Review of Modeling And Simulation of Car Cruise Control System Using PID Controller

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Abstract

This work focuses on the modeling and simulation of car cruise control systems with the implementation of a Proportional-Integral-Derivative (PID) controller. The primary objective is to develop a comprehensive model that integrates a PID controller for maintaining car speed under varying conditions. The methodology involves detailed modeling techniques to simulate car dynamics and the tuning of PID parameters for optimal control.

The research findings showcase the efficacy of the developed model in regulating car speed, demonstrating the PID controller's ability to respond to disturbances and maintain set speed levels accurately. Comparative analyses of different PID configurations reveal insights into their performance under diverse driving scenarios.

This study's outcomes provide valuable insights into the design and implementation of PID-based car cruise control systems, offering a foundation for further advancements in automotive control technology. The model's adaptability and accuracy highlight its potential for enhancing vehicle safety and efficiency.

Keywords: Car Cruise Control, PID Controller, Modeling, Simulation, Automotive Control Systems

Introduction

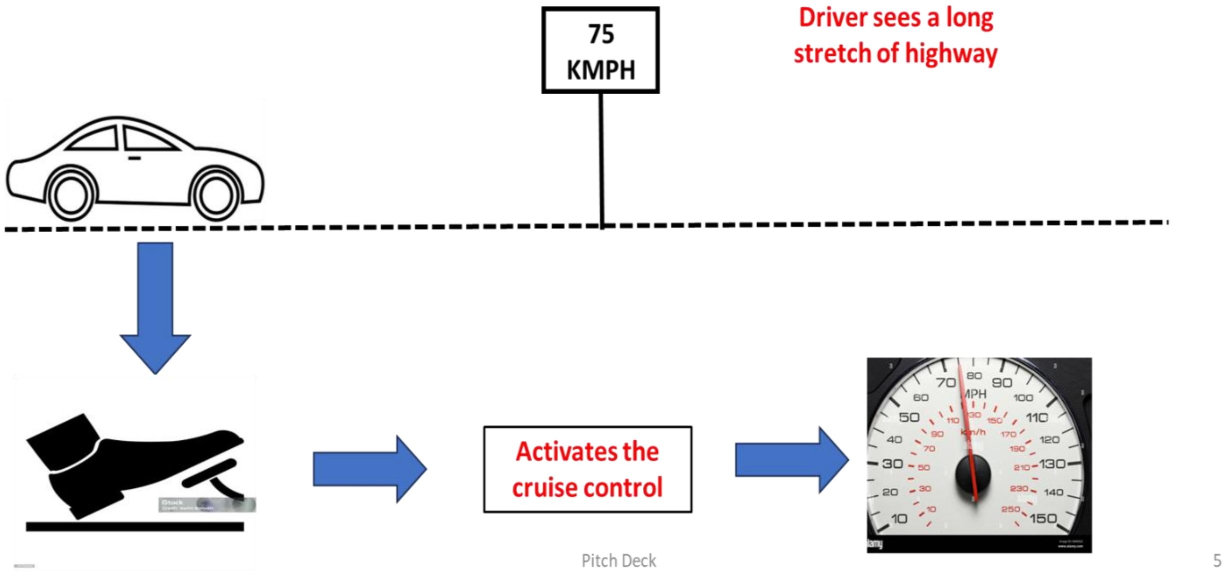
Car cruise control systems have become integral components of modern vehicles, offering drivers a convenient means to maintain a steady speed and enhance overall driving comfort and fuel efficiency. Existing cruise control systems predominantly utilize simplistic control mechanisms that might lack the precision needed to handle diverse driving conditions effectively.

The primary aim of this research is to develop a PID controller model that accurately emulates the dynamics of car cruise control and integrates a PID controller for real-time adjustments. By doing so, this work seeks to address the need for advanced control mechanisms in automotive systems, aiming to improve both performance and adaptability.

