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And scientific research
University Of Diyala
College Of Engineering
Computer and Software
Engineering Department

Analysis and Performance Evaluation of the Velocity Control of DC Motor

A project
Submitted to college of engineering, University of Diyala, in partial fulfillments of the requirements for degree of BSC. in computer and software engineering.

By

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Supervised by

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بسم الله الرحمن الرحيم

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ۞خَلَقَ الْإِنسَانَ
مِنْ عَلَقٍ۞اقْرَأْ وَرَبُّكَ الْأَكْرَمُ۞الَّذِي عَلَّمَ
بِالْقَلَمِ۞عَلَّمَ الْإِنسَانَ مَا لَمْ يَعْلَمْ ۞

سورة العلق (١-٥)

صدق الله العظيم

الإهـــــــــــداء

إلى من جرع الكأس فارغاً ليسقيني قطرة حب

إلى من كلّت أنامله ليقدم لنا لحظة سعادة

إلى من حصد الأشواك عن دربي ليمهد لي طريق العلم

إلى القلب الكبير والدي العزيز

....

إلى من اعطتني الحب والحنان

إلى رمز الحب وبلسم الشفاء

إلى القلب الناصع بالبياض والدتي الحبيبة

....

إلى القلوب الطاهرة الرقيقة والنفوس البريئة إلى رياحين حياتي إخوتي

....

إلى الأرواح التي سكنت تحت تراب الوطن الحبيب الشهداء العظام

....

الآن تفتح الأشرعة وترفع المرساة لتنطلق السفينة في عرض بحر واسع مظلم هو بحر الحياة وفي هذه الظلمة لا يضيء إلا قنديل الذكريات ذكريات الأخوة البعيدة إلى الذين أحببتهم وأحبوني أصدقائي

....

إلى الذين بذلوا كل جهدٍ وعطاء لكي أصل إلى هذه اللحظة أساتذتي الكرام ولا سيما الدكتور الفاضل سعد عبد المجيد سلمان

إليكم جميعاً أهدي هذا العمل

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In the name of Allah, the Most Beneficent, the Most Merciful

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Finally, family for their unconditional care until I reach to this point, without their continuous support and precious prayers I could not have been able to finish my research. I know their blessings will always be with me in all my endeavors and I dedicate this success to them. Thanks my beloved family.

SUPERVISORS CERTIFICATION

We certify that this project entitled "**Analysis and Performance Evaluation of the Velocity Control of DC Motor**" was prepared under our supervision at the Computer and Software Engineering Department/College of Engineering by((**Mustafa R. Abass ,Aymen J. Ibarhim and Hafsa A. Ali**)) as a partial fulfillment the requirements for the degree of B. Sc. in Computer and Software Engineering.

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Name: Dr.Saad Al-Qaisy

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Date: / / 2016

In view of the available recommendations, I forward this project for debate by the examining committee.

Signature:

Name: Dr. Ali J. Abboud
(Head of the Department)

Title: Lecturer

Date: / / 2016

CERTIFICATION OF THE EXAMINATION COMMITTEE

We certify that we have read this project entitled "A**nalysis and Performance Evaluation of the Velocity Control of an DC Motor**" and as examining committee examined the students((**Mustafa R. Abass ,Aymen J. Ibarhim and Hafsa A. Ali**)) in its contents and that in our opinion it meets the standards of a project for the degree of B. Sc. in Computer and Software Engineering.

Signature:	**Signature:**
Name:	**Name:**
Title:	**Title:**
(Member)	**(Member)**
Date: / /2016	**Date: / /2016**

Signature:

Name:

Title:

(Chairman)

Date: / /2016

Approved for Computer and Software Engineering Department.

`Signature:

Name: Dr. Ali J. Abboud

(Head of the Department)

Title: Lecturer

Date: / /2016

ABSTRACT

This project presents an analysis and performance evaluation of the velocity control of DC motor Mathematical model which represents the velocity control of DC motor is used in this Paper. where is obtained experimental data of the DC motor. Different types of controllers are used to analyze and evaluate the performance of the velocity control of DC motor. Classical Proportional-Integral-Derivative PID, Fuzzy like Proportional Derivative (FPD) and Fuzzy Proportional Derivative with integral(FPD plus I) used for the purpose of this project. For classical controllers, the rising time was decreased with most types, overshoot decreased with most types, settling time decreased in Tuning With Ziegler-Nichols but got small change with other method. FPD plus I improves the most characteristics of the control system, FPD plus I eliminates the overshoot, the FPD with I got the better response performance of the control system.

Contents

List of Symbols

DC	Direct Current
P	Proportional Controller
PI	Proportional plus Integral Controller
PD	Proportional plus Derivative Controller
PID	Proportional Plus Integral Plus Derivative Controller
e(s)	error
Δe(s)	Change of error
Yp	output of the plant
Yd	desired output
Ts	Settling time
Tr	Rise Time
Mp	Maximum Overshoot
Kp	Proportional gain
KI	Integral gain
L	Delay time
T	Time constant

CHAPTER 1

INTRODUCTION

Chapter 1 Introduction

1.1 Background:

Fuzzy logic has rapidly become one of the most successful of today's technologies for developing sophisticated control systems. With its aid, complex requirements may be implemented in amazingly simple, easily maintained, and inexpensive controllers [1].

In order to design a classical controller for controlling a physical system, the mathematical model of the system is needed. A common form of the system model is differential equations for continuous-time systems or difference equations for discrete-time systems. Strictly speaking, all physical systems in existence are nonlinear. Unless physical insight and the laws of physics can be applied, establishing an accurate nonlinear model using measurement data and system identification methods is difficult in practice. Even if a relatively accurate model of a dynamic system can be developed, it is often too complex to use in controller development especially for many conventional control design procedures that require restrictive assumptions for the plant (e.g., linearity) [2,3].

As an alternative, fuzzy control provides a formal methodology for representing, and implementing a human's heuristic knowledge about how to control a system, which may provide a new paradigm for nonlinear systems. Fuzzy controller is unique in its ability to utilize both qualitative and quantitative information. Qualitative information is gathered not only from the expert operator strategy, but also from the common knowledge [2,3].

Although much of the opposition to fuzzy logic is based on misconceptions, fuzzy control is not a cure-all. Fuzzy control should not be employed if the system to be controlled is linear, regardless of the availability of its model. PID control and various other types of linear controllers can effectively solve the control problem with significantly less effort, time, and cost. In summary, PID control should be tried first whenever possible [2].

The benefits of fuzzy controllers could be summarized as follows:

1. Fuzzy controllers are more robust than PID controllers because they can cover a much wider range of operating conditions than PID, and can operate with noise and disturbances of different nature.
2. Developing a fuzzy controller is cheaper than developing a model-based or other controller to do the same thing.
3. Fuzzy controllers are customizable, since it is easier to understand and modify their rule, which not only use a human operators strategy, but also are expressed in natural linguistic terms.
4. It is easy to learn how fuzzy controllers operate and how to design and apply them to a concrete application.

It is also worth to notice that fuzzy logic can be blended with conventional control techniques. This means that fuzzy system does not necessarily replace conventional control methods. In many cases fuzzy systems augment them and simplify their implementation[4].

1.2 Literature Survey:

Duha Hakeem, Ghada Abood Salman and Omar Adel," Analysis and Performance Evaluation of the Position Control of an AC Motor", 2012, the project discussed the Effect of PID and Fuzzy on the response performance of AC motor. Classical Proportional- Integral-Derivative PID, Fuzzy-like Proportional-Derivative (FPD) are used in this project.

1.3 Research objectives:

The aim of this project is to analyze and evaluate the performance of the speed control of an DC motor with different types of controllers. To achieve this aim, the following points are addressed:

To design a PID controller , PD-Fuzzy and PD-Fuzzy plus I controller with the system and compare the performance analysis with both type of controllers.

1.4 Outline of the Project:

The Project is basically divided into four chapters.

Chapter 1 this chapter provides general background to field of the search, followed by explanation of the problem statement and the proposed objective that deals with the search problem.

Finally, the scope of the work is also discussed.

Chapter 2 describes the field of the software of the project; it includes introduction of the PID controller and design of PD-Fuzzy plus I controller.

Chapter 3 presents the project simulation results with the controllers.

Chapter 4 presents a conclusion of the entire design and results as well as the recommendation for future work.

CHAPTER 2

STABILITY THEOREMS AND CONTROLLERS DESIGN

Chapter 2 Stability Theorems and Controllers Design

2.1 Introduction:

This chapter is an introduction to the basic technology of PID control with classical and tuning PID controller It opens with a brief look at the way in which control engineers solve process control problems in different stages, and contain the fuzzy logic PD controller (such as IF THEN rules) only for the design step (so as to improve performance) and contain DC motor.

2.2. Classical PID:

PID control refers to a family of controllers with various configurations of the Proportional, Integral and Derivative terms. Conventional PID controllers have been extensively used in industry due to their simplicity in design and tuning and effectiveness for general linear systems with convenient implementation and low cost. It is well known that in general, the P-controller is used to reduce the detected tracking error, independent of the phase shift between the output and input [6].

