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EFFICIENT PERFORMANCE ANALYSIS OF ADAPTIVE CRUISE CONTROL SYSTEM AND SECURITY IN ELECTRIC VEHICLE

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ABSTRACT

Designing of Adaptive cruise control on a Electric Vehicle for better performance is discussed in this research paper. Adaptive Cruise control system maintains without the driver's assistance, the throttle-accelerator pedal linkage is actuated to precisely the driver's desired speed. The ACC system takes over control of the vehicle's speed while maintaining the driver's selected speed. As a result, this technology can aid in minimising driver tiredness during long road trips while also conserving energy, resulting in energy optimization. Since 1910, this method of speed control has been used in the car industry. Adaptive Cruise Control (ACC) is a cutting-edge driver aid technology helps in comparing given speed with reference speed. In this paper, an Adaptive Cruise Control step response behaviour under P, PI Controllers is discussed and executed results are being analysed. Design, analysis of performance of Adaptive Cruise Control for steady state behaviour and energy optimization is performed in the MATLAB and executed results are analysed.

Keywords: Adaptive Cruise Control, Hybrid Electric Vehicle, Remote Control, Steady State Behaviour, Energy Optimization.

I. INTRODUCTION

Everywhere in the world, there is a traffic problem. Every day, the number of vehicles on the road grows, resulting in an increase in the number of accidents. According to the poll, the majority of accidents are caused by driver error. The advanced driver assistance system is critical to the advancement of the automobile industry. Automobile safety is really crucial. Many accidents occur as a result of the driver's inability to maintain control in a timely manner. Due to the heavy traffic in metro centres, drivers are under a lot of stress and are often unable to handle their vehicles effectively, resulting in accidents. The introduction of new car technologies can help to reduce the frequency of accidents. They begin by introducing cruise control for vehicle. They first offer vehicle cruise control, in which the speed is chosen by the driver, and the car maintains it. In a congested freeway, cruise control is useless. If a car enters the same lane as the host vehicle and the gap between them is relatively short, cruise control is useless. They later devised a new system known as adaptive cruise control. It maintains the distance between two cars, and the vehicle's speed varies depending on the distance.

II. STRUCTURE OF THE ADAPTIVE CRUISE CONTROL SYSTEM

ACC's purpose is to accomplish cruise control while maintaining a fixed distance from the vehicle in front of you. We can divide things into categories. Traffic scenarios such as steady following, preceding vehicle emergency braking, preceding vehicle emergency accelerating, vehicle cutting in, vehicle cutting out, and host vehicle emergency braking are based on a range of different traffic circumstances have been developed. A vehicle equipped with ACC looks to be capable of dealing with the aforementioned circumstances. Furthermore, the switching method must be smooth, allowing the driver to be as comfortable as possible, while still ensuring driving safety. In most cases, the ACC system is envisioned as a multilayer controller structure with upper and bottom controllers, as shown in Figure 1. The top controller is in charge of calculating the desired acceleration. The bottom controller turns the intended acceleration into brake and throttle commands for the vehicle actuator to apply, based on current road circumstances.