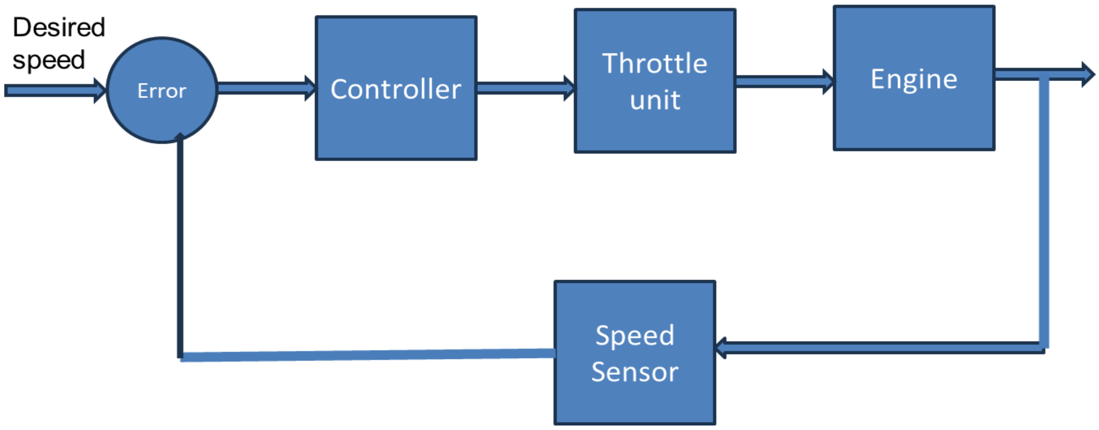
Methodology

Need to design the system model by considering some things. This system is a feedback control system and the purpose is to maintain constant vehicle speed despite external disturbances, such as changes in wind or road grade. This can be accomplished by

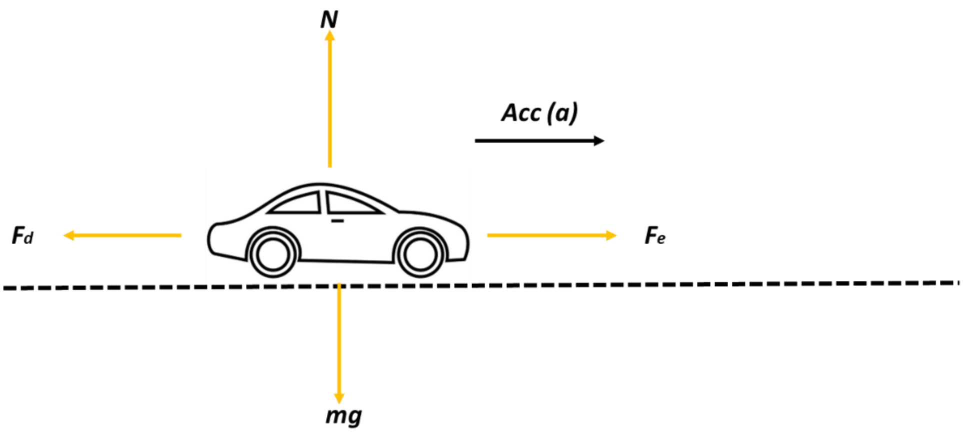
- Measuring the vehicle speed.
- Comparing it to the desired or reference speed
- Automatically adjusting the throttle according to a control law.



(Figure-1: Understanding cruise control system)



(Figure-2: Generalize Block Diagram representation)



(Figure 3: Freebody diagram of a car moving on a flat surface)

The mathematical model & the equation of motion is as follows.

$$\Sigma force = mass.acceleration$$

$$F_e - F_d = ma$$

$$F_e \ \alpha \ \text{throttle position } \alpha \text{ input}$$

$$F_e = k_1.(\text{Input to the throttle})$$

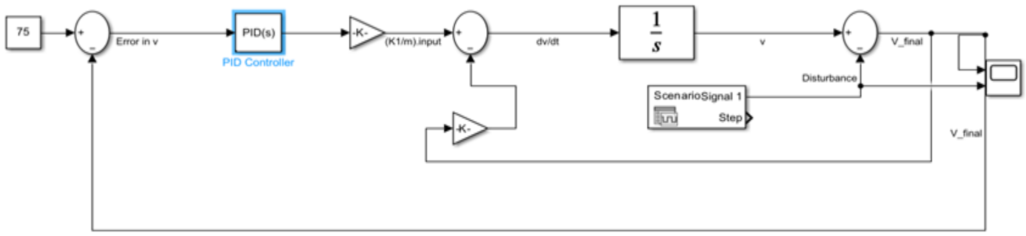
$$F_d = k_2 . v$$

$$K_1(\text{input}) - k_2 .v = ma$$

$$m\frac{dv}{dt} = -k_2 v + k_1(input)$$
$$\frac{dv}{dt} = -\frac{k_2}{m} v + \frac{k_1}{m}(input)$$