2.2.1 Proportional Controller (P-controller):

A proportional control system is a type of linear feedback control system The proportional control system is more complex than an on-off control system like a bi-metallic domestic thermostat, but simpler than proportional-integral-derivative (PID) control system the controller output is proportional to the error signal, which is the difference between the set point and the process variable. In other words, the output of a proportional controller is the multiplication product of the error signal and the proportional gain this can be mathematically expressed as :

$$Pout = Kp\, e(t) \qquad \dots\dots\dots\dots\dots\dots.(2.1)$$

$$e(t) = SP - PV \qquad \dots\dots\dots\dots\dots\dots(2.2)$$

Where Pout: output of the proportional controller

Kp: Proportional gain

e(t): Instantaneous process error at time 't'.

SP: Set point

PV Process variable

2.2.2. Proportional plus Derivative Controller (PD-controller):

The PD-controller can reduce the maximum overshoot (but may retain a steady state tracking error) The use of derivative control is limited At first glance, derivative control looks attractive as shown in figure (2.1). It should help reduce the time required to stabilize an error. However, it will not remove offset. The control signal from derivative action ceases when the error stops changing, which will not necessarily be at the set point. Its use, in practice, is also limited to slow acting processes. If used on a fast acting process, such as flow. control signals due to derivative action will often drive the control valve to extremes following quite small but steep (large de/dt changes in input. Mathematically proportional plus derivative (PD) control is expressed as:

$$m = k\left(e + T\mathrm{D}\frac{de}{dt}\right) + b \qquad \ldots\ldots\ldots\ldots (2.3)$$

Where: m = controller signal

k = controller gain

TD= derivative time

e = error

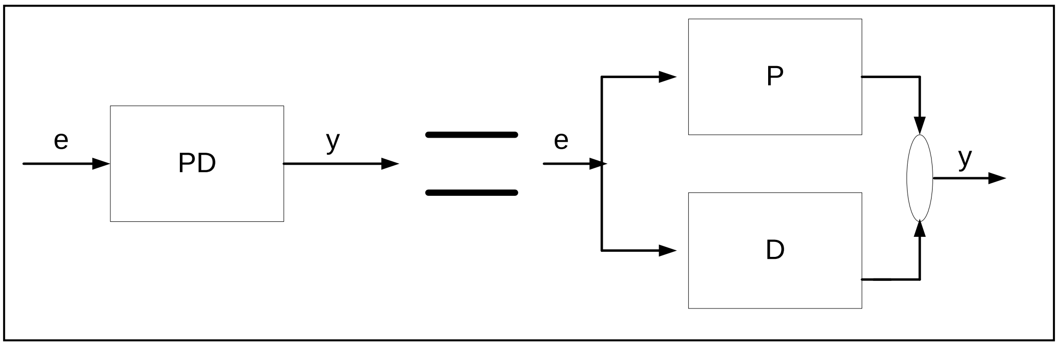


Figure (2.1): PD controller.

2.2.3 Proportional plus Integral Controller (PI-controller):

Is the controller which is applied to reduce (or even eliminate) the steady state tracking error. A proportional plus integral (PI) controller has the transfer function: Gc(s)= KP+KI/s as shown in figure (2.2). The task is to tune the control parameters KP and KI to achieve better control. By combining the advantages of P and I controllers, we have freedom of choice and can achieve better performance since there are two parameters to tune.

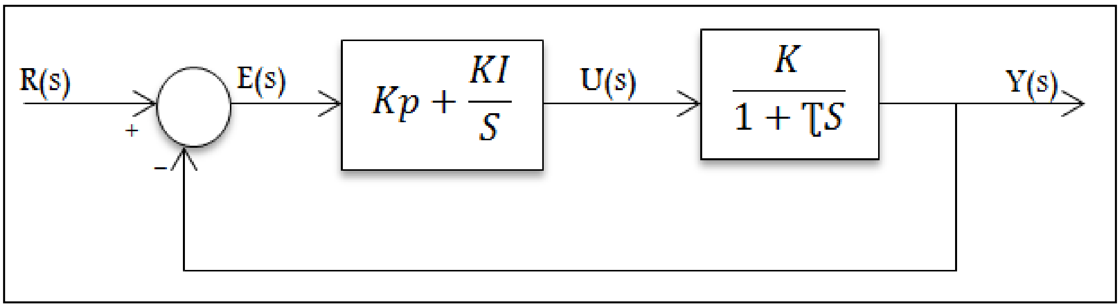


Figure (2.2): PI Controller in unity Feedback.

2.2.4. Proportional Plus Integral Plus Derivative Controller (PID Controller):

Is a controller which is namely to have fast rise time and settling time, with small or no overshoot and oscillation, and with small or no steady state error as shown in figure (2.3) below. Although PID controllers can be analytically designed and pre-tuned for precisely given lower-order linear systems, they have to be manually operated for most practical systems that involve higher-order components. nonlinearity and uncertainties. To find easy ways of choosing suitable control gains in these controllers, Ziegler-Nichols and Cohen-Coon of the Taylor Instrument Company initiated the now well-known heuristic rules for experimental design and tuning methods. However, tuning the gains is always a challenge in the state of the art of PID controller design. This problem becomes more important and critical, in particular, when issues including specifications, stability and performance are considered.

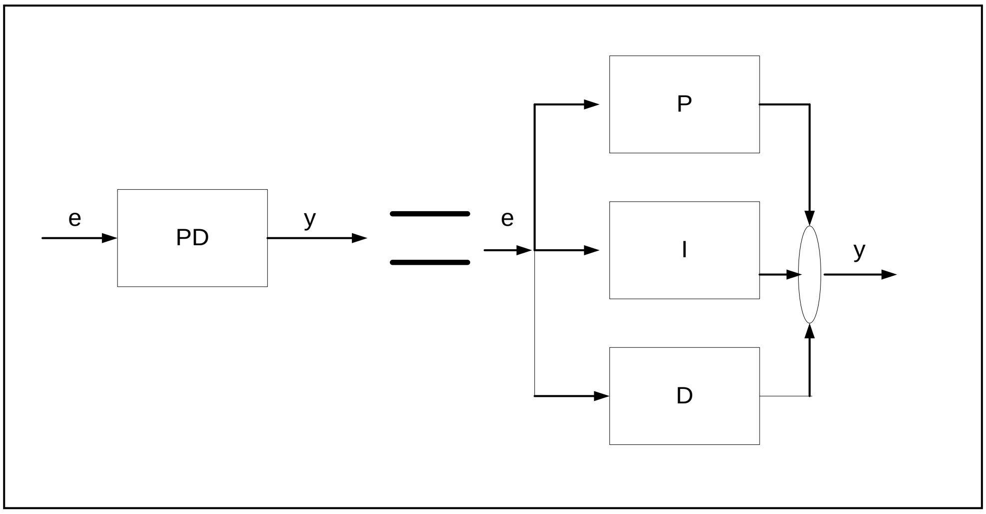


Figure (2.3): PID Controller Structure.

2.3. Tuning of PID-Controller:

Because these methods do not need to use any model of a controlled object, they are still widely used in industrial applications. In order to take this advantage, we systematically present the design process based on the Ziegler and Nichols' approach. In the Ziegler-Nichols technique, the parameter tuning is based on the stability limits of a system. The derivative and integral terms are initially put out of the system and proportional gain is increased until the critical oscillation point. A desirable function for industrial automation is the tuning of PID control parameters, mainly comprising the control gains and perhaps also some scaling parameters used in the controller, according to the changes of the systems (plants, processes) and their working environments. However, due to the convergence of the population, a restart of the optimization cycle is usually needed for a direct approach The result of tuning the classical PID controller which can obtained by using Matlab toolbox to the speed control of DC motor with transfer function:

DC motor T.F = 2030/(s^2 + 28.58s + 60.34) …… (2.4) as shown in figure (2.4) include the tuning of PID controller with speed control of an DC Motor and tuning PID controller by using Ziegler-Nichols rules (the first method) with speed control of DC Motor [6].

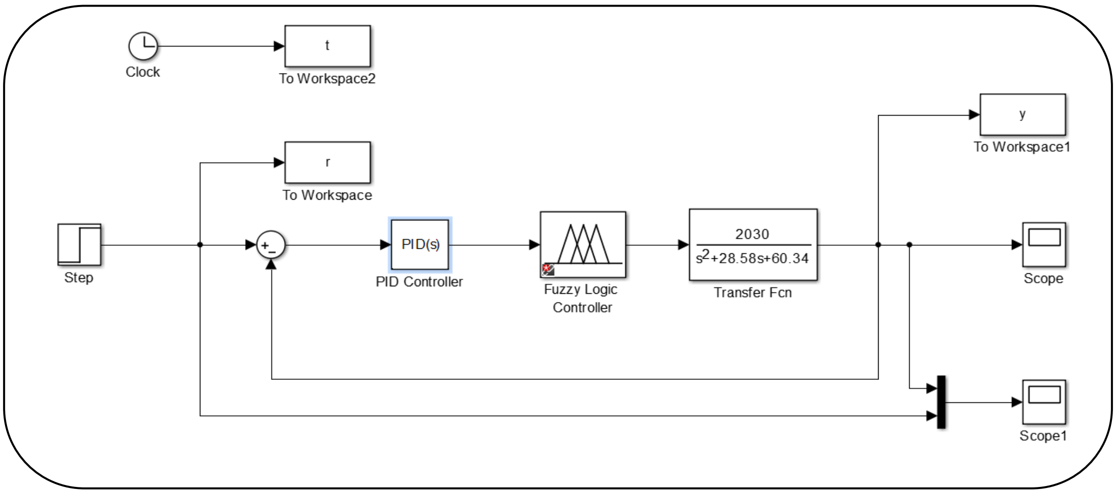


Figure (2.4): Position control of an DC motor.

