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INTELLIGENT CAR SPEED CONTROL USING FUZZY LOGIC

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ABSTARCT

This article proposes naive fuzzy algorithm for enhancing speed control mechanism in heavy and complex mechanical car models travelling on curved roads. This research aims to resolve issues of increasing accidents on hills and rural areas in Indian environment effectively. The article targets controlling speed of vehicle effectively using P, PI and PID controller. Algorithm combines fuzzy logic and PID algorithm applied in. Fuzzy algorithm takes advantage of human driving experience and target speed value is made reach it through P , PI and PID controller. Fuzzy logic helpful for speed calculation while accuracy achieved by P, PI and PID controller mechanism. Through simulation smooth and steady control is achieved which will helpful for complete drive by wire system for economical car.

Keywords: fuzzy algorithm, speed control, PID controller

1. INTRODUCTION

Generally, human driver performs three major functions while driving. He controls speed of car, applies brake when needed and controls the steering wheel of car. Intelligent Driving System performs these major functions of human driver and fully controls the vehicle. Intelligent driving system consists of Brake control system, Steer control system and Speed control system. Usually, a classic approach system designed to do such functions could be very complicated, since obtaining a model for it is difficult and also time consuming. Considering this, fuzzy logic is a much better approach to the problem, because it gives enough flexibility and capability for the design of the system.

Secondly, the trade-off between performance and complexity is the main factor in IDS design. Fuzzy systems arose from the desire to describe complex systems linguistically, and fuzzy controllers allow a human approach to control design without the demand for knowledge of mathematical modelling of more conventional control design methods.

This paper describes the use of fuzzy logic in the design of Speed Control System for controlling the speed of car when car drives into curves. The objective is to create a system that is capable of controlling speed of the car and making the system capable of determining appropriate speed for different roadmap.

2. DESIGN OF SPEED CONTROL SYSTEM

By considering the speed requirement of car, a method to calculate the exact speed value will be becomes important. Fuzzy control algorithm has advantages. It can easily make use of human driving experiences and have strong robustness for parameters (Rajasekaran, 2006). This paper put forward a speed control system shown in Fig.1. Speed of controlled object is given from fuzzy controller then P/ PI/ PID controller will make the Engine reach it.

In Fig.1, input to fuzzy controller is current position deviation and output of fuzzy controller is speed value of controlled object, this speed value is given to the P/PI/PID controller which provides speed control signal that controls the engine rpm. There is real-time engine rpm feedback.

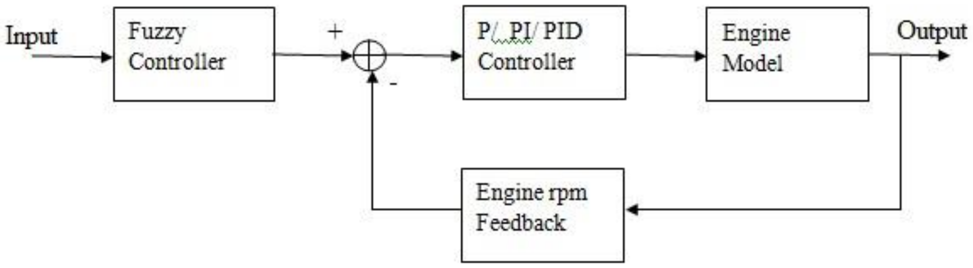

Figure 1: Speed control system structure

The objective of this paper is to control the speed of the car. Engine is called heart of the car; it is the engine that provides speed to the car. So engine model is considered as the main object that has to be controlled. Input to engine is combination of fuel and air and output of engine is engine rpm (revolution per minute) which depends upon the amount of fuel and air. So actually engine rpm is controlled.

2.1 Fuzzy Controller

Fuzzy controller has three functional modules: fuzzification, fuzzy inference, and defuzzification.

2.1.1 Fuzzification

Fuzzification is the process where the crisp quantities are converted to fuzzy (crisp to fuzzy) (Rajasekaran, 2006). By identifying some of the uncertainties present in the crisp values, we form the fuzzy values. The conversion of fuzzy values is represented by the membership functions.

fuzzification process may involve assigning membership values for the given crisp quantities. There are various methods to assign the membership values or the membership functions to fuzzy variables. The assignment can be just done by intuition or by using some algorithms or logical procedures.

