Fuzzy Based PID Controller Using VHDL for Transportation Applications

K.B. Mercy Evangilin and R. Kannan

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FUZZY BASED PID CONTROLLER USING VHDL FOR TRANSPORTATION APPLICATIONS

K. B.Mercy Evangilin[1], R.Kannan [2],

1. UG Student ,Department of ECE (BTech), Saveetha School Of Engineering,Chennai-602105

2.Assistant Professor, Department Of ECE(BTech), Saveetha School Of Engineering,Chennai-602105

ABSTRACT:

The designing of PID-type (Proportional-Integral-Derivative) controller based on Fuzzy set of rules using VHDL to apply in transportation cruising system. The cruising machine with Fuzzy concept has evolved to avoid the collisions between automobiles on the street. The evolved Fuzzy Logic Controller (FLC) offers a reference for controlling the vehicle speed either boom or decrease. The controlling pace relies upon on the distance of the preceding automobile while it gets too near or alert the motive force while necessary. The Mamdani Fuzzy Inference idea is studied, and developed in Matlab package deal before everything for designing the PID-type FLC hardware machine. The behavioral of the PID-type FLC algorithm is then simulated the use of VHDL language. The contrast of simulation consequences among Matlab and VHDL are presented for designing the PID-type hardware implementation. The synthesis tool from Quartus-II surroundings is selected to synthesize the designed VHDL codes for acquiring the Register Transfer Level (RTL) hardware architecture of the PID modulus. The developed and designed Fuzzy based PID-kind cruising controller is inexpensive in price compare to standard PID controller gadget, and, thus we can advocate this evolved chip to apply to the entry-level cars along with the national car.

This may be in addition reduced the road coincidence and ensure the protection of the street users in the future.

A type of fuzzy parameter PID set of rules is advanced. It can become aware of the parameters of the PID controller in actual time on line. This permits that the controllers can adapt to the parameters' exchange of the controlled object and it could also realise the fast parameters' adjustment in the multi points controlled device. When applied within the system controlled by way of the mobile strip fumace, its control effewt is higher than that of the ordinary PID controller. This proves the availability of this method. The proposed PID device is capable of produce a near approximation of a linear characteristic for approximating the GPP system.

I.INTRODUCTION:

In[1],PID controller is the excellent called business method controller. It is strong in wide range of performance. However, conventional PID controller is not suitable for nonlinear gadget. Therefore, PID-kind

Fuzzy Controller is preferred within the non-linear process because of its simplicity, robustness, and variable structure. Moreover, the PID controller does no longer require specific know-how of the version of the dynamic plant, which is complicated and very difficult to obtain. The PID controller mostly can be implemented to the control technique which includes motor drives, flight controls, high-velocity trains, and others application. Improvement on the PID controller gadget can lead to large effect in the control process for industrial application. Therefore, the PID-type Fuzzy controller machine is investigated, layout and simulated on this project.Fuzzy gadget is well known with its non-linearity feature behavior. Therefore, the non-linear function of the traditional PID controller can be stepped forward greatly the use of fuzzy logic algorithm. Besides, maximum of the research works have executed at the Fuzzy PID controller, which are, focusing at the traditional two-input PI (Proportional-Integral) or PD (Proportional-Derivative) type as proposed by way of Mamdani.In[2],(PID) controllers are via a ways the maximum usually used controllers in manner manage programs because they are simple, reliable, and smooth to construct. No doubt that PID is the excellent known sort of controller. However, their performance in cases where methods are too complicated for analysis via conventional manipulate strategies or in which the available assets of statistics are inexact or uncertain is not as suitable as desired. To overcome these difficulties, we proposed a Digital Fuzzy-PID control strategy which combining the bushy device with the traditional adaptive manage have been typically demonstrated in the nonlinear manipulate because of their powerful nonlinear modeling adaptability and capability. Fuzzy control has emerged as one in every of the most active and crucial application branches of fuzzy theory for the reason that first cognizance of the bushy controller the use of fuzzy logic by using Mamdani in 1974. . An ideal way to gain the Fuzzy logics is based totally at the hardware. With the fast improvement of EDA Technology, the Field Programmable Gate Array (FPGA) has been greater widely used by the advantage of its high integration, rapid calculation speed, excessive universality and bendy circuit design.

In[3],AC velocity regulation technology, which discards the concept of decoupling within the vector-manage generation, and adopts the orientation of stator flux and temporary space vector theory. By manner of detecting the modern-day and voltage of the stator, observing the flux and torque underneath stator coordinate system, then evaluating the observed price and set fee a good way to accumulate the control signal, and in the end synthesizing the flux and torque indicators to select the corresponding voltage space vector, this generation controls the flux and torque of the stator directly, this is to say, at the same time as flux manage is accomplished, torque manage is achieved as well. Its blessings are fast dynamic torque perfomance and less dependent at the motor variables.In[4],Analytic tendencies of the describing feature of an FLC are made and the limit-cycle of a machine controlled via the FLC is theoretically addressed by way of the analytic describing feature of the FLC. To facilitate the derivation of the analytic expression of the describing function, simplest the subsequent two varieties of the FLC are considered and a few assumptions on the structure of the FLC are made.