2.3.1 Tuning with Ziegler-Nichols methods (The First Method):

This method of tuning PID controller by obtaining experimentally the step response of the position control of an DC Motor as shown in figure (2.5) the curve characterized by two constants, delay time L and time constant T. The delay time and time constant determined by drawing a tangent line are at the infection point of the curve and determining the intersection of the tangent line with the time axis and line c(t)=k as shown in figure (2.5) the transfer function c(s)/u(s) can be by a approximated first-order system with a transport lag as follows: C(s) / u(s)=k $e^{\wedge -Ls/Ts+1}$,Ziegler-Nichols suggested to set the values of Kp, Ti and Td according to the formula in table (2.1) bellow:

Table (2.1): Ziegler-Nichols values of Kp, Ti and Td

Type of controller	Kp	Ti	Td
P	T/L	∞	0
PI	0.9T/L	L/0.3	0
PID	1.2T/L	2L	0.5L

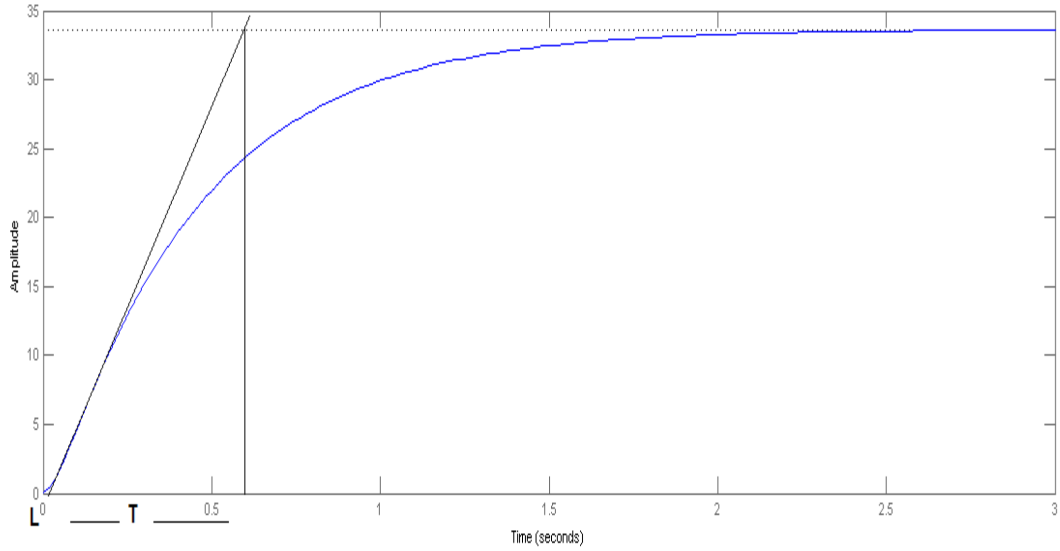


Figure (2.5): The step response of the speed control of DC Motor

2.4 Fuzzy logic PD controller Design:

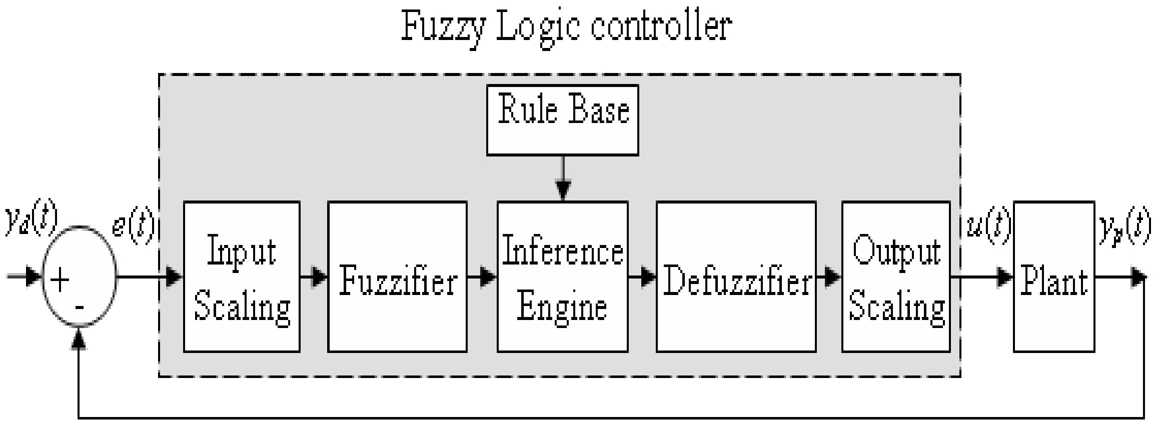
Fuzzy Logic has been successfully applied to a large number of control applications. The most commonly used controller is the PID controller, which requires a mathematical model of the system. A fuzzy logic controller provides an alternative to the PID controller. It is a good for the control of systems that are difficult to model fuzzy logic has rapidly become one of the most successful of today's technologies for developing sophisticated control systems. With its aid, complex requirements may be implemented in amazingly simple, easily maintained, and inexpensive controllers [3]. Fuzzy control only uses a small portion of the fuzzy mathematics that is available. This portion is also mathematically quite simple and is conceptually easy to understand. In this chapter, we introduce some essential concepts, terminology, and arithmetic of fuzzy sets and fuzzy logic. The fuzzy controller, as explained in Figure (2.6) have four main components:

1) The Rule-Base holds the knowledge, in the form of a set of rules, of how best to control the system.

2) The Inference Mechanism evaluates which control rules are relevant at the current time and then decides what the input to the plant should be.

3) The fuzzification Interface simply modifies the inputs so that they can be interpreted and compared to the rules in the rule-base.

4) The Defuzzification Interface converts the conclusions reached by the inference mechanism into the inputs to the plant [4], [5] .



Figure(2.6):Structure of Fuzzy Logic Controller with Unity Feedback Control System.

Generally, this controller accepts two input signals, error and change of error (e(s) and Δe(s)). These inputs represent the PD gain inputs the error signal is obtained by subtracting the output of the plant (Yp) from the desired output (Yd); the change of error is obtained by multiplying the delay signals with the error signal and then subtracting this signal from the original error signal; the controller delivers the control action signal as output. For the purpose of simulation symmetric triangular fuzzy sets as shown in figure (2.7) and singleton fuzzy sets are used for input and output variable respectively. In addition to Groups of (three, five and seven) triangular membership functions for inputs/outputs variables, and rule table of (9, 25 and 49) rules were used in this design as will be discussed later in chapter three [7].

