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Tuning with Ziegler Nichols Method for Design PID Controller At Rotate Speed DC Motor

Nicolaus Allu[1], Apriana Toding[2]

[1,2] Study Program of Electrical Engineering Study Program, Faculty of Engineering, [Universitas Kristen Indonesia Paulus]

* Corresponden Email: nicolaus.allu@ukipaulus.com

Abstract. DC motor is a type of motor that is widely used in industry, electronics and supporting components for some electronic equipment or instrumentation. But now the PID controller is still widely used in various industrial sectors, this is due to its toughness to overcome various problems that exist in the industry. But there is one drawback that is the tuning method, the tuning process must be done by trial and error. More tuning procedures done manually by trial and error method that the result is not necessarily true. To overcome these problems required an alternative approach that can achieve a relatively better value and faster to perform the tuning process. In this case the alternative method used is tuning with Ziegler Nichols. Based on the simulation performed with the controlled torch, the value of the disturbance with the controller Kp = 3,6, Ki = 2,857 and Kd = 1,134 happened to the motor rotation at the lowest interference occurred at 1818 RPM while the highest rotation disturbance reached 2177 RPM from the nominal rotation speed of 2000 RPM for 80 seconds and suffered a friction coefficient of about 20 seconds.

1. Introduction

Direct current or direct current motors are included in the category of most widely used motor types in industrial environments, household appliances to children's toys or as instruments supporting electronic instrument systems. Electric motors are electromagnetic devices that convert electrical energy into mechanical energy. This mechanical energy is used for, for example, rotating the pump impeller, fan or blower, moving the compressor, lifting materials, and others [1]. The physical model of a complete DC motor describing the electrical and mechanical charts can be seen in [2]. PID controller (Proportional - Integral - Derivative) is a combination of three types of controllers. If each of the three types of controllers are independent then the results achieved will be less good because each has its own weaknesses and advantages. To meet the desired system, the three PID parameters must be optimally set. There are several conventional PID tuning or tuning methods that have been developed, such as the cut and try method, the Ziegler-Nichols method, the step response and the analytic method [3]-[5].

From some experiments that have been done with the above methods can be seen that with the use of PID controller in a system has a weakness, namely that the parameters in the controller must always be tuned up (tuned up) when there is a change in the system, the change will cause tuning returns from these PID parameters.

2. Model of PID CONTROLS

The response of a control system always indicates damped oscillation before it reaches steady-state. Classification of transient response characteristics of a control system to the unit step input [3]. As the name implies, this controller is a combination of three control systems namely, proportional, integral and derivative. If each of the three controllers stands alone, the results are less good because each has its own weaknesses and advantages. Therefore, the combination of these three control systems is expected to eliminate weaknesses respectively and capable of contributing from their respective advantages [3]. In the design of the PID control system that needs to be done is to set parameters P, I or D for the response of the system output signal to certain input as desired. PID tuning can also be based on the Ziegler-Nichols tuning method. This method aims to achieve maximum overshoot (MO): 25% against step input. The shape of the curve of the PID control using the Ziegler-Nichols method [6]-[8].

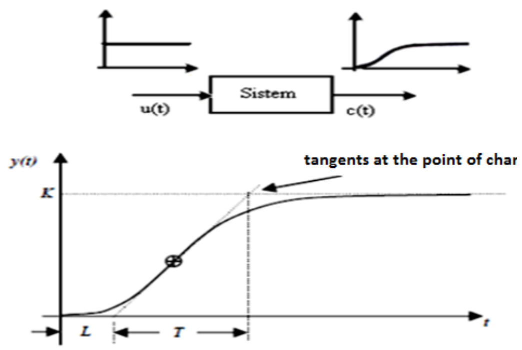

Fig.1 PID Ziegler-Nichols Tuning Curve

Where: L = Delay time
T = Time delay constants

PID value calculation table [6]:

Table 1. ZIEGLER-NICHOLS

Tipe	Kp	Ti	Td
P	T/L	~	0
PI	0.9 T/L	L/0 .3	0
PID	1.2 T/L	2L	0.5 L

3. Direct Current Motors

Direct current motor used is direct current controlled anchor motor type 73186 class 0.3. Direct current motor parameters controlled anchors in the simulation are given in Table 2.

