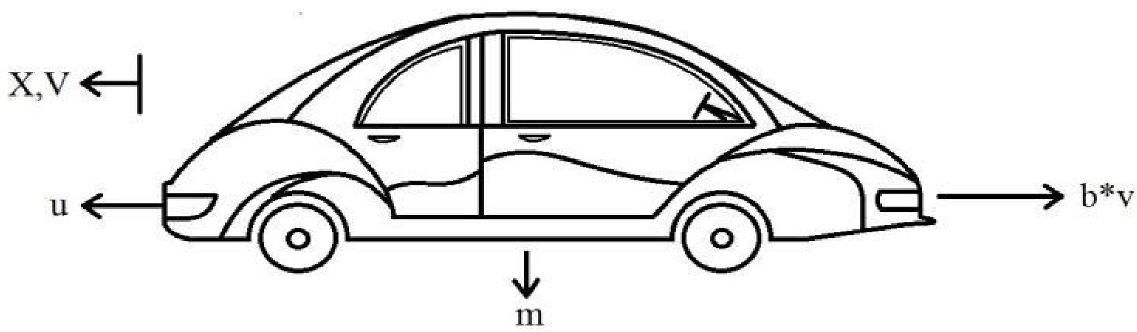

Fig.2 Free body diagram of a car

From the Newton's second law of motion, a differential equation of the cruise control model can be obtained, as in Eqn.1

$$m\frac{dv}{dt} + bv = u(t) \qquad \text{Eqn.1}$$

Where, v is the velocity of the car, b is the friction obtained by the car and u is the force from the engine.
Now taking Laplace transform of eqn.1

$$ms.V(s)+bV(s)=U(s)$$

Now arranging the terms,we get open loop transfer function of cruise system as:

$$\frac{U(s)}{V(s)} = \frac{1}{ms+b}$$

Now, we can study the steady state behaviour of the system using the transfer function. Let us consider the mass of the car is 1200kg, friction co-effiecient is 50Ns/m and the applied force U is 500Newton. Now the car moves at a maximum speed of 36km/h.

To adjust the car speed within the limits of specification, a controller has to be added.

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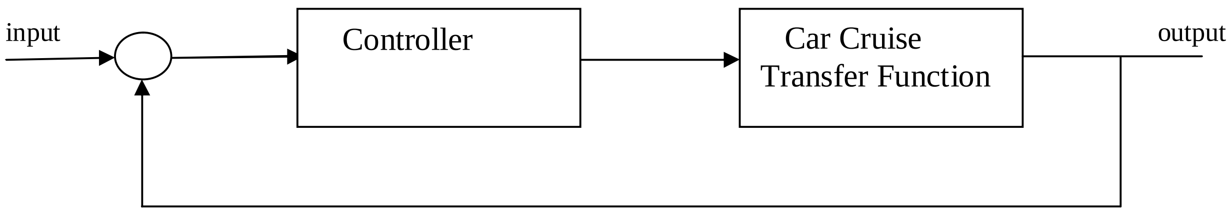

Fig.3 Car cruise control with controller

(B) Controller Action :

(i) **P Controller**: if the controller chosen is proportional one then the transfer function becomes

$$\frac{Y(s)}{U(s)} = \frac{Kp}{ms + b + Kp}$$

The characteristic curve for this proportional controller is seen on fig.3

(ii) **PI controller**: If integral control action is added along with the proportional control action then the transfer function becomes

$$\frac{Y(s)}{U(s)} = \frac{sKp + Ki}{ms^2 + (b + Kp)s + Ki}$$

The effect of addition of integral control action can be seen in graphs.

(iii) **PID controller**: Now, the addition of derivative controller to the PI controller will give a transfer function

$$\frac{Y(s)}{U(s)} = \frac{Kds^2 + Kps + Ki}{(m + Kd)s^2 + (b + Kp)s + Ki}$$

III.SIMULINK MODEL OF CAR CRUISE SYTEM

A trial version of the simple cruise control system is modelled in Matlab7.0 simulink and then the response is analysed along with Matlab simulation result. For this we have used the closed loop car cruise system.