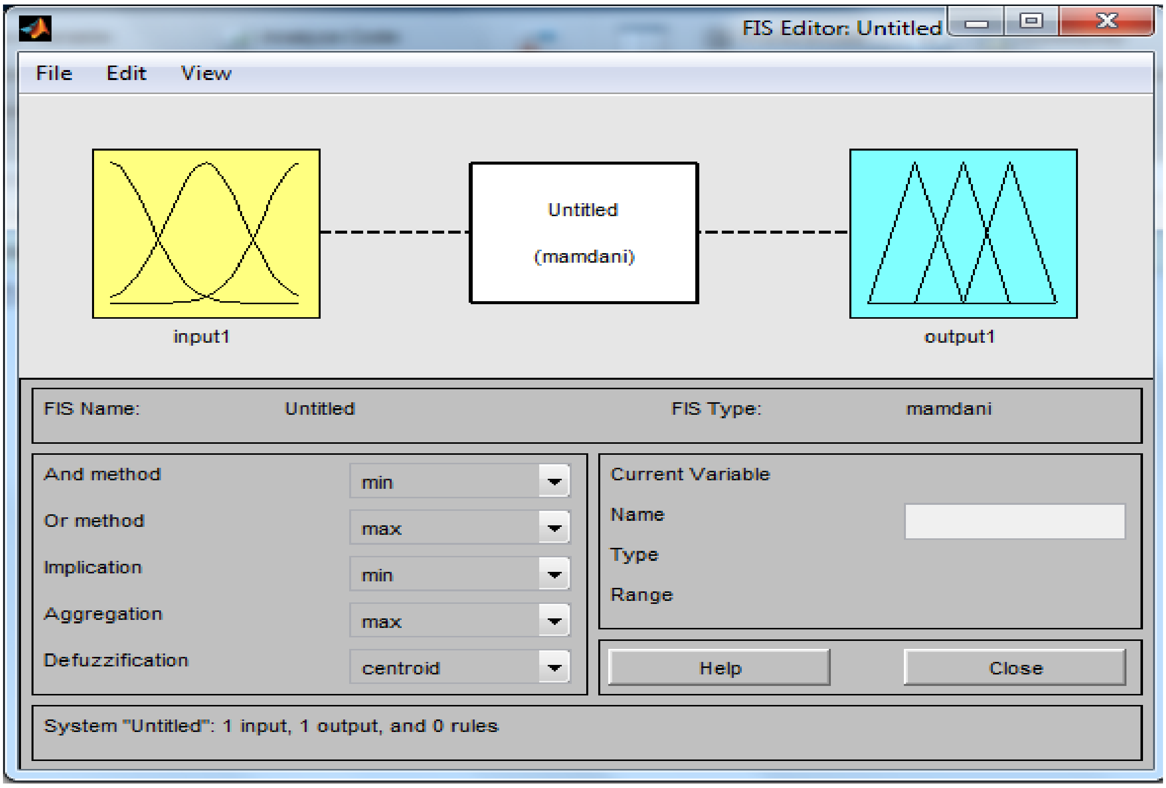


Figure (2.7): Input/output Fuzzy Sets.

The control action in fuzzy logic controllers can be expressed with membership function and simple "if-then" rules to the position control of an DC Motor as shown in figure (3.6) will implemented with a3*3, 5* 5 and7*7 rule base in chapter three.

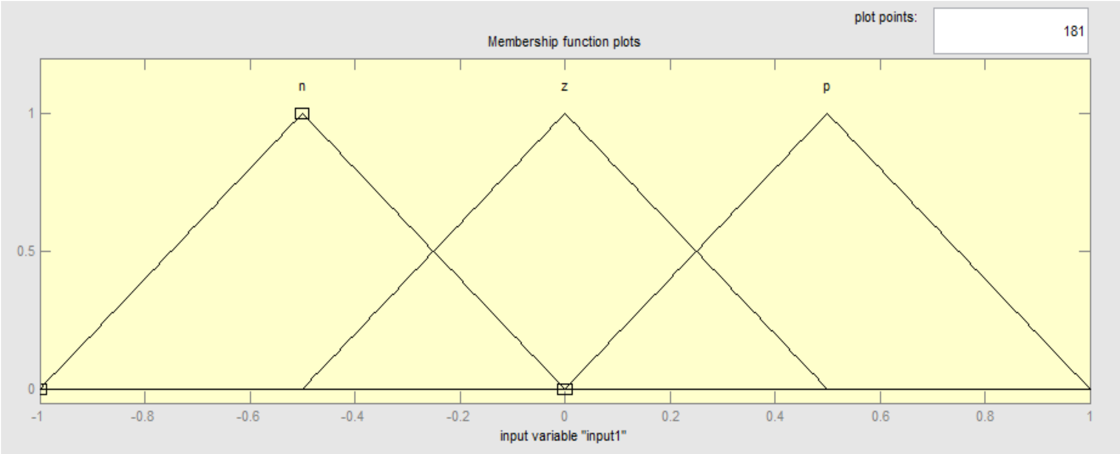
2.4.1. Membership Function of 3*3 Rule Base:

By using group of three triangular membership functions for input/output variables and rule table of 9 rules were used in this design a 3*3 rule base was defined in table (2.4) to develop the speed control of an DC Motor system.

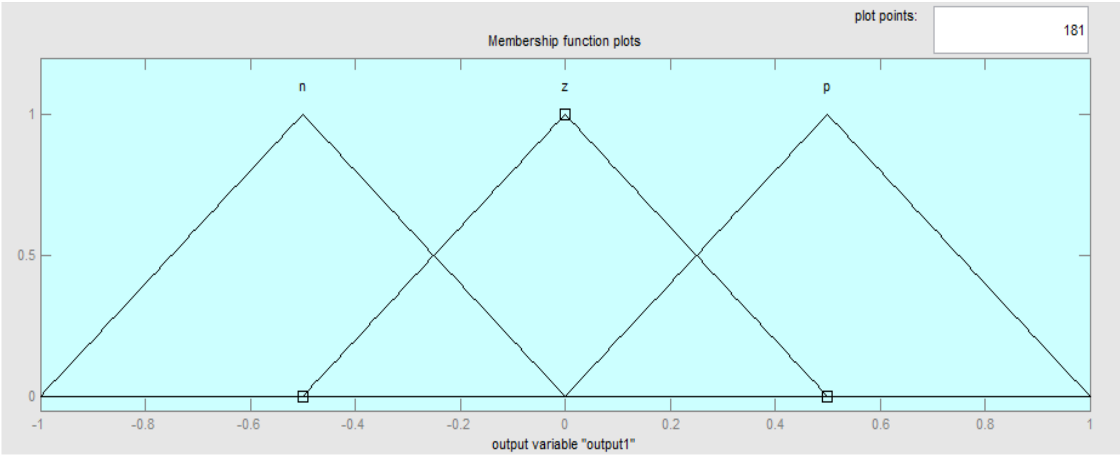
Table(2.4):fuzzy Rule Base.

e/de	N	Z	P
N	N	N	Z
Z	N	Z	P
P	Z	P	P

The membership function of 3*3 rules is shown in figure bellows



(a)



(b)

Figure (2.8): Membership function of 3*3 (a) Inputs variables (b) Output Variable.

The response from applying fuzzy logic controller to the speed control of a DC motor for the 3*3 rule base as shown in figure (3.7) in chapter three.

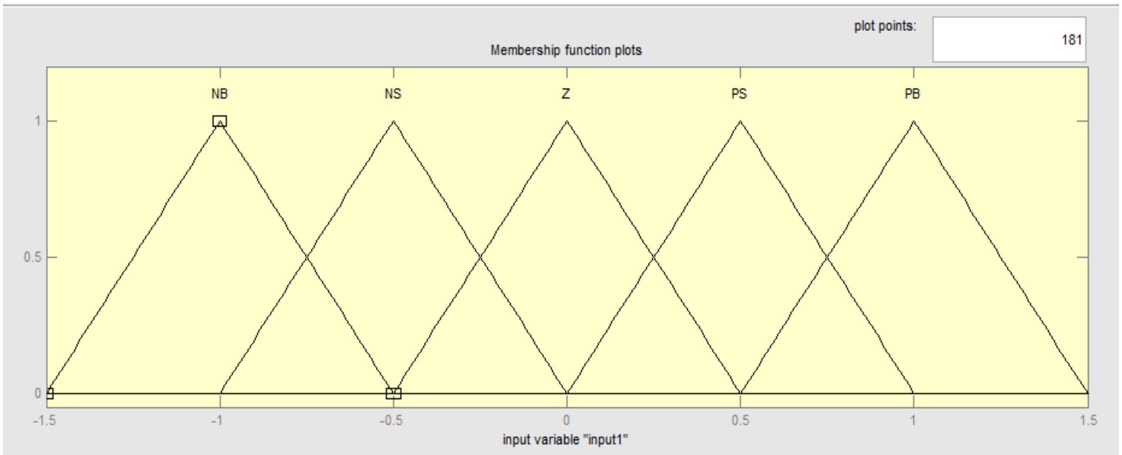
2.4.2. Membership Function of 5*5 Rule Base:

By using group of five triangular membership functions for input/output variables and rule table of 25 rules were used in this design a 5*5rule base was defined in table (2.5) to develop the speed control of an DC Motor system.

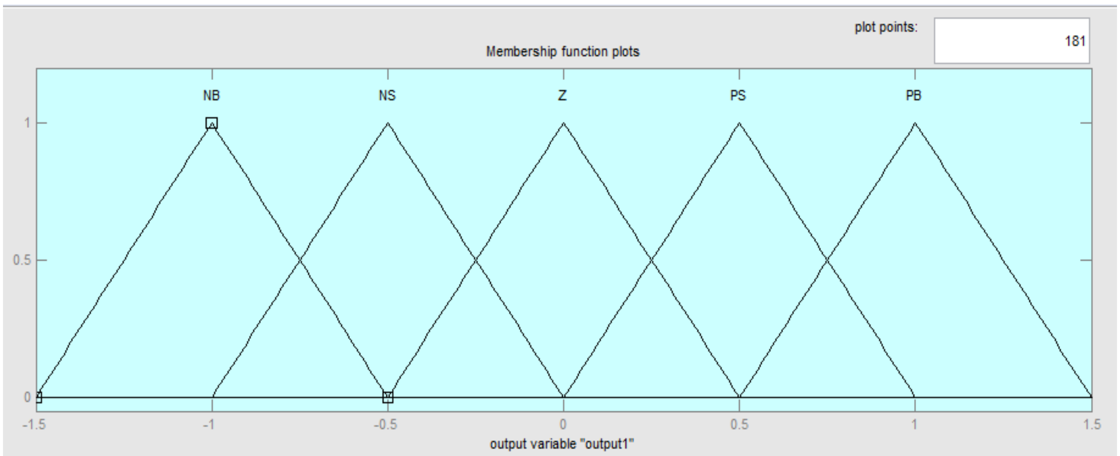
Table (2.5): Fuzzy rule Base.

e/de	NB	NS	Z	PS	PB
NB	NB	NS	NB	NS	Z
NS	NB	NB	NS	Z	PS
Z	NB	NS	Z	PS	PB
PS	NS	Z	PS	PB	PB
PB	PB	PS	PB	PB	PB

The membership function of 3*3 rules is shown in figure bellows



(a)



(b)

Figure (2.9): Membership Function of 5*5 (a) Inputs Variables (b)Output Variable.