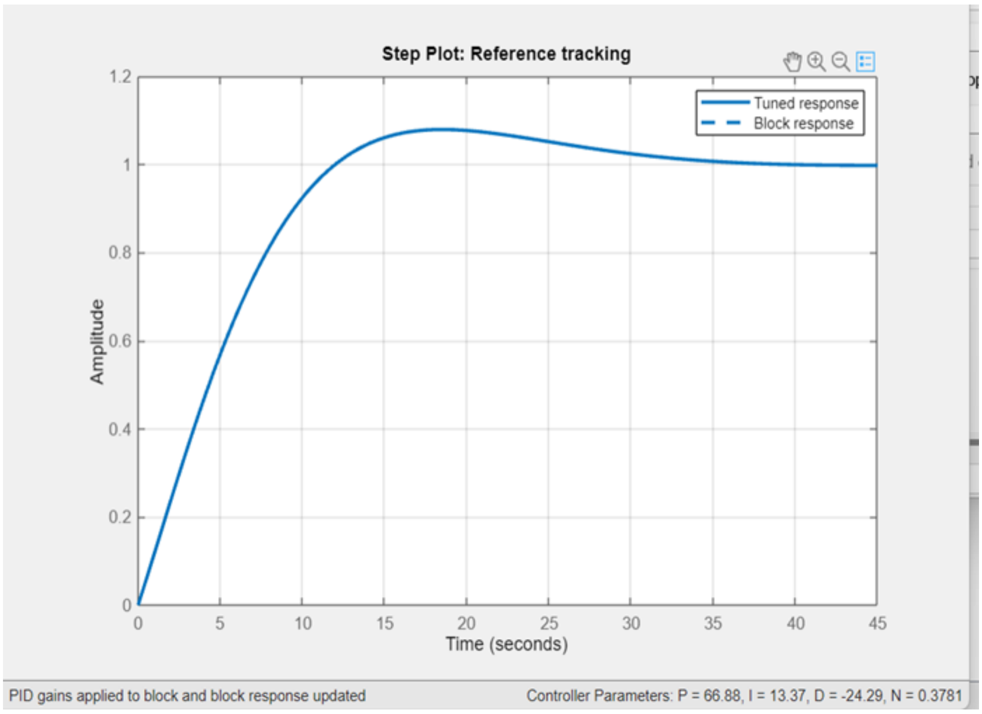
Simulation with the help of MATLAB SIMULINK

Considering m=1000 kg, K1=2 and k2=100(imperial values)



(Figure-4: PID controller schematic diagram using Simulink).

