



Zagazig University
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Motor Test Bench

Project Report
by

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Control Project (Motor Characteristics)

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Software Tools: **Matlab** (issues the control commands and does all the plotting), **Arduino IDE** (write the serial code in Arduino to make it understand what Matlab is saying and how to reply) and **Proteus** (used as a virtual way of communication between Arduino and Matlab, only used for testing).

Hardware Tools: **Arduino board** (used to read sensors outputs and sent it to Arduino such as voltage, current and RPM), **Current sensor** (used to measure current 'ACS712'), **RPM counter** (used to count RPS and we converted to RPM 'IR sensor'), **Motor driver chip** ('L293D') and a 9V **battery**.

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Motor Test Bench

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Group D

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Abstract:

Given any motor with unknown characteristics, the project aims to get and plot the characteristics of this motor with the help of a known (or even unknown) motor that works as a reference.

The project uses Arduino and Matlab to get the characteristics of the motor using serial ports as a means of communication. Characteristics we aim to identify are current running in motor (in Amps), Voltage applied on the Motor (in Volts) and the RMP of the motor.

Of course these Characteristics are measured for both motors.

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Figure 2.2. Explaining IR sensor principle that we use to calculate RPS and from it we Get the RPM of the Motors

Figure 2.3 Showing Hardware connection Diagram of the project

1. Introduction

Our objective is quite clear, given any DC motor we should be able to obtain it's characteristics by inserting it in our Motor Test Bench.

We achieved our goal by securely holding our reference motor on a board and color coding our wires to know which wire goes where and attaching a spinning gear to the reference motor then we simply place the other motor we want to obtain it's characteristics in front of the other motor and attach it's gear to the reference motor gear and then we make sure that every motor is securely placed on the board.

After that it's all a matter of running the test and waiting for the results to appear.

NOTE: this specific project has no fixed output due to the fact that every motor have different characteristics.

2. Background Theory

- 1- When a motor is rotated at a certain speed by an outer force then the motor will produce current proportional to the speed it's being rotated by, due to the fact that wires that moves in a magnetic field produces current (the opposite of motor working principal) **Figure 2.1** .
- 2- When an IR receiver receives an IR light wave it produces voltage. This voltage can be amplified to logical levels. An IR led emits infra-red light, when that light hits an object then it echo back to a neighboring IR receiver **Figure 2.2**.

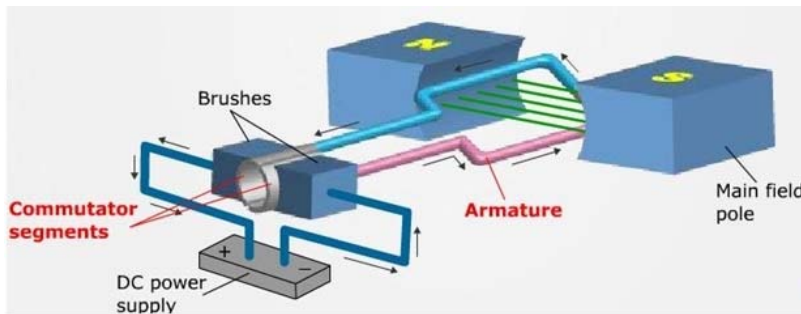


Figure 2.2. Motor Working Principle.

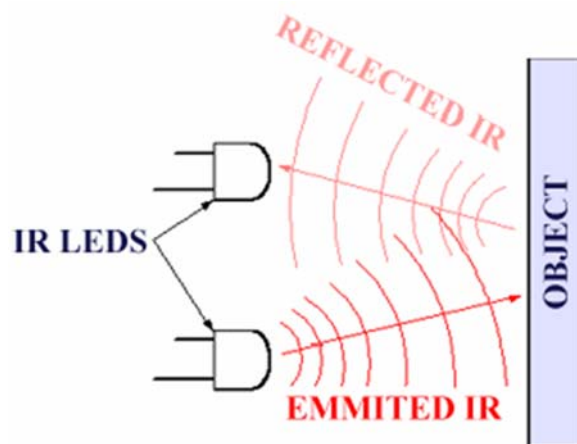


Figure 2.2. IR transmitter and receiver

3. Hardware Implementation

We connected two motors to one another

The current sensor is connected in series with the main motor and another one to the secondary motor.

RPM sensor is connected on the other side of the motor where the pierced wheel is connected.

Whenever a hole in the wheel is passed, we get a pulse.

Knowing the number of holes in the wheel, the number of pulses and the time the sensor took to calculate the pulses we can calculate the RPM.

As for the voltage it's very strait forward, we need to connect an analog pin to the motor 2 (+) and Arduino's ground to motor 2 (-).

We will also need to output a varying voltage to drive the motor and to be able to calculate the Characteristics at different applied voltage.