The response from applying fuzzy logic controller to the speed control of an DC Motor for the 5*5 rule base as shown in figure (3.8) in chapter three.

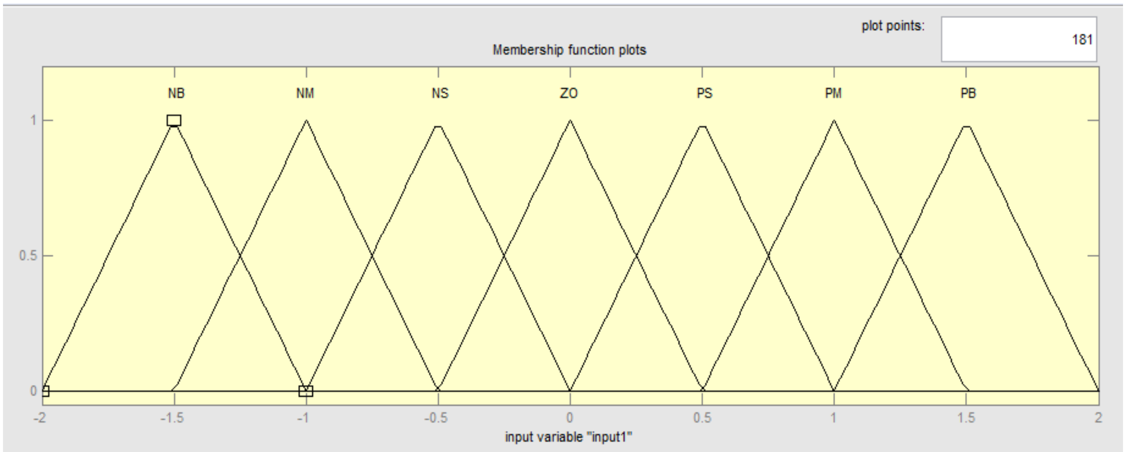
2.4.3. Membership Function of 7*7 Rule Base:

By using group of seven triangular membership functions for input/output variables and rule table of 49 rules were used in this design a 7*7 rule base was defined in table(2.6) to develop the speed control of an DC Motor system.

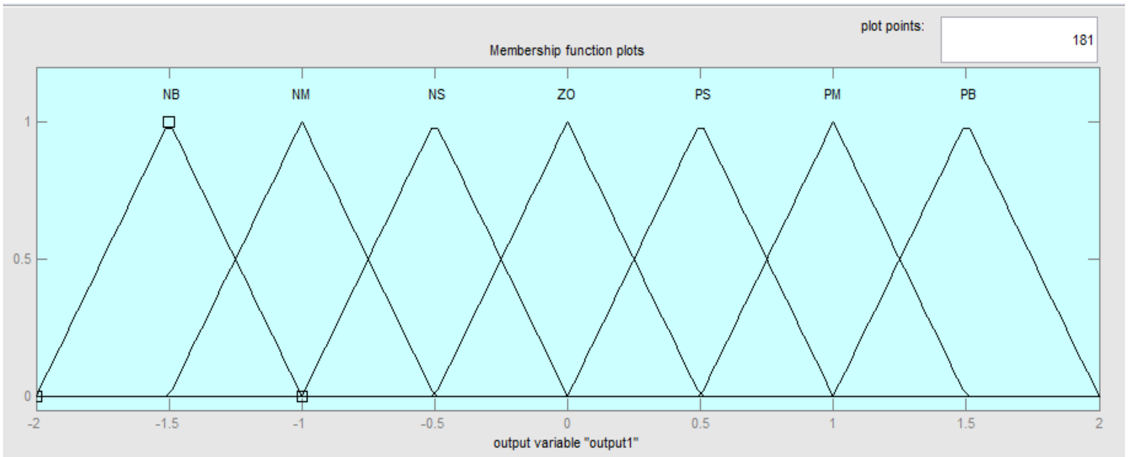
Table (2.6): Fuzzy Rule Base.

e/de	NB	NM	NS	ZO	PS	PM	PB
NB	NB	NB	NM	NM	NS	NS	ZO
NM	NB	NM	NM	NS	NS	PS	PS
NS	NM	NM	NS	NS	ZO	PS	PS
ZO	NS	NS	NS	ZO	PS	PS	PM
PS	NS	ZO	PS	PM	PS	PM	PM
PM	NS	ZO	PS	PS	PM	PM	PB
PB	ZO	PS	PS	PM	PM	PB	PB

The membership function of 7*7 rules is shown in figure bellows



(a)



(b)

Figure (2.10): The Membership function of 7*7 (a) Inputs variables

(b) Output Variable.

The response from applying fuzzy logic controller to the speed control of DC motor for the 7*7 rule base as shown in figure(3.9) in chapter three.

2.5 DC Motor

Electric motors exist to convert electrical energy into mechanical energy. This is done by two interacting magnetic fields; one stationary and another attached to a part that can move .DC motors have the potential for very high torque capabilities; although this is generally a function of the physical size of the motor, are easy to miniaturize, and can be "throttled" via adjusting their supply voltage. DC motors are also not only the simplest, but the oldest electric motors. The basic principles of electromagnetic induction were discovered in the early 1800's by Oersted, Gauss, and Faraday. In 1819, Hans Christian Oersted and Andie Marie Ampere discovered that an electric current produces a magnetic field. The next 15 years saw a flurry of cross-Atlantic experimentation and innovation, leading finally to a simple DC motor. Because of the work of these people, DC motor are one of the most commonly used machines for electromechanical energy conversion. Converters which are used continuously to convert electrical input to mechanical output or vice versa are called electric machines as shown in Figure (2.11) An electric machine is therefore a link between an electrical system and a mechanical system. In these machines, the conversion is reversible. If the conversion is from mechanical to electrical, the machine is said to act as a generator. If the conversion is from electrical to mechanical, the machine is said to act as a motor. Therefore, the same electric machine can be made to operate as a generator as well as a motor.

The parameters of an actual DC motor used are listed in Table

Ra	4.67 Ω
La	$170e-3\ H$
J	$42.6e-6\ Kg.m2$
f	$47.3e-6\ N.m/\ rad\ /\ \mathrm{sec}$
K	$14.7e-3N.m/\ A$
Kb	$14.7e-3V.\mathrm{sec}/\ rad$

And the transfer function for this DC Motor is:

$$\mathrm{Gp} = \frac{0.0147}{7.242\mathrm{e} - 006\mathrm{s}^2 + 0.000207\mathrm{s} + 0.000437}$$

And the simplification transfer function is:

$$\mathrm{Gp} = \frac{2030}{\mathrm{s}^2 + 28.58 + 60.34}$$

By this system definition we design the system controller.

CHAPTER 3

RESULTS AND DISCUSSION

Chapter 3 Results and Discussion

3.1 Introduction

This chapter contains all the result of the project which can be obtained by using Matlab toolbox to design fuzzy logic system like (PD-Fuzzy and PD-Fuzzy plus I) controller and applying this controller for speed control of an DC motor and compare the results with the classical PID controller by using Ziegler-Nichols rules (the first method) with speed control of DC motor and Computer simulations have shown these fuzzy already that PID controllers work equally as well as conventional PID controllers for low (first and second) order linear plants, and yet have significant improvement over conventional controllers for high-order and time-delayed.