Table 2. Motorcycle Search Parameters Controlled The Media

No	Parameter	Symbol	Value	Unit
1	Power	P	0,3	KWatt
2	Nominal rotational speed	$\square_{nom}$	2000	RPM
			209,440	rad/sec
3	Anchors Voltage	Ea	220	Volt
5	Anchor current	Ia	1,8	Ampere
6	Anchor resistor	Ra	12	$\square$
7	Moments of Inertia	J	0,177	Nmsec^2/rad
8	Friction constant	B	6,83x10^{-3}	Kg.m^2/rad.sec
9	Motor constants	Km	0,796	N.m/Amp.
10	GGL constants opponents	Kb	0,947	Volt.sec/rad
11	Torque	T	1,432	Kg.m^2/sec^2

Source: Directional Motor Controlled Anchors Type 73186 class 0.3 at the Electrical Engineering Laboratory Faculty of Engineering Department of Electrical Engineering Hasanuddin University.

Direct Current Flow Motor Anchors with Non-Controller Disorder

Under these conditions the motor is in an interference condition as shown in the schematic diagram below:

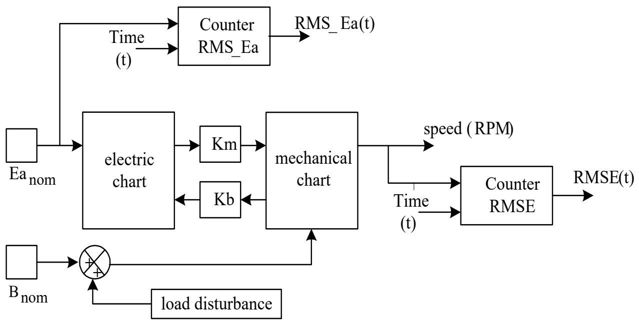

Fig. 2 Chart motion simulation image of direct current uninterrupted disturbance

Changes in rotation speed of a direct current motor occur along with the load changes, meaning that the speed or speed of motor rotation depends on the rise or fall of the motor load. The change of the load itself is then called disturbance. Despite the disturbance that occurs but the rotation speed of the direct current motor wherever possible keeps spinning at its nominal speed. As described above, what is meant by the disturbance condition is how much the load changes are given to the motor that affects the change in the speed of direct current motor. Based on the simulation image of direct current motor without controller (Figure 2) above if executed the graph obtained simulation results as follows

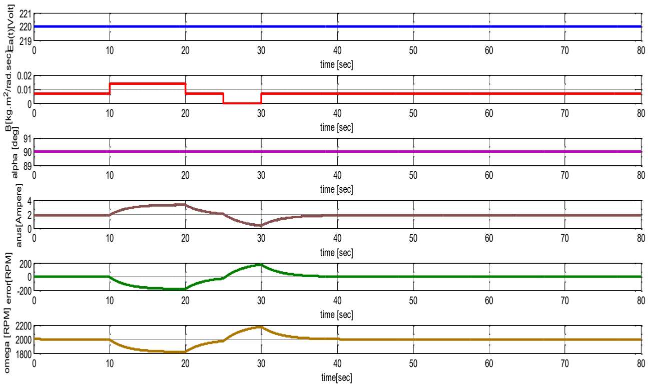

Fig. 3 Graph of simulation results between voltage, load, alpha (angle of ignition), anchor current, error and rotational speed over time without control.

The value of the disturbance that occurs in motor rotation on the graphic image above: The lowest lap disruption occurred in 1872 RPM while the highest lap disruption reached 2214 RPM from the nominal round of 2000 RPM.

Direct current motor with anchor control on the condition of the disorder (Closed loop Control)

The controller used is the Proportional-Integral-Derivative (PID) control. Shown graph pieces simulated direct motor speed simulation results against unmanageable interference conditions such as Fig. 4.