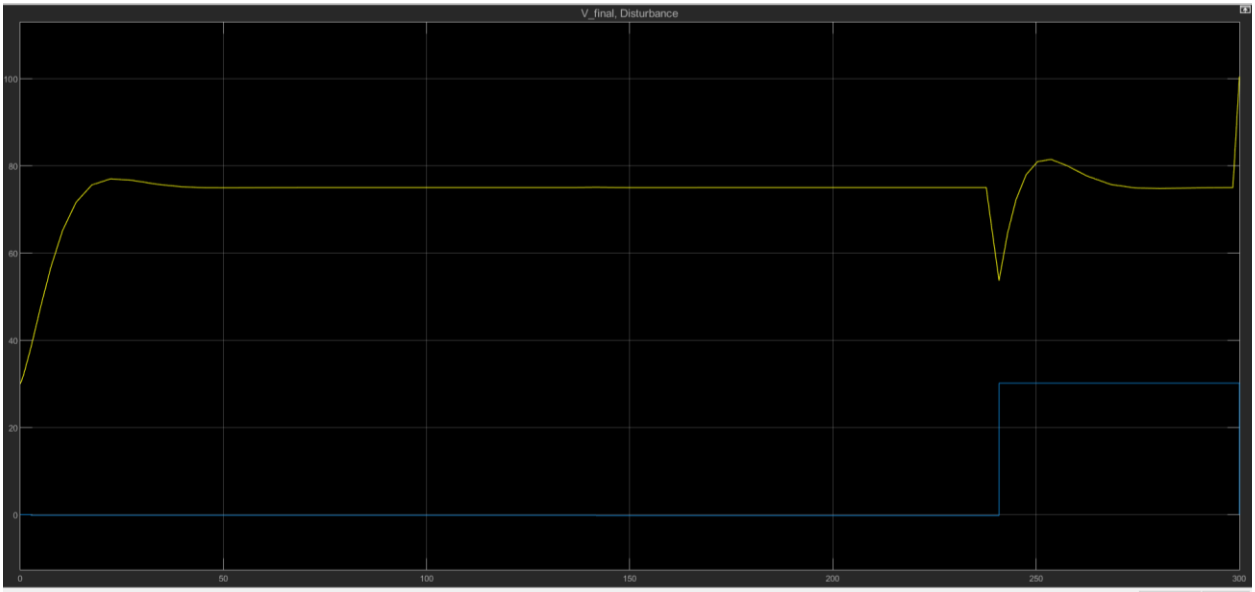
PID tuner done using simulation



(Figure-5: Setting PID Controller Values).

And we get P=66.88,I=13.37 ,D=-24.29

Result



(Figure-6: Cruise control system response).

Taking the vehicle's initial speed as 30 km/hr. The graph shows when the driver desires to set the speed to 75 km/hr, then the cruise control activates, and the vehicle moves till there is no disturbance in the pathway. But when there is a slight disturbance or increase in slope, the vehicle speed starts to decrease. But the PID controller comes into action and manages the vehicle's speed to the desired set speed i.e. 75 km/hr.

Conclusion

In this study, a PID controller has been proposed to undertake the controlling of cruise control system. A Comparison based on the system performance has been done among the PID controller values and the initial speed of the vehicle.

References

1. **"Modern Control Engineering" by Katsuhiko Ogata-4th Edition**
2. "Control Systems Engineering" by Norman S. Nise
3. IEEE Transactions on Control Systems Technology
4. IEEE Transactions on Intelligent Transportation Systems
5. Journal of Dynamic Systems, Measurement, and Control
6. K. Sailan and K. D. Kuhnert, "MODELING AND DESIGN OF CRUISE CONTROL SYSTEM W ITH F EEDFORWARD," pp. 339–349, 2013.
7. Y. Shi and R.C. Eberhart, "Parameter selection in particle swarm optimization," in Evolutionary Programming VII: 7th International Conference, EP 98 San Diego, California, USA, March 25--27, 1998 Proceedings, V. W. Porto, N. Saravanan, D. Waagen, and A. E. Eiben, Eds. Berlin, Heidelberg: Springer Berlin Heidelberg, 1998, pp. 591–600
8. J. Kennedy and R. Eberhart, "Particle swarm optimization, "Neural Networks, 1995. Proceedings. IEEE Int. Conf., vol. 4, pp. 1942–1948 vol.4, 1995.

a. Khaled Sailan and Klaus. Dieter Kuhnert, "Modeling and Design of Cruise Control System with Feedforward for all Terrian Vehicles", Second International Conference on Advanced Information Technologies and Applications, Nov 2, 2013 - Nov 3, 2013.
9. Andrew A. Frank, S. J. Liu, and S. C. Liang, "Longitudinal Control Concepts for Automated Automobiles and Trucks Operating on a Cooperative Highway", Society of Automotive Engineers Technical Paper Series, no. 891708, 1989
10. N. Vedam, I. Diaz-Rodriguez, and S.P. Bhattacharya, "A novel approach to the design of controllers in an automotive cruise-control system", In proceeding of the 40th Annual Conference of the IEEE on Industrial Electronics Society (IECON ' 14), pp. 2927-2932, 29 Oct - 01 Nov 2014.
11. O. Dwyer, "PI and PID controller tuning rules: an overview and personal perspective GC, (s) = K," pp. 161–166, 2006.
12. K. Osman, M. F. Rahmat, and M. A. Ahmad, "Modelling and Controller Design for a Cruise Control System," no. 1, pp. 254–258, 2009.
13. N Adhikari, M Choubey and R Singh, "DC motor control using Ziegler–Nichols and genetic algorithm technique" International Journal of Electrical, Electronics and Computer Engineering, April 2012
14. M. M. Gulzar, B. Sharif, D. Sibtain, L. Akbar, A. Akhtar "Modelling and Controller Design of Automotive Cruise Control System using Hybrid Model Predictive Controller." IEEE International Conference on Emerging Technologies (ICET), 2019