The system uses conventional fuzzy controller. The input is current position deviation e, and the output is speed control signal u. Position deviation “Deviation” is the deviation between actual location and car’s axis (Zhan, 2012). The value of position deviation “Deviation” is made to fuzzification. Define fuzzy subset: Deviation = {BTL, VBL, BL, SL, VSL, ZE, VSR, SR, BR, VBR, BTR}. It can be quantized： Deviation = {−9, −7.5, −6, −4.5, −3, −1.5, 0, 1.5, 3, 4.5, 6, 7.5, 9}. When Deviation is zero; it means no deviation from the path. Positive Deviation means deviated to the right, and negative Deviation means deviated to the left.

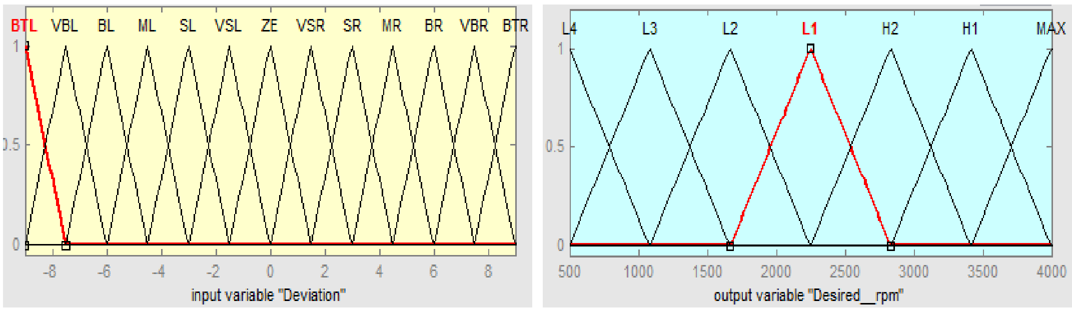

Figure 2: Membership function of Deviation and Desired rpm, respectively

Define fuzzy subset： Desired_rpm = {L4, L3, L2, L1, H2, H1, MAX}. Desired_rpm can be also quantified to seven grades, the domain of Desired_rpm = {500, 1083, 1667, 2280, 2833, 3417, 4000}. The membership function of Deviation and Desired_rpm is shown in Fig.2, respectively.

2.1.2 Fuzzy Inference

Taking advantages of human driving experience, for instance, when deviation is quite small, means position of car is in the middle or the path is straight, speed could be improved and Desired_rpm = MAX. When deviation is quite big, means path is very curve, then speed should be reduced to minimum value, so Desired_rpm = L4. All rules are obtained through human driving experience and intuitive thinking.

Table 1: Rules

Deviation	BTL	VBL	BL	ML	SL	VSL	ZE	VSR	SR	MR	BR	VBR	BTR
Desired rpm	**L4**	**L3**	**L2**	**L1**	**H2**	**H1**	**MAX**	**H1**	**H2**	**L1**	**L2**	**L3**	**L4**

2.1.3 Defuzzification

Defuzzification means the fuzzy to crisp conversion . The fuzzy results generated cannot be used as such to the applications, hence it is necessary to convert the fuzzy quantities into crisp quantities for further processing. This can be achieved by using defuzzification process. The defuzzification has the capability to reduce a fuzzy to a crisp single-valued quantity or as a set. Defuzzification reduces the collection of membership function values in to a single sealer quantity. Centroid method is the most widely used method. This method is also called centre of gravity or centre of area method (Sivanandam, 2007).

3. RESULT

Simulation is done in Matlab 7.8.0 simulink environment. Different cases are considered and results are analyzed as follows.