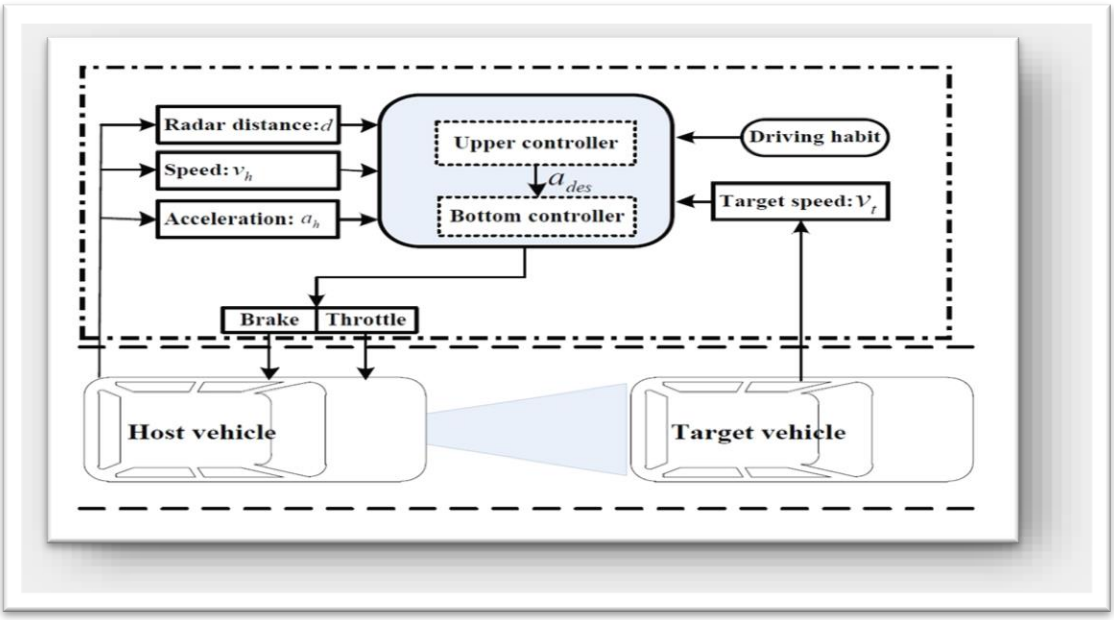

Figure 1: Structure of Adaptive Cruise Control

2.1 Analysis of Controller Selection :

1) Proportional Controller: If the proportional controller is chosen, TF is approximated as follows:

$$\frac{Y(S)}{U(S)} = \frac{Kp}{ms+b+Kp} \qquad (1)$$

2) PI controller: The transfer function is approximated as follows when an integral controller action is added to the proportional controller action,

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

In graphs, the effect of adding integral control action may be seen.

III. SIMULATION EXAMPLES WITH RESULTS

System transfer function model and parameters:

The following is the system TF:

$$\mathbf{P(s)} = \frac{\mathbf{Y(S)}}{\mathbf{U(S)}} = \frac{\mathbf{1}}{\mathbf{ms+b}} \quad \left[\frac{m/s}{N}\right] \qquad (3)$$

The following are the parameters used in this example:

- Vehicle mass (m) : 900 Kg
- Damping coefficient (b) : 50 N.s/m
- Reference speed (r) : 10 m/s

System Specifications:

- Rise time : < 5sec
- Peak overshoot : < 10%
- Steady-state error : < 2%

Example:

A) Proportional Control: (P)

(C = Kp) is a proportional control closed-loop transfer function

For the time being, use a KP of 100 and a reference speed of 10 m/s

Program:

```
m = 900;
b  =  50;
```

```
r  = 10;
s  = tf (‘s’);
p_cruise = 1/(m*s+b);
Kp  = 100;
C  = pid (Kp);
T  = feedback (C*P_cruise,1)
t  = 0: 0.1: 20;
step(r*T,t)
axis ([0 20 0 10])
```

Results :

```
                100
T =         ------------
              900 s + 150
```

Continuous-time transfer function .