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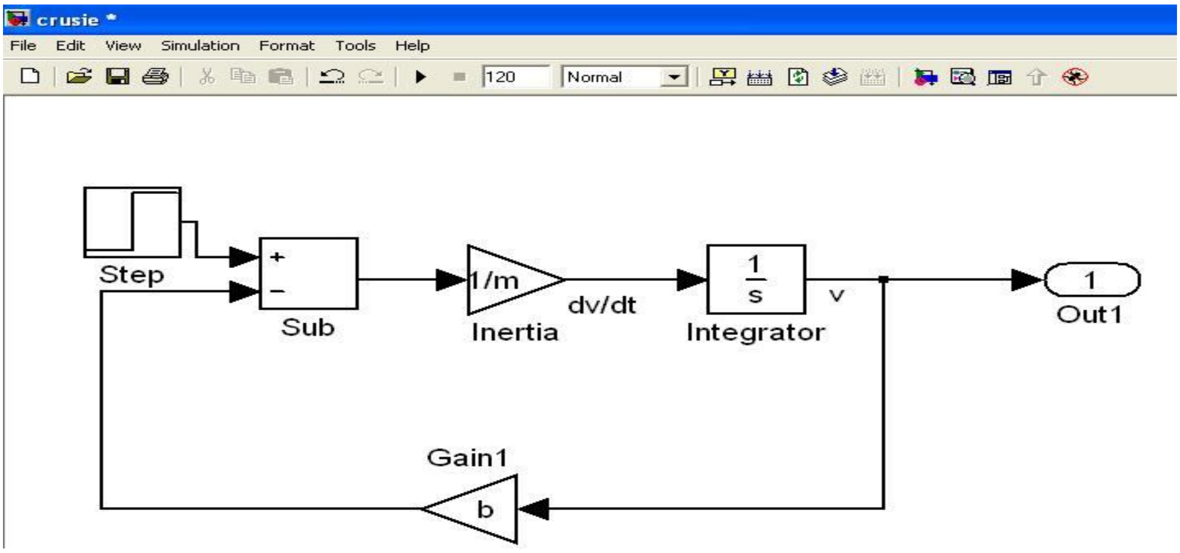

Fig.4 Simulink block of general car cruise system

Simulink model of car cruise system with PI-controller:

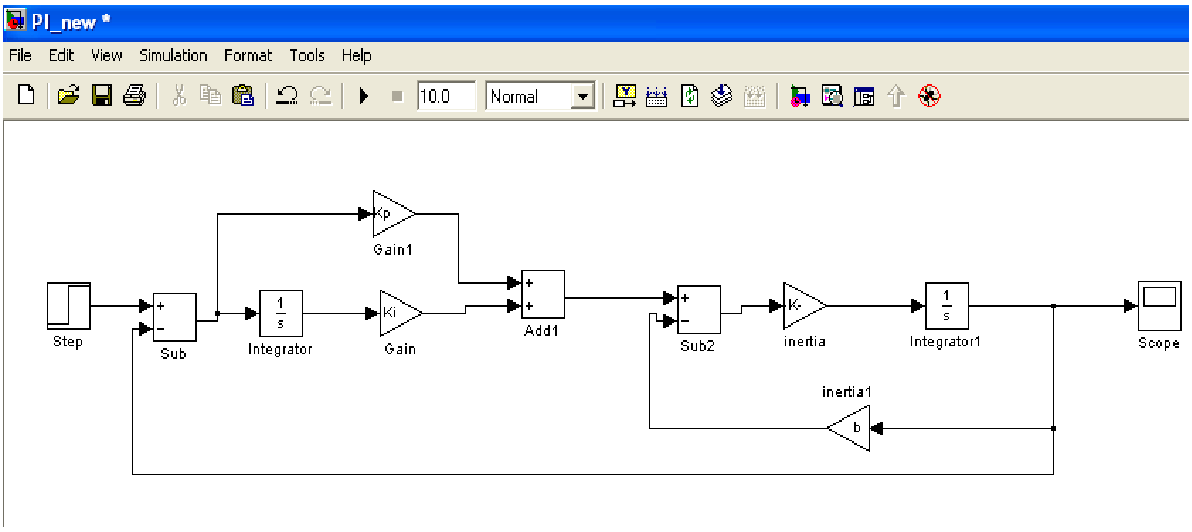

Fig.5 Simulink block for car cruise control using PI controller

V. RESULTS AND DISCUSSIONS

Simulation of closed loop car cruise system steady state response with Kp=1000 is observed as shown below

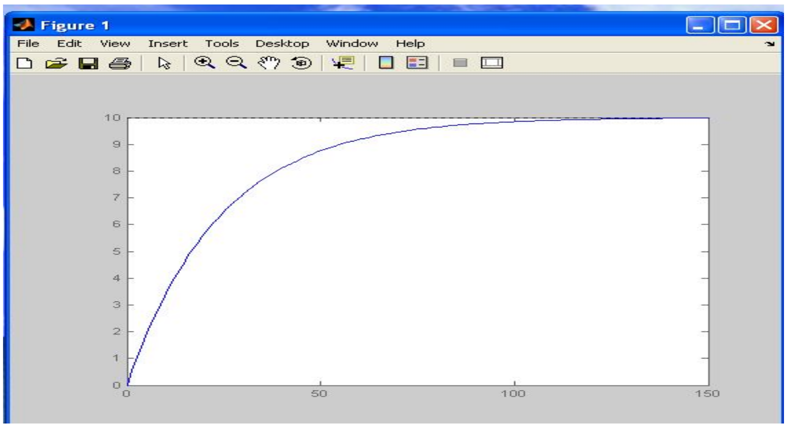

Fig.6 Matlab simulation of basic car cruise closed loop system

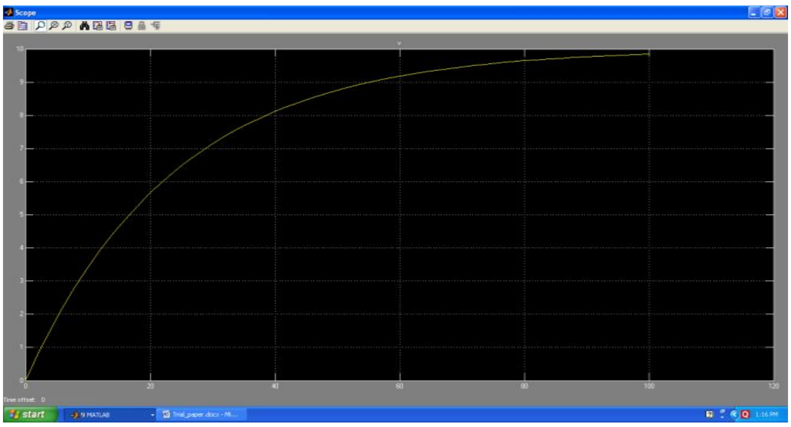

Fig.7 Matlab Simulink response of basic car cruise closed loop system

Thus we have seen that the response of a car cruise system in matlab simulation and simulink is almost same.

Now after addition of PI controller in matlab & the simulink the response can be observed as follows. From the graphs it can be seen that after addition of the PI controller the car reaches to the required speed faster.

