

# PC based real time control of DC motor

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# PC Based Real Time Control of DC Motor

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**Abstract** – This final project report present a Pc based real time control of DC motor. Real time control systems can be defined as a technology which is related to mechanical application, electronic, and computer-based systems. In general, the equipment that is often used for controlling speed system is Arduino Mega 2560, DC motor, motor driver IC L298N, speed sensor IC LM393, and voltage sensor. Software in the system I used Matlab Simulink to monitor and control the speed of dc motor will show real data, they are displayed in signal RPM and signal Voltage, Matlab Simulink is used program to let the operator operates the system well. This monitor and control system can improve the effectiveness and efficiency in various industrial fields.

**Keyword** – PC, Real Time, Control, DC Motor

## INTRODUCTION

Industrial world is always increasing and the efficiency of the production is calculated as a key for succeed in the industry. The number of human resources in the manufacture of a product can make the selling price to be expensive [1]. Automation was chosen by the most of the industry to enhance efficiency with a power machine that automatically perform and organize the work, so that it requires less human supervision. The development of industrial technology does not require human power too much and prefer to technology improvement.

Automatic control systems can be defined as a technology which is related to mechanical application, electronic and computer-based systems, PLC or microcontroller which is used to regulate the function of the system with purpose to match with our goal point. A system that has the ability to start, manage and stop the process to obtain the desired is called control system. If the control system works automatically (without using manpower) then the system is called automatic control system. Each control system has three main elements, as follows: input, process and output [2]. Automation systems currently being developed because it is directed to the manufacture and design of equipment and

production systems in the industry. Production unit which is less effectively done by human, start to be replaced with automatic control machine using, which definitely gives a lot of advantages, such as: accuracy and precision in making a product, reducing the price of materials and the accurate of time production.

This project describes a real-time control system of dc motor and speed sensor with Matlab to monitor and control the speed of DC motor. Matlab Simulink is used program to let the operator operates the system well [3]. This monitor and control system can improve the effectiveness and efficiency in various industrial fields.

## Design Control

Matlab Simulink used in the system is used as a program in the form of blocks and also as a controller on the motor to get the output of motor speed signal and the voltage required on the motor. For data communication or controller, is used the Arduino Mega 2560, voltage sensor in the system is used to read the voltage on the DC motor, speed sensor with IC LM 393 in this system is used as a feedback by reading the rounds in DC motor, DC motor in the

system is used as a mover with an input voltage of 9 V, motor driver with IC L298N in the system is used as a reinforcing the voltage. Figure 1 show a design system.

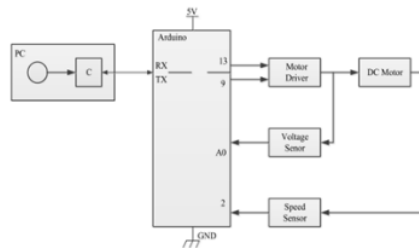


Figure 1. Design system

In this control system, operate dc motor required wiring to Arduino Table 1 show a mapping pin Arduino, Arduino pin that is used for dc motor is a pin 13 pin 9 and ground pin. Pin 13 is used to activate the motor driver, pin 9 is used for (PWM) Pulse Width Modulation. For wiring speed sensor on Arduino using pin 2, pin 3.3V, and ground. For pin voltage sensor that is used in Arduino is pin A0, 5V pin and ground pin.

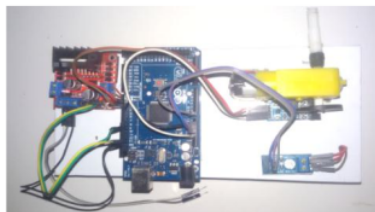


Figure 2. Hardware implementation

Figure 2 show a hardware implementation of a system design explained in figure 1. Table 1 describe the mapping pin Arduino.

Table 1. Mapping pin Arduino

Motor Driver	Speed Sensor	Voltage Sensor
Pin 13 (Digital input)	Pin 2	Pin A0 (Analog input)
Pin 9 (Dig input)	Pin 3.3 V (Digital input)	Pin 5 V
Pin GND	Pin GND	Pin GND

### Control System Simulink

Simulink control in this chapter discusses about the implementation of control on the software, the start program, the Simulink component, the variable value and the block function that is used. The Start program is used for the function of Time Sample (Ts), the start programs designed to simplify the conversion of the time sampling value in Simulink block since for each block has a sampling value. Time sample is the number of samples data retrieval per second.

For this control system, sample time value that is used about 0.08, which means having a sample as 12.5 samples per second. To run a simulation first, run start programs at window Matlab, which gives the initial setting that is sample time value. Simulink block diagram that is used to operate the system is shown in Figure 3.

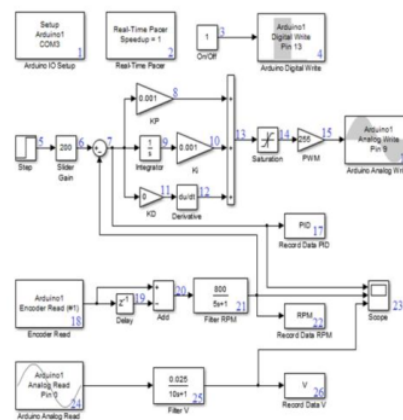


Figure 3. Diagram block Simulink

In the developed PID control system is an additional feature, because the main control is used in this control system only Proportional control that has a characteristic as a gain without giving the dynamical effect to the controller worker. Although undynamical Proportional has comparable or proportional output with the difference between the amounts desired by the actual price.