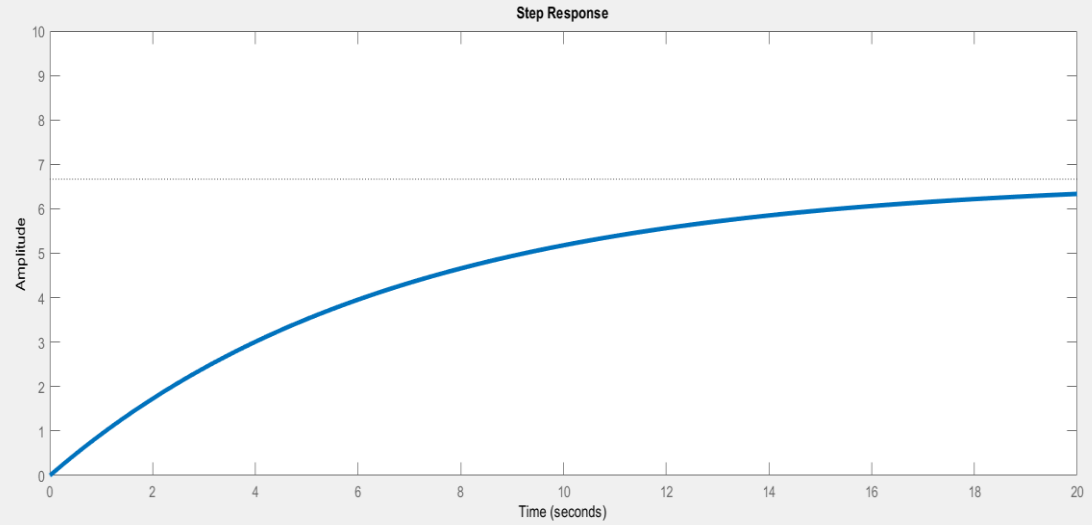

Figure 2: Closed-loop Proportional Control Response with K_P = 100

So that if K_P value increase to 5000 and reference speed of 10 m/s then final response shown below.

Program:

```
m = 900;
b  =  50;
r  = 10;
s  = tf (‘s’);
p_cruise = 1/(m*s+b);
Kp  = 5000;
C  = pid (Kp);
T  = feedback (C*P_cruise,1)
t  = 0: 0.1: 20;
step(r*T,t)
axis ([0 20 0 10])
```

Results :

$$T = \frac{5000}{900\,s + 5050}$$

Continuous-time transfer function .

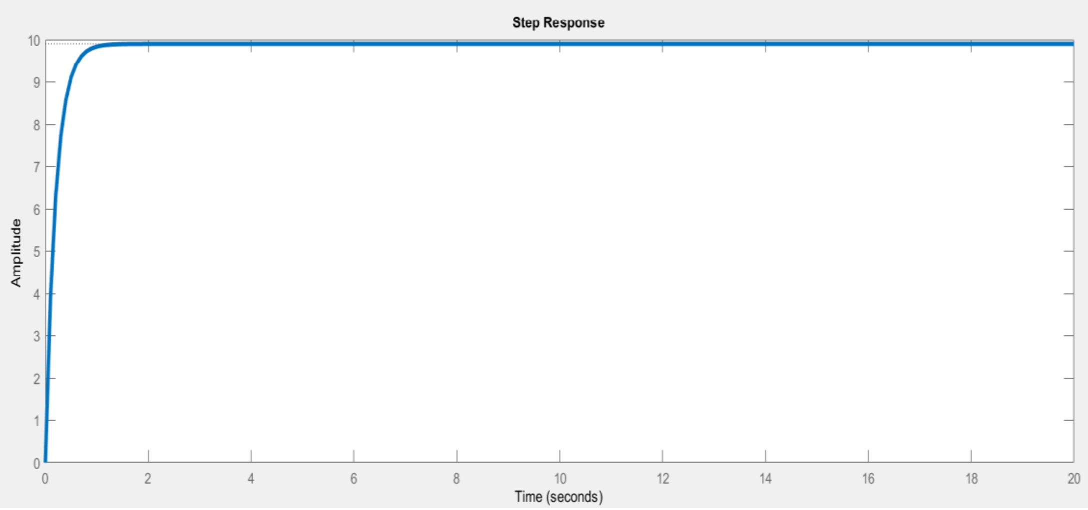

Figure 3: Closed-loop Proportional Control Response with $K_P = 5000$

(B) Proportional Integral Control: (PI)

The PI controller's closed-loop transfer function (C = KP + Ki/s)

Program:

```
Kp = 700;
Ki = 1;
C = pid(Kp,Ki);
T = feedback(C*P_cruise,1);
step(r*T,t)
axis([0 20 0 10])
```

Result:

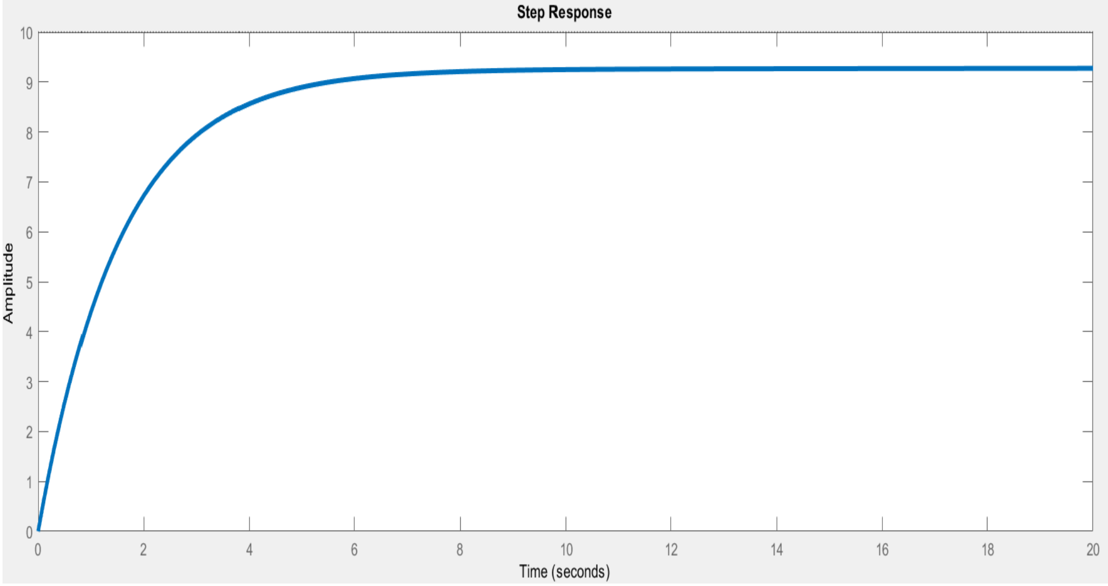

Figure 4: Closed-loop PI Control Response with $K_P = 600$, $K_i = 1$

Where the value of K_P is equal to 900 and K_i = 40 then the PI closed loop response shown below,

Program:

```
Kp = 900;
Ki = 40;
C = pid(Kp,Ki);
T = feedback(C*P_cruise,1);
step(r*T,t)
axis([0 20 0 10])
```

Result:

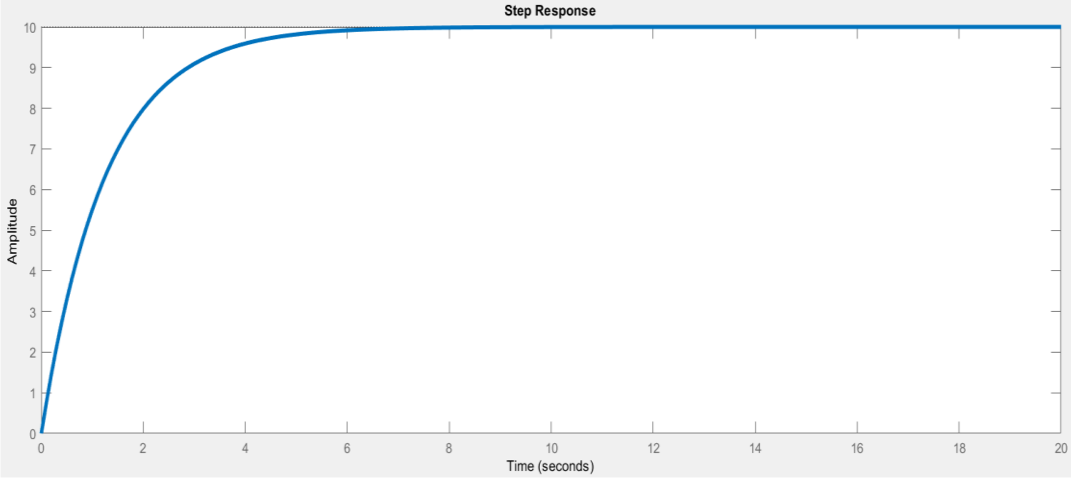

Figure 5: Closed-loop PI Control Response with K_P = 800, K_i = 40

IV. CONCLUSION

Following a thorough examination of the findings, it is observed that in this paper PI controller plays a crucial role in giving better response and desired speed of the vehicle when used to Adaptive Cruise Control. Further the experiments can be extended to using of other controllers like Fuzzy to achieve some more intelligence of speed and response.

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