I) A static fuzzy good judgment controller.

II) A dynamic fuzzy good judgment controller with and because the input variable.

The relaxation of the paper is organized as follows. After the introduction, an FLC is reviewed in short and some assumptions on the structures of the FLC used on this paper are explained . In describing characteristic method, an crucial tool for the prediction of the limit-cycle, is explained.In[5],While an analytically based study is conducted for the first relationship, the second dating is solved by the usage of a genetic method. A simple controller applying a unmarried variable, three rules, and six design parameters is developed. The homes of the manipulate motion are discussed in phrases of the design parameters.The nonlinear proportional benefit is explicitly derived in an error domain. The issues of nonlinear controller layout are mentioned, and a conservative design approach is usually recommended for a guaranteed-PID-performance. Two indexes are proposed for the assessment of nonlinear controller designs. For an optimal machine design the use of genetic algorithms, an overall performance index is proposed consisting of several individual performance indexes. Finally, numerical research are finished on several tactics consisting of nonlinearities due to time postpone and saturation.In[6],Two indexes are proposed for the assessment of nonlinear controller designs. For an optimal device design the usage of genetic algorithms, an overall overall performance index is proposed along with several man or woman performance indexes. Finally, numerical studies are carried out on several techniques consisting of nonlinearities because of time delay and saturation.

Properties of Fuzzy PID Controller:

The analysis of fuzzy proportional movements is crucial because the movements are an immediate output from the fuzzy inference, and in addition they influence the bushy crucial and derivative moves. Several homes of the connection between and are summarized beneath to offer some useful design tips for fuzzy PID controller design.

1) Limits the significance of normalized proportional action to be much less than or identical to one.

2) It is a vital condition for a 0 steady-state error.

3)It shows a most proportional controller output for a quick riseup response while mistakes is at an extreme.
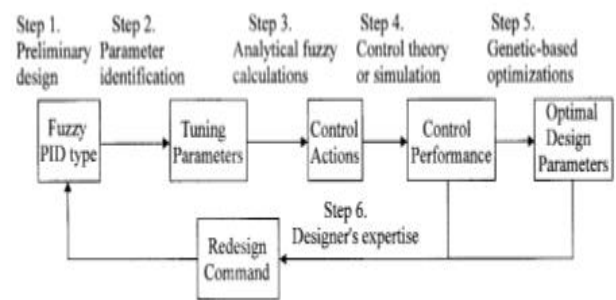
II.BLOCK DIAGRAM:

Fig-1 Block diagram of PID controller

A new technique is proposed for the analytical layout of a fuzzy PID controller. Fig. 1 indicates the proposed method with recognize to the records or parameter flow in off-line layout. In Step 1, the structure of a fuzzy PID controller is designed and the structural parameters are set for the preliminary layout. The tuning parameters

are identified in Step 2, while in Step three an analytical fuzzy calculation is performed, which produces a closed-form relationship among the design parameters and control movement for the fuzzy inference. In Step 4, numerical simulation (or control theory) is used to acquire the manipulate performance statistics. In Step 5, genetic-based totally optimizations are performed to provide optimal layout parameters. This also affords useful facts for the remodel of the authentic system. Finally, if necessary, remodel is undertaken the usage of the designer's information for further development to the manage system. Note that the theoretical look at in Step three makes the fuzzy controller transparent. This step is important since it will set up a near link among fuzzy control design method and classical/present day manage theory.

Synthesis is the method of transforming one representation inside the layout abstraction hierarchy to another representation. Synthesis method has performed the use of synthesis tools (Quartus II) for synthesizing the compiled VHDL layout codes into gate degree schematics. It initially strategies the VHDL building blocks to Register Transfer Level (RTL) block for all six hardware modules of PID controller system. The additives of modules are along with multiplier, registers, gates and flip flops etc. While synthesizing the layout, HDL library browser turned into used to synthesize the layout in a hierarchical manner. In this paper, we have presented one of the RTL blocks amongst of six modules.