Simulation of car cruise system with Kp=1000 & Ki=50

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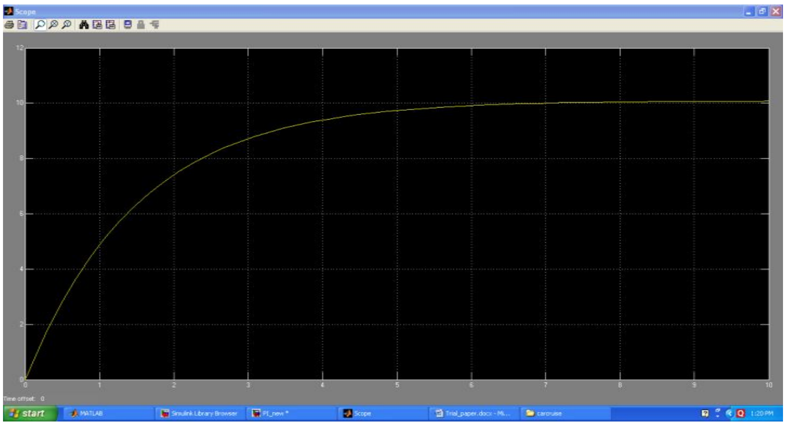

Fig.8 Simulink result of car cruise using PI control

Now the same will be implemented in Matlab simulation

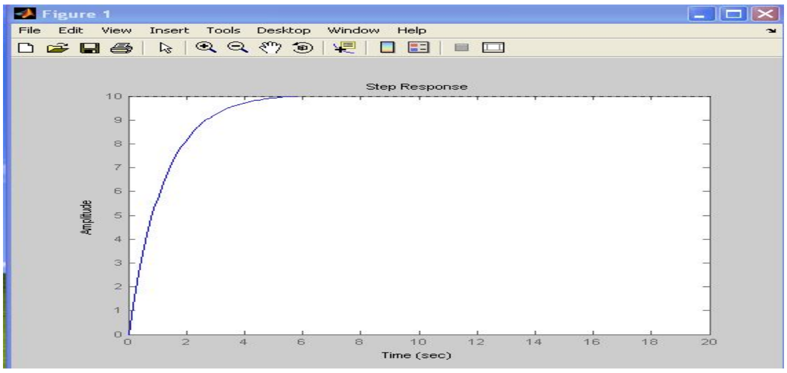

Fig.9 Matlab response of car cruise using PI control

VI.CONCLUSION

Although the PID control constitute one of the most important topics in the in controlling any model yet in this paper only PI controller gives the desired speed to the driver of an intelligent Vehicle. The PI controller in this case provides faster speed of response when used to conventional closed loop car cruise system.

REFERENCES

[1] S. Moon, I. Moon, and K. Yi, "Design, tuning and evaluation of a full range adaptive cruise control system with collision avoidance," *Control Eng. Pract.*, vol. 17, pp. 44 K. M. Passino, "Biomimicry of bacterial foraging for distributed optimization," IEEE Control Systems Magazine, vol. 22, no. 3, pp. 52-67, 2002.
[2] Control tutorials for Matlab: Example: Modeling a cruise control system. http://www.engin.umich.edu/group/ctm/examples/cruise/cc.html.
[3] Ronald K. Jurgen, Adaptive Cruise Control, Warrendale, PA, SAE International, 2006.
[4] D. Swaroop and R. Huandra, "Intelligent cruise control design based on a traffic flow specification," *Vehicle Syst. Dyn.*, vol. 30, pp. 319–344,Nov. 1998 .
N. Shimomura, "A study on preceding vehicle tracking on curved roads using stereo vision," Tech. Rep. PRMU97-27,IEICE, 1997.
Karnfelt, C. et al..77 GHz ACC Radar Simulation Platform,IEEE International Conferences on Intelligent Transport Systems Telecommunications (ITST), 2009IEICE, 1997.
J Wang,R Rajamani "The impact of adaptive cruise control systems on highway safety and traffic flow" University of Minnesota Department of Mechanical Engineering ,Minneapolis, Minnesota, USA.
D. Corona and B. De Schutter,"Adaptive cruise control for a SMART car: A comparison benchmark for MPC-PWA control methods,"-IEEE Transactionson Control SystemsTechnology, vol. 16, no. 2, pp. 365-372, Mar. 2008