3.2 Response of DC motor

By taking the closed-loop transfer function of DC motor show in equation (2.4) with unity feedback and step input the results are show in figure (3.1):

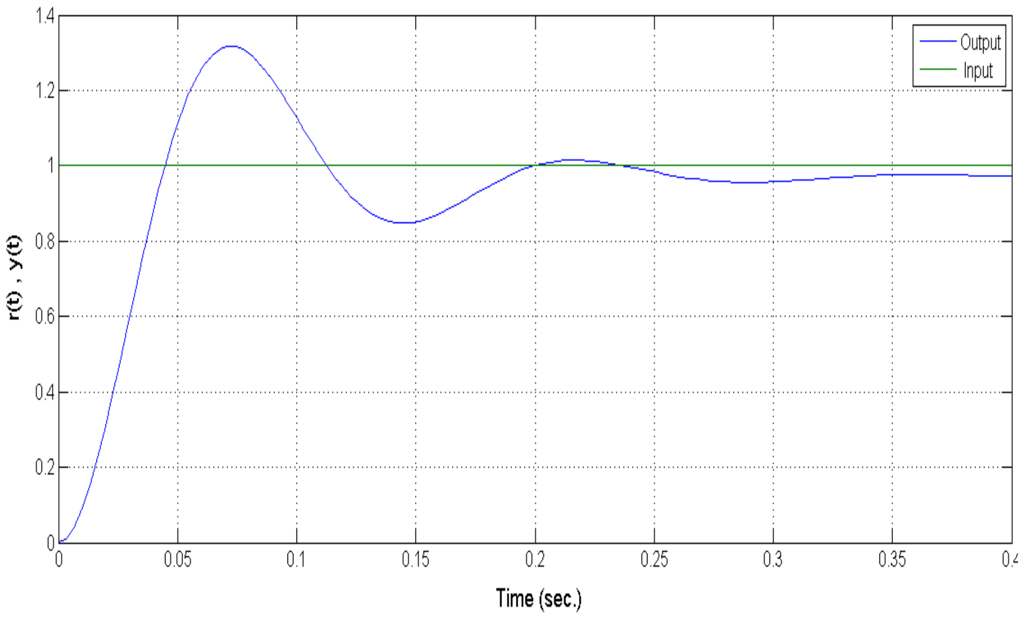


Figure (3.1): DC motor in unity feedback.

3.3 Tuning using PID controller results:

In this section the tuning of classical PID controller include with Ziegler-Nichols (The first method).

The result in table (3.1) was obtained by applying the Ziegler-Nichols (The first Method) to tuning classical PID controller for speed control of DC motor.

Table (3.1): Result of applying the Ziegler-Nichols (The First Method)

Kp	Ti	Td	Ts	Tr	Mp
17.38	0.077	0.019	0.03	0.24	35.5

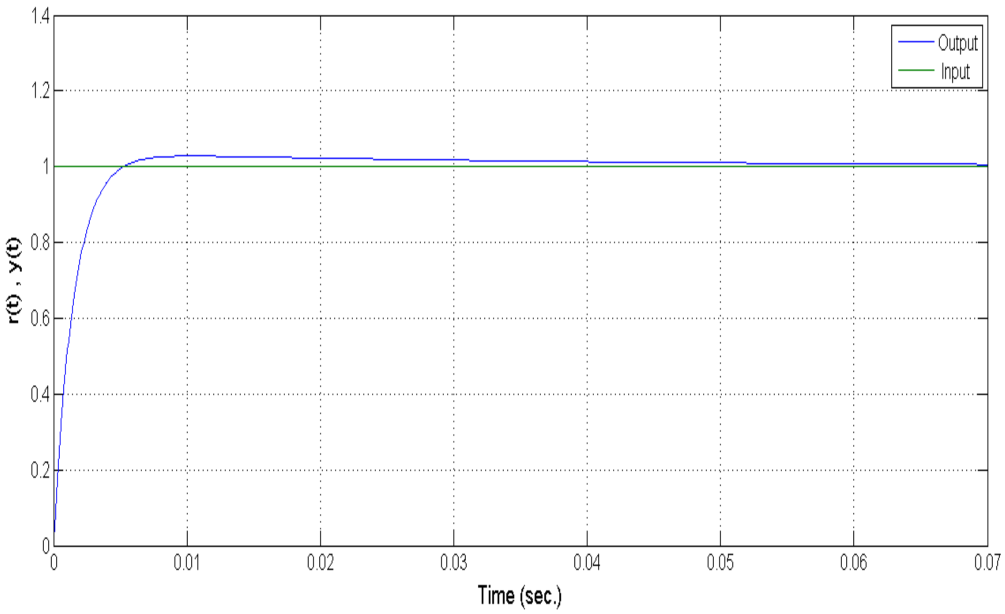


Figure (3.2): The response of PID controller

3.4 PD fuzzy logic controller results:

The control action in fuzzy logic controllers can be expressed with membership function and simple "if-then" rules to the speed control of DC motor which will implemented with a 3*3, 5*5 and 7*7 rule base as shown in figure (3.3) below:

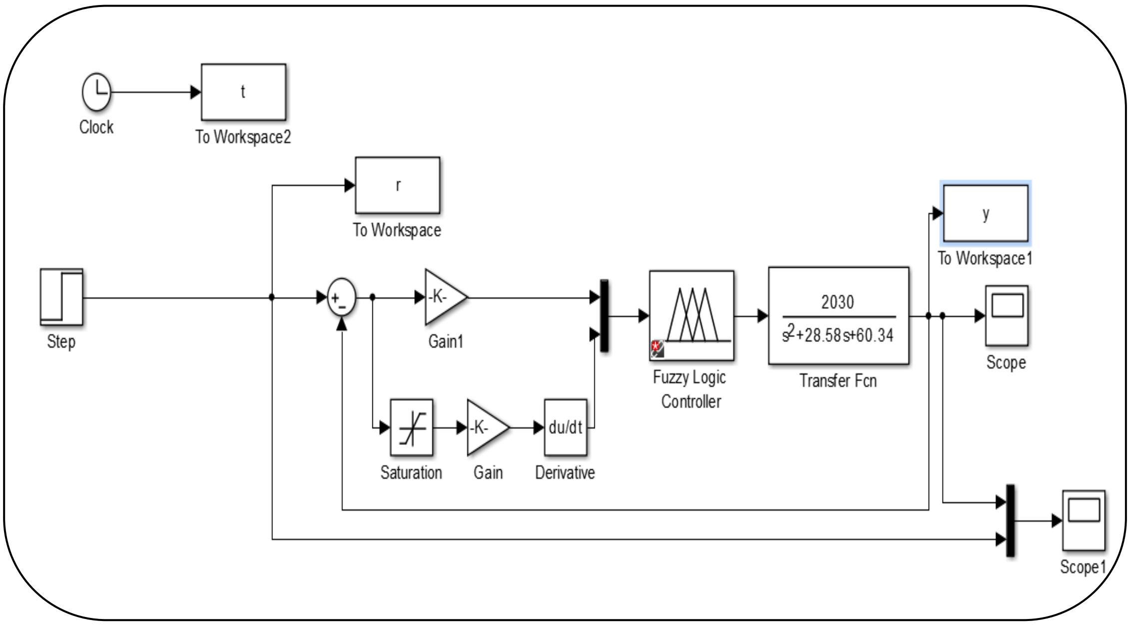


Figure (3.3): PD-Fuzzy logic controller

3.4.1 Membership function of 3*3 rule base results:

By using group of three triangular membership functions for input/output variables and rule table of 9 rules were used in this design a 3*3 rule base was defined in table (2.4) in chapter two to develop the speed control of DC motor system we obtained this response:

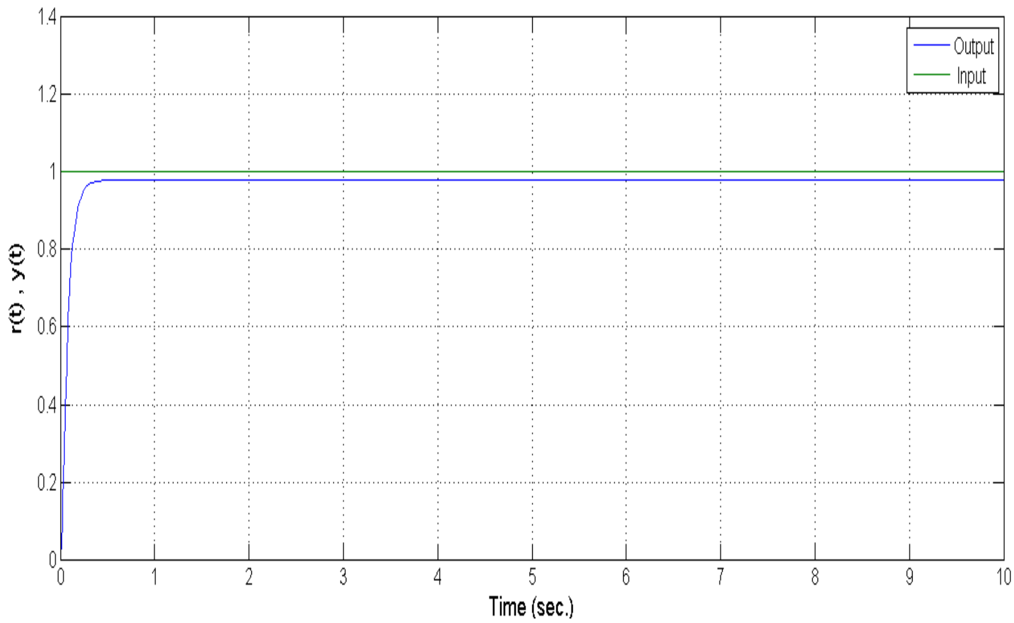


Figure (3.4): The response of PD-Fuzzy logic controller 3*3 rule base

3.4.2 Membership function of 5*5 rule base results:

By using group of five triangular membership functions for input/output variables and rule table of 25 rules were used in this design a 5*5 rule base was defined in table (2.5) in chapter two to develop the speed control of DC Motor system we obtained this response:

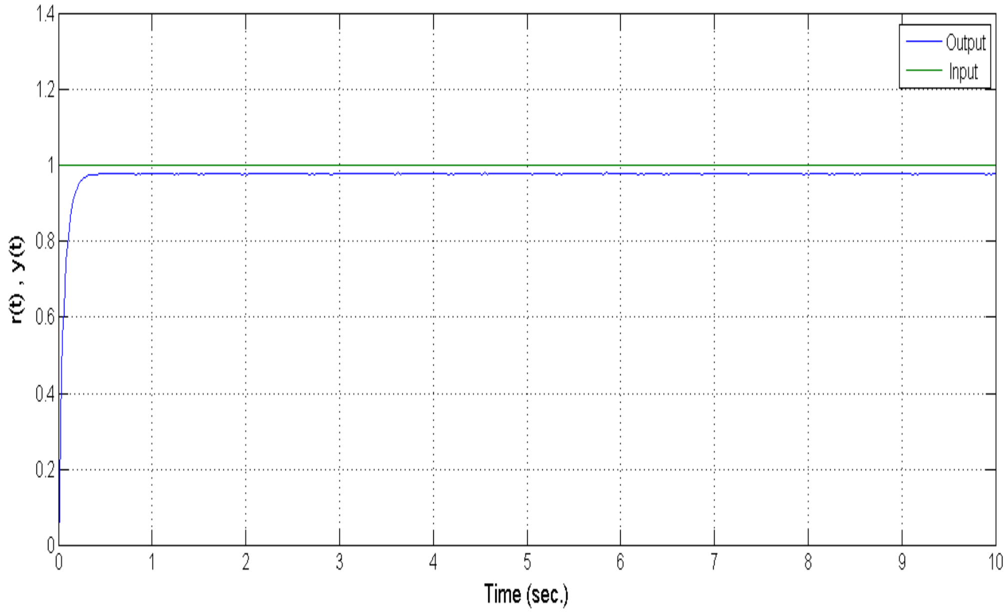


Figure (3.5): The response of PD-Fuzzy logic controller 5*5 rule base.

3.4.3 Membership function of 7*7 rule base results:

By using group of seven triangular membership functions input /output variables and rule table of 49 rules were used in this design a 7*7 rule base was defined in table (2.6) in chapter two to develop the speed control of DC motor system we obtained this response:

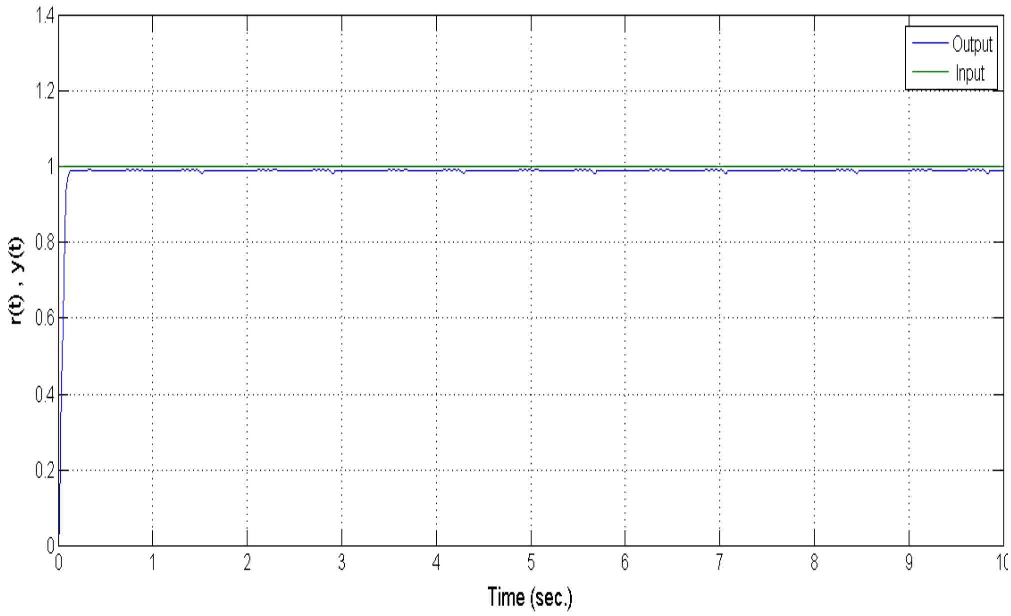


Figure (3.6) The Response of PD-Fuzzy Logic Controller 7*7 rule base.

3.5 Results of PD-Fuzzy logic plus I controller:

In this section applying I controller as assistant to PD controller with fuzzy logic Controller to the speed control of DC motor which will implemented with a 3*3, 5*5 and 7*7 rule base as shown in figure (3.7) below:

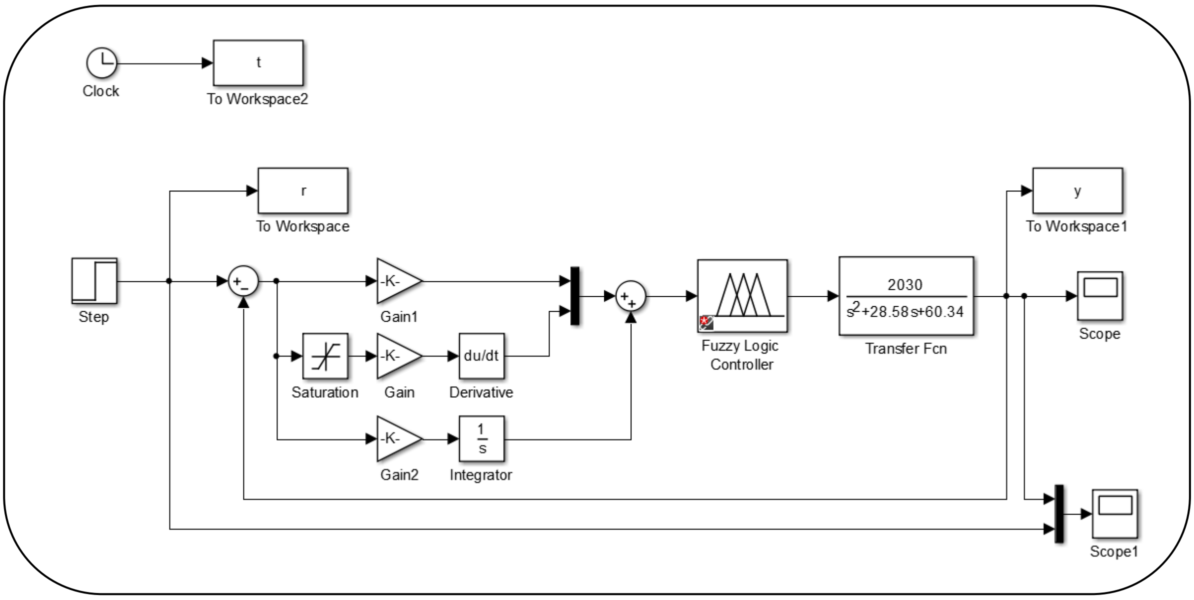


Figure (3.7): PD-Fuzzy logic plus I controller

3.5.1 Membership function of 3*3 rule base results:

The response from applying PD-Fuzzy Logic plus I controller to the speed control of DC motor for the 3*3 rule base was defined in table (2.4) in chapter two to develop the speed control of an DC motor system we obtained this response:

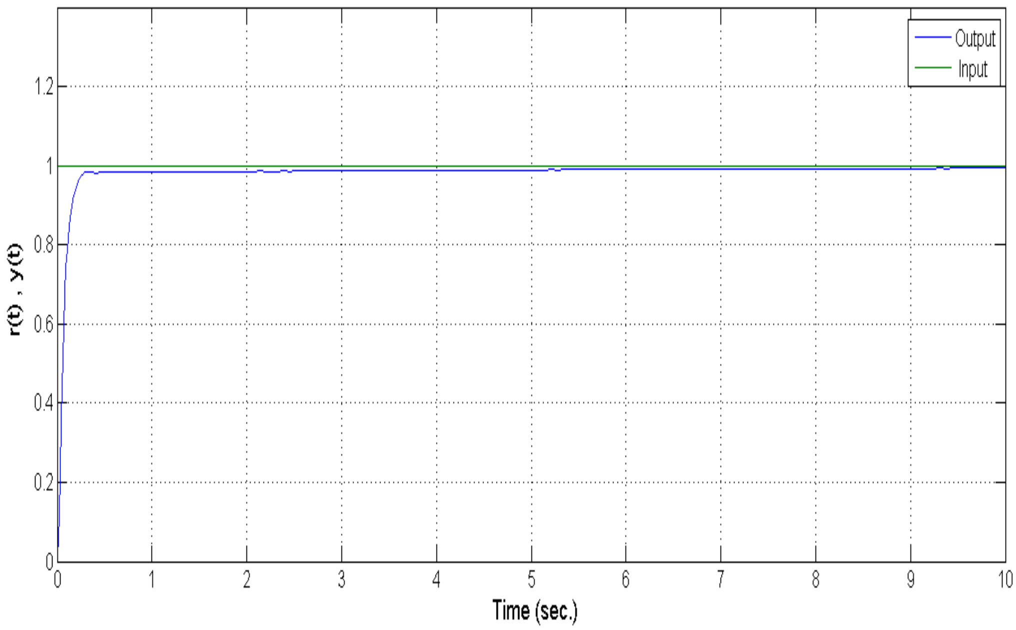


Figure (3.8): The response of PD-Fuzzy Logic plus I controller 3*3 rule base.