Although the capabilities of fuzzy structures have the advantage of being relatively smooth to understand, the structures become complicated or nontransparent

because of many layout parameters involved. Considering fuzzy PID-like controllers, we summarize the design parameters within groups: structural parameters and tuning parameters
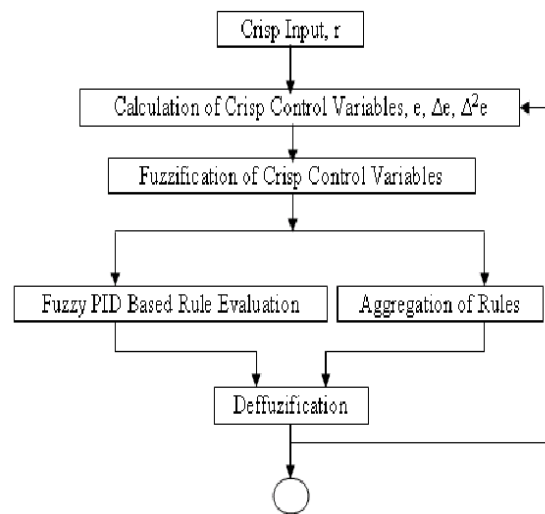
III. IMPLEMENTATION:

Fig -2 Flow chart of PID controller

A fuzzy common sense controller (FLC) is based on fuzzy logic that's much closer in spirit to human wondering and natural language than the traditional logical gadget. The essential a part of the FLC is a hard and fast of linguistic control guidelines associated through the dual standards of fuzzy implication and the compositional policies of inference. The derivation is developed based totally on the design method of the overall FLC, the resultant manage law has an analytical PID controller form and linguistic shape. The stability of the nonlinear fuzzy PID control gadget is completely established upon the linear PID controller that's naturally generated in

growing the nonlinear fuzzy PID control regulation.

Fuzzy Logic algorithm:

The FLC is the core of the design, which is a two-input,three-output controller. It takes inputs, along with error (E) and fee of change of error (C E) approximately a set-point. The case of E is a map which occurs from the real line to the interval [-10, 10] and C E is [-1, 1]. Outputs of the controller are 3 profits of the PID controller, i.E. P K ,i K and d K . Each map of them is from the real line to the interval [-1, 1].The linguistic variables necessary to every input variables and output variables are divided into 7 parts, i.E. NB, NM, NS, ZO, PS, PM and PB. Membership features for inputs and outputs are chosen the usage of the Triangle distribution form. In this research, MATLAB/SIMULINK, a technical computing surroundings for high-performance numerical computation and visualization, is used.

The most crucial gain of the Digital fuzzy-PID controller is that it's miles feasible to layout a control device whose plant dynamics isn't known, by most effective using the input/output information. Also, a linear PID controller can obviously be derived below the design method of the Digital fuzzy-PID controller, although plant dynamics isn't always known. Fuzzy control rules should be made based totally on expert enjoy and control engineering understanding, or based totally at the operator's manage action. In order to fulfill the requirement of the PID parameters underneath one of a kind E and distinctive C E , the PID parameters are modified on line by means of fuzzy control policies. The accuracy of the traditional PID manage blended with the intelligence of the fuzzy control will make the dynamic feature and static feature of the controlled object well. The empirical information on how the domain experts perform the technique is modeled and stored inside the fuzzy rule base .

IV.RESULT:

APPLICATION:

The targeted utility of the Fuzzy based totally PID controller on this work is the transportation cruising machine. The cruising device that developed is to avoid the collision between motors at the road. The device sense the distance of the preceding vehicle and reduce the rate when it get too near or alert the motive force whilst necessary. Besides, it additionally limits the acceleration of the vehicle relying on the distance of the preceding vehicle.This machine is being evolved by Mercedes Benz and is mounted in its new line of S-Class. However, the era developed is steeply-priced because the radar machine and image processing is involved.

Comparison of six numeric examples

	P1(based on F)	P2(based on F1)	P3(based on F2)
Kp, Kj,K i Sn	0.394,0.06 30,0.992 4.17	0.213,0.0 394,8.90 4.17	0.906,0.3 23,0.575 0.551
T1(s ec)	2.5	2.5	5.5
T2(s	16.5	25	9.5

ec)			
POS (%)	4.55	13.5	0.923
F	0.245	0.253	0.176
F1	0.104	0.0805	0.186

Table -1

Six numerical examples have been investigated. Within those examples, the fuzzy PID controllers constantly gift the great overall performance results. For a higher assessment of the non linearityselected by using the optimal method corresponding to each process, we list the related information in Table -1. Out of the 4 primary nonlinear curves, simplest Types I and II nonlinear curves, corresponding to the simplest, are decided on from the optimization.

V.CONCLUSION:

The PID type fuzzy controller algorithm has defined first the usage of MATLAB platform. The described PID controller also has evolved with all fuzzy rules for designing the hardware PID chip using VHDL. Then, the synthesize device has used to get the logic gates of hardware PID modules. The designed PID chip can be used to the centered application. As an example, transportation cruising machine. The cruising system based totally on PID chip can be prevented the collision between cars on the road.The control effect we can see that the effect controlled by using the bushy parameters adaptive PID controller is much better than that through the Zigeler Nichols controller. The parameters of the PID controller are changeable in real time, so it has higher control effect than the Zigeler Nichols controller in the real time system.

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