Arduino's current will not drive the motor so we used a motor driver L293D to drive the motor.

Arduino's analogWrite function uses PWM method to output voltage, we use this method to tell the motor driver L293D what to do.

Main motor is the reference motor and secondary motor being tested.

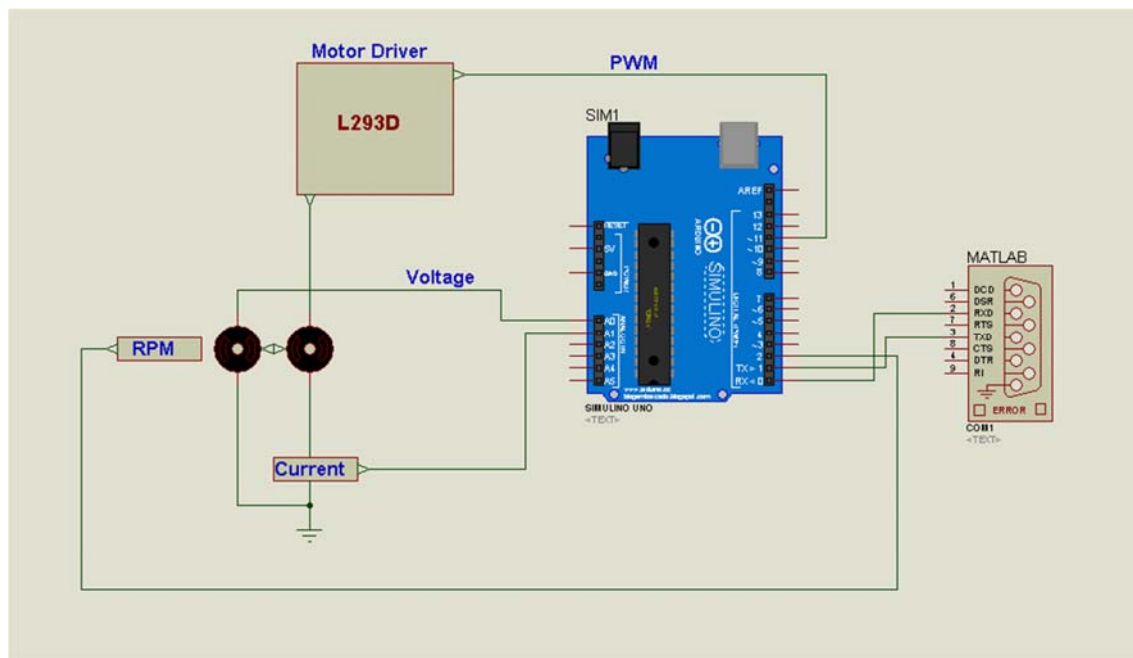


Figure 3.3. Hardware Connection

4. Results and Conclusion

The result was quite correct but we noticed that our reference motor won't work with a high torque motor because the reference motor simply won't be able to generate enough torque to drive the other motor.

The RPM sensor will skip some pulses at high speed due to the fact that it's not designed to measuring RPM.

So all things considered the accuracy is very high.

5. References

Matlab site and Arduino site. Both sites were used to get information on Matlab and Arduino's Syntax.

Matlab : <https://www.mathworks.com/help/index.html>

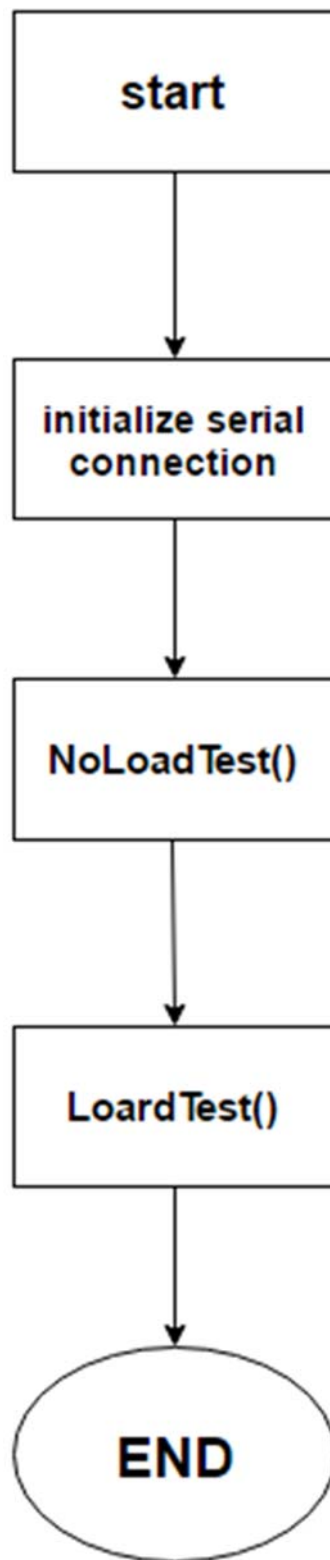
Arduino: <https://www.arduino.cc/en/Reference/HomePage>