Case 1: Straight path (No Curve)

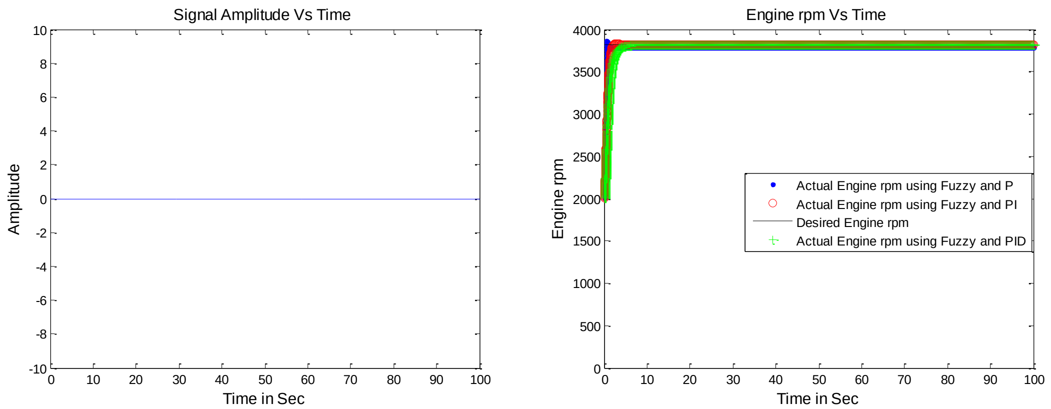

Figure 3: Input and output for case 1

Case 2: Curve following straight path

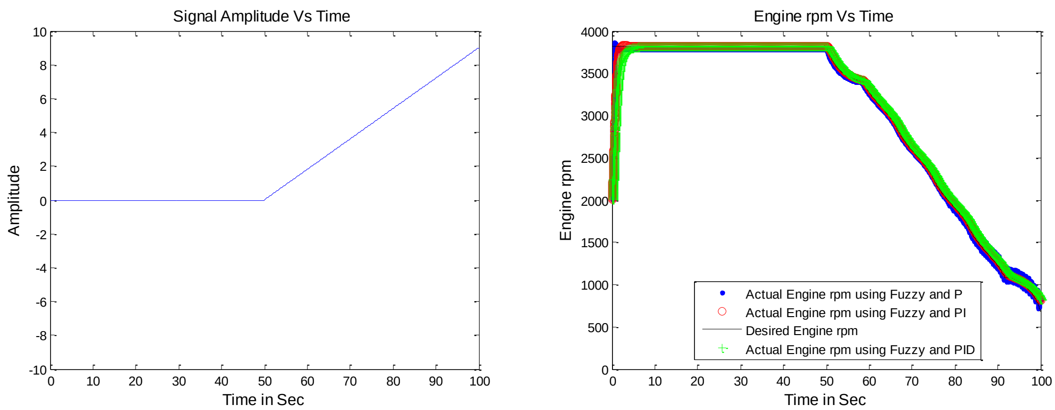

Figure 4: Input and output for case 2

Case 3: Straight path following curve

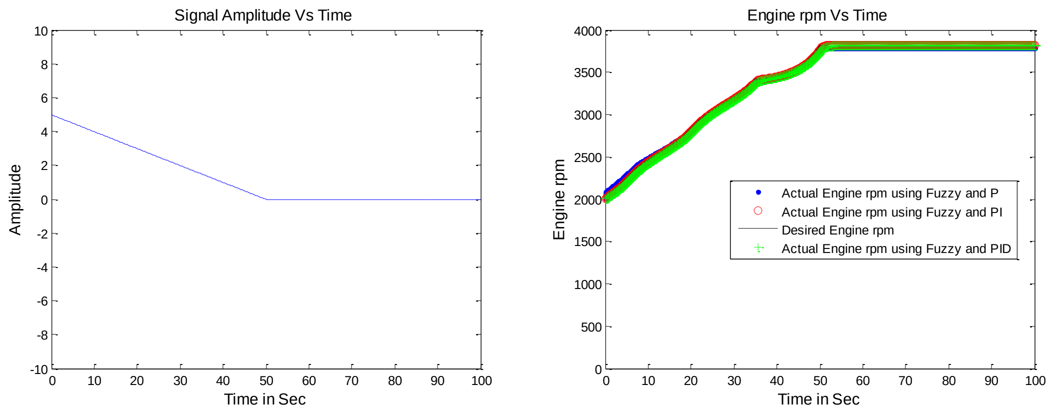

Figure 5: Input and output for case 3

Case 4: Highway

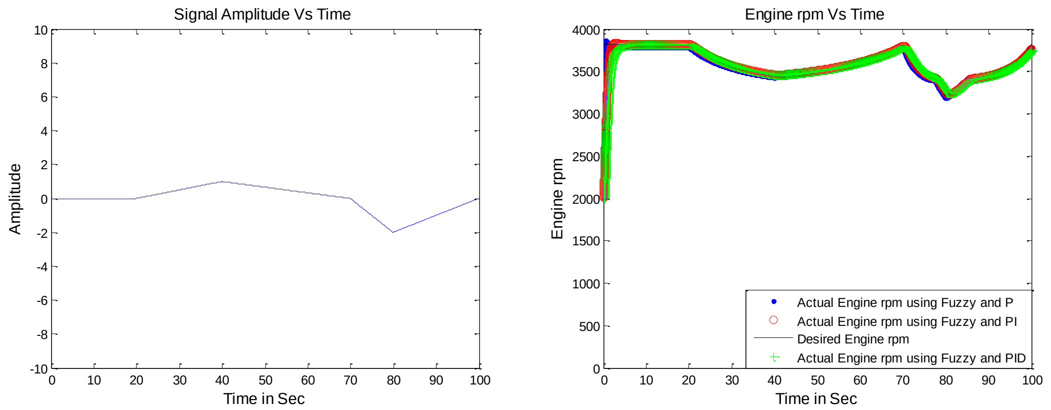

Figure 6: Input and output for case 4

Case 5: Random curves

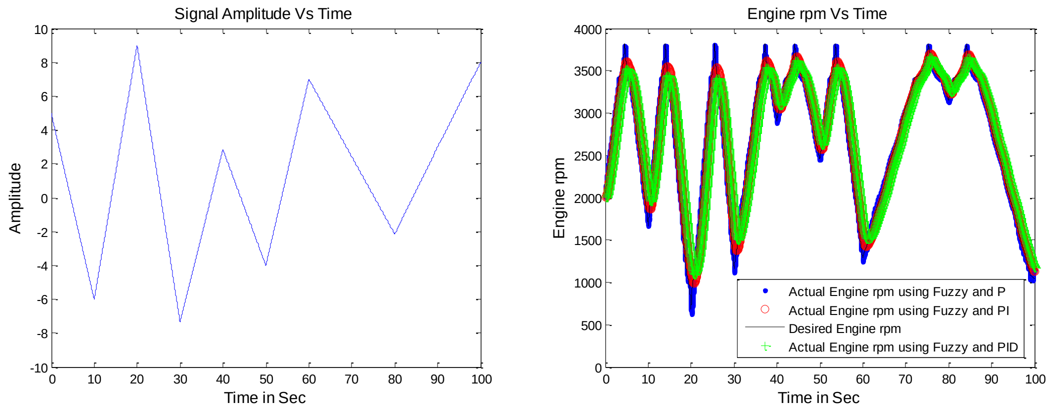

Figure 7: Input and output for case 5

4. COMPARISON TABLE

Sr. No	**Control Method**	**Max to Min rpm delay**	**Min to Max rpm delay**	**Comment**
1	Fuzzy and P Controller	2 sec	5 sec	Very fast response but not stable
2	Fuzzy and PI Controller	11 sec	8 sec	Oscillation in the output rpm in case of rapid change in curves
3	Fuzzy and PID Controller	15 sec	11 sec	Slow but smooth response

5. CONCLUSION

This article proposed the fuzzy algorithm with P/PI/PID controller for car speed control system for different roadmap. The response of P/PI/PID controller with fuzzy algorithm for engine rpm variation is analysed for maximum and minimum speed for curve roadmaps. This article proposed the alternate solution which will overcome the human driving error on curved roadmaps with low cost and small electronics improvements in bulky dynamics mechanical moving models.

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