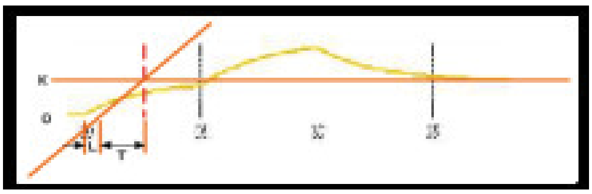

Fig. 4 Graphic pieces of motor speed simulation results on time with uninterrupted interference.

From the picture above graph obtained:
L = 0.63 and T = 1.89.
So obtained:

Kp = 1.2T/L = 1.2 (1.89/0.63) = 3.6
Ti = 2L = 2 x 0.63 = 1.26
Ki = Kp / Ti = 3.6 / 1.26 = 2.857
Td = 0.5L = 0.5 x 0.63 = 0.315
Kd = Kp x Td = 3.6 x 0.315 = 1.134

In making closed-cycle control on direct current motor controlled anchors. More can be seen in the following chart image.

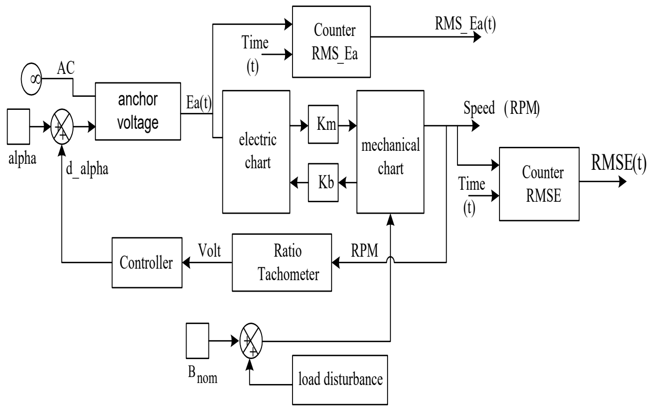

Fig. 5 Picture of DC motor simulation chart of disturbance condition with controller (closed loop control)

When the direct current motor is closed loop control with PID system initialization: Proportional-Integral-Derivative Controller (Kp = 3,6, Ki = 2,857, Kd = 1,134) above is executed the graph of simulation result as follows.

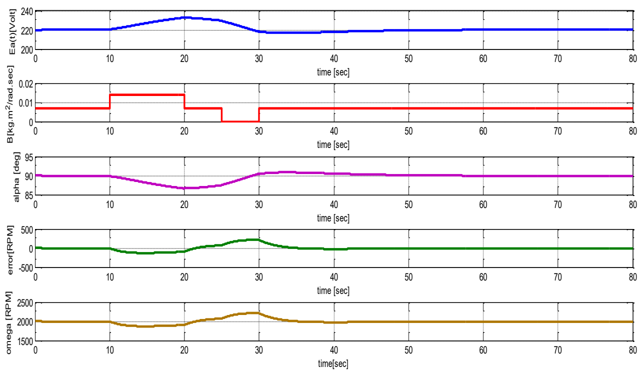

Fig. 6 Graph of DC motor simulation result with controller Kp = 3,6, Ki = 2,857 and Kd = 1,134

The value of the disturbance that occurs in the current and motor rotation in the graphic image above:

The lowest lap disruption occurred at 1818 RPM while the highest lap disruption reached 2177 RPM from the nominal round of 2000 RPM.

4. Conclusion

From the above simulation results can be taken two conclusions:

1. The value of the non-controller disturbance occurring at motor rotation at the lowest spinning disturbance occurred at 1872 RPM while the highest rotation failure reached 2214 RPM from the nominal round of 2000 RPM for 80 s and having a friction coefficient disturbance of about 20 seconds.

2. The value of the disturbance with the controller Kp = 3.6, Ki = 2.857 and Kd = 1.134 which occurred at motor rotation at the lowest rotation disturbance occurred at 1818 RPM while the

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highest rotation disturbance reached 2177 RPM from the nominal round of 2000 RPM for 80 seconds and has a friction coefficient of about 20 seconds.

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