3.5.2 Membership function of 5*5 rule base results:

The response from applying PD-Fuzzy Logic plus I controller to the speed control of DC Motor for the 5*5 rule base was defined in table (2.5) in chapter two to develop the speed control of an DC Motor system we obtained this response:

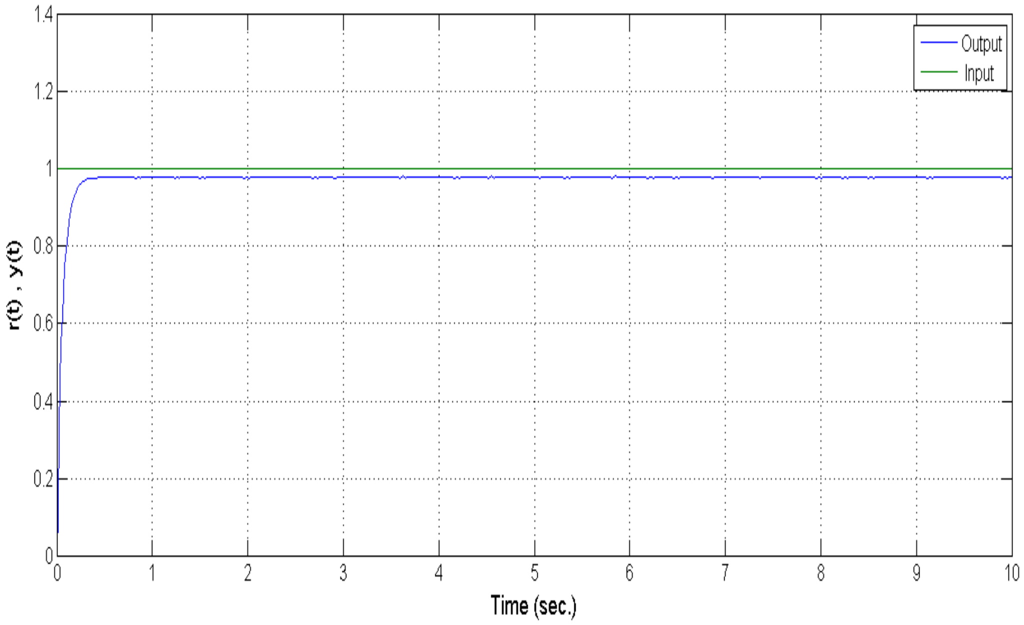


Figure (3.9): The response of PD-Fuzzy logic plus I controller 5*5 rule base.

3.5.3 Membership function of 7*7 rule base results:

The response from applying PD-Fuzzy Logic plus I controller to the speed control of DC motor for the 7*7 rule base was defined in table (2.6) in chapter two to develop the speed control of an DC motor system we obtained this response:

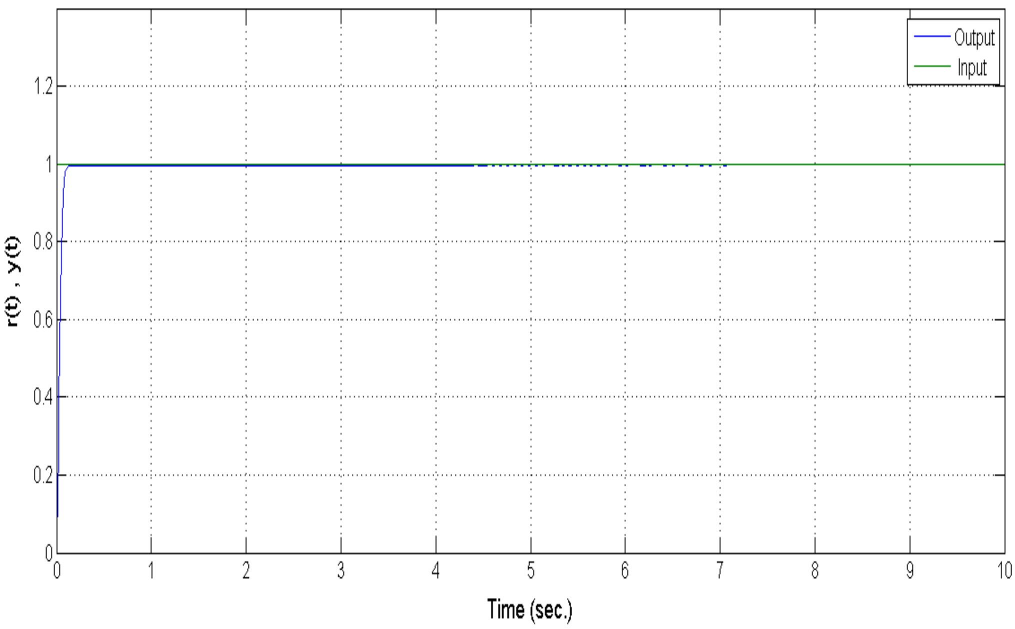


Figure (3.10): The response of PD-Fuzzy logic plus I controller 7*7 rule base.

3.6 Discussion

To discuss the results which are obtained by using Matlab toolbox to design fuzzy logic system like (PD-Fuzzy and PD-Fuzzy plus I) controller by applying this controller for speed control of an DC motor, it is necessary to compare the results of the tuning classical PID controller by using Ziegler-Nichols rules (the first method). The response of the DC motor system has large (rise time , settling and over shoot) and these result start to decrease when applying other method.

Table (3.2) discussion of result

	Rise Time (sec.)	Settling Time (sec.)	Overshoot (%)
DC motor	0.0293	0.245	35.5072
Tuning With Ziegler-Nichols	0.0030	0.0151	2.2372
PD Fuzzy logic controller 3*3	0.1425	0.2669	0
PD Fuzzy logic controller 5*5	0.1271	0.2389	0
PD Fuzzy logic controller 7*7	0.0632	0.098	0
PD-Fuzzy logic controller Plus I 3*3	0.1325	0.2578	0
PD-Fuzzy logic plus I controller 5*5	0.1399	0.2913	0
PD-Fuzzy logic plus I controller 7*7	0.0587	0.0933	0

CHAPTER 4

CONCULUSION AND FUTURE WORK

Chapter 4 Conclusion and Future Work

4.1 Conclusion:

This project present the analysis and performance evaluation of speed control of DC motor.

1. Classical PID controller provides higher execution for DC motor.
2. PD-Fuzzy controller provides a better control performance and faster execution speed for DC motor than the classical PID controller.
3. PD-Fuzzy plus I controller improved the system much more than PD-Fuzzy controller by increasing the speed of system and decrease time delay.

4.2 Future Work:

It is hoped that some future work could settle down the feasibility of the suggestions which are listed below:

1. Optimization of the scaling gains (kp, ti, td and ko) of the fuzzy controller or membership functions by using genetic algorithm or neural network.
2. Experimental test of the system with the fuzzy controller.

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REFERENCES

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الخلاصة

هذا البحث يقدم تحليل وتقييم اداء للسيطرة على سرعة الخاصة بالمحرك الكهربائي للتيار المستمر، انواع مختلفة من المسيطر استخدمت في هذا المشروع، استخدم المسيطر التقليدي من نوع التناسبي التفاضلي التكاملي ومسيطر المنطق الضبابي شبيه بل تناسبي التفاضلي بل الإضافة الى مسيطر المنطق الضبابي التناسبي التفاضلي واضافه التكاملي له للحصول على اداء افضل، تم توليف المسيطر التقليدي باستعمال الطرق التقليدية لغرض استخراج القيم المناسبة التي تعمل مع النظام ،ثم استحصال استجابة جيده بخصائص سريعة ومقبولة باستعمال المسيطر التقليدي، استعمال المسيطر الضبابي ادى الى زياده سرعه الاستجابة والغاء الخطأ في استجابة النظام.

وزارة التعليم العالي والبحث العلمي

جامعة ديالى

كلية الهندسة

قسم هندسة الحاسوب و البرامجيات

تحليل وتقيم اداء للسيطرة على سرعة الخاصة بالمحرك الكهربائي للتيار المستمر

مشروع مقدم الى قسم هندسه الحاسوب والبرامجيات في جامعه ديالى – كليه الهندسة كجزء من متطلبات نيل درجه البكالوريوس في هندسه الحاسوب والبرامجيات

من قبل

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أيار 2016