### Implementation and Analysis

The analysis and data collection on dc motor control system is performed to determine that the system operates as the desired

expectation to happen, so it must be done some hardware tests

#### a. PWM Frequency Response

The result of DC motor test at frequency of 100-400 Hz, DC motor moves sequentially while at frequency of 600 - 900Hz, DC motor resulting a noise and it cannot rotate perfectly. Results is obtained at 489Hz Frequency and at 165mA, motor can rotate perfectly.

#### b. PWM Duty Cycle Signal with Variation of Load

The test of motor speed to the PWM duty cycle signal with the variation of load is performed to see the response of duty cycle if it is given varying load. The results of the test can be seen in Table 2 it shows that if the same duty cycle is given load, then the value will be greater than before.

Table 2. Duty cycle against load

Load	Duty Cycle
(gr)	(%)
0	19
65	23
113	28
178	30

#### c. PID Control System Test

Figure 4.1 shows three PID response signal with the different values with the speed 200 RPM. On signal with the red line has a value as  $K_p = 0.005$ ,  $K_i = 0.001$ ,  $K_d = 0.00001$ , the response is very slow, it has not steady state error and high overshoot Has error value about 22 or 11%. On signal with the blue line has a value as  $K_p = 0.001$ ,  $K_i = 0.001$ ,  $K_d = 0$ , slow response, it has steady state error, and under damped signal and for a control system that is used, PID value response with the best response because it has the smallest error signal, has error value about 19 or 9.5%. Signal with the green line has a value as  $K_p = 0.0005$ ,  $K_i = 0.001$ ,  $K_d = 0.0001$  quick response, it has steady state error, and high overshoot, has error value about 38 or 19%.

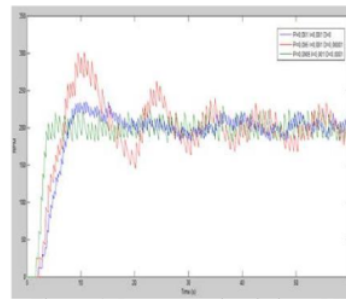


Figure 4. Response simulations PID

#### d. Speed Against Load and Voltage

Here is shown on Figure 5 is a DC motor signal response speed displayed to know the difference between variation load 0 gr has error value 9.5%, 65 gr has error value 10.5%, 113 gr has error value 13%, 178 gr has error value 13%. with a given load speed of 200 RPM and the same time 60 s. Table 3 show speed against load and voltage

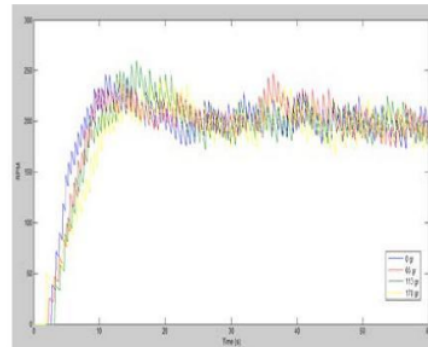


Figure 5. Response testing with variations load

Table 3. Speed against Load and Voltage

Load (gr)	Voltage (V)
0	3.1
65	3.6
113	3.9
178	4.1

In Figure 6 shows the difference between signal output without load and the load 65gr. Seen in the picture at the time of 60s overshooting the signal due to the different load. the PID controller responds to calculate the error and improves the signal back to 70s.

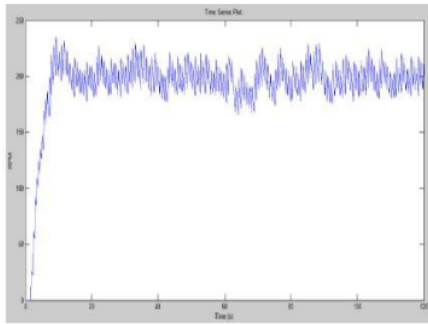


Figure 6. Response testing without a load and the load 2 after 60 second

#### e. Changes in Transient Speed

Here is a picture of dc motor speed signal response shown to know the difference between the change of the increase speed that starts from the speed of 100 rpm to 300 rpm speed with the difference of time per 60 seconds. From the Figure 7. that the faster the speed is given, the greater the overshoot generated response.

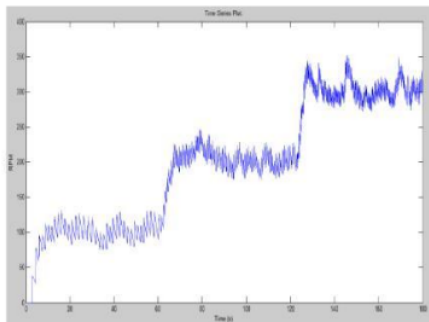


Figure 7. Transient response

## CONCLUSION

From the results indicated that the characterization of the DC motor, PWM frequency response is 489 Hz or of 20.4 ms period. From the characterization result, for motor control at constant 200 RPM, with variation of the load of 0 gr, 65 gr, 113 gr, 178 gr are produced duty cycle respectively by 19%, 23%, 28%, 30%. The result which is obtained from speed variation 100 RPM, 200RPM, and 300 RPM resulting control voltage 2.4 V, 3.1 V, 3.9 V respectively. The result which is obtained from control display for 200 RPM on variation load 0 gr, 65 gr, 113 gr, and 178 gr, resulting control voltage 3.1 V, 3.6 V, 3.9 V and 4.1 V respectively. With the error signal 9.5%, 10.5%, 13%, and 13% respectively. PID controller and speed sensor signal conditioning can read the error well when given the disruption of the load, with the error signal 9.5% at a speed 200 RPM.

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