6. Flow Chart

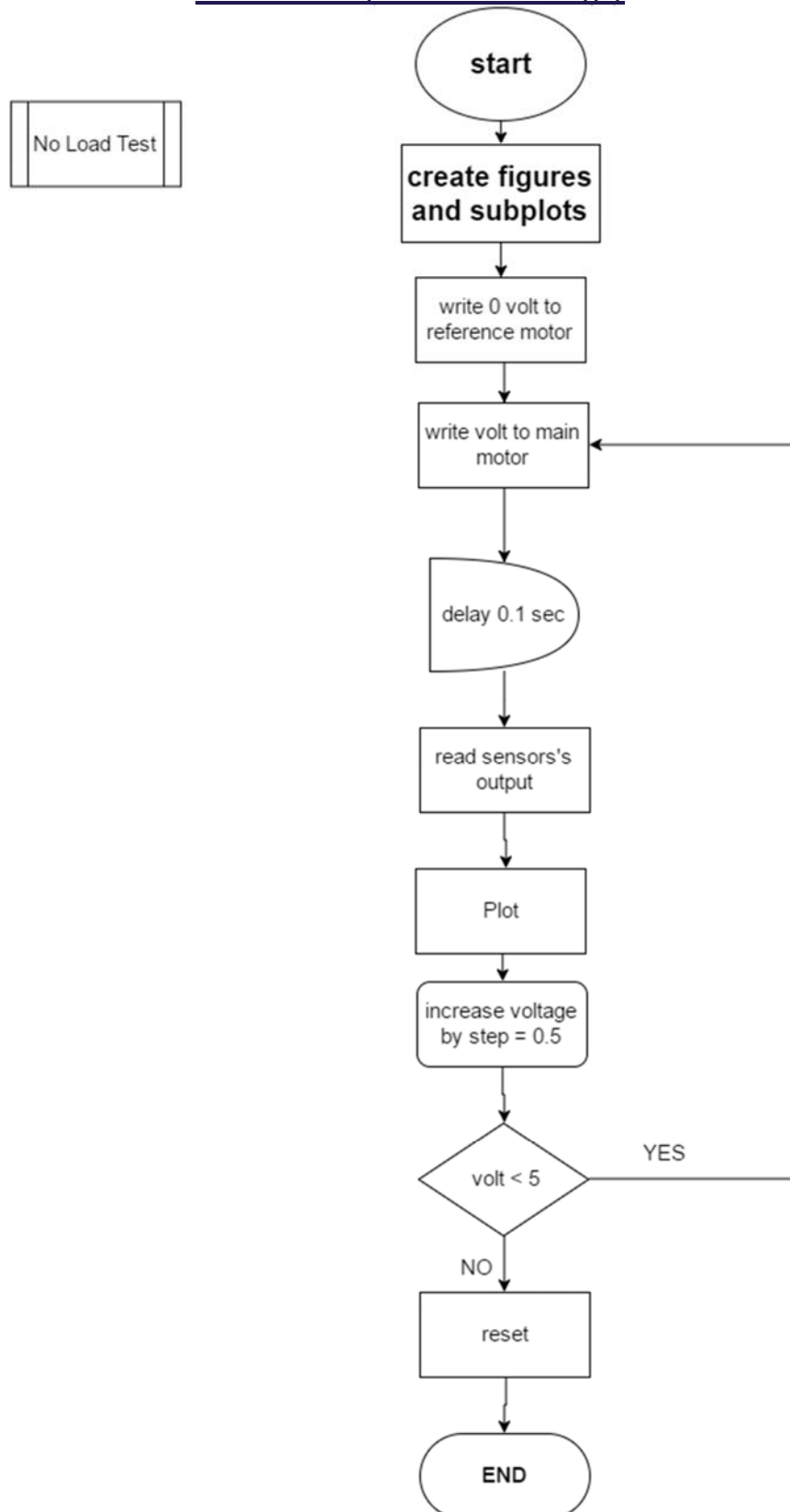
- The controller work as follows.
- At initial stat the controller doesn't receive any input.
- The first stage is Applying no load test which obtain voltage and current when no load is applied to the motor
- Then load test is applied.
- At load test we start the test motor at full 5V and then gradually apply voltage on the other motor to run at the opposite direction.
- We obtain the current, voltage and RPM at every instance at both test.
- We also calculate the efficiency and plot relevant information at each test.

This flow is divided into 2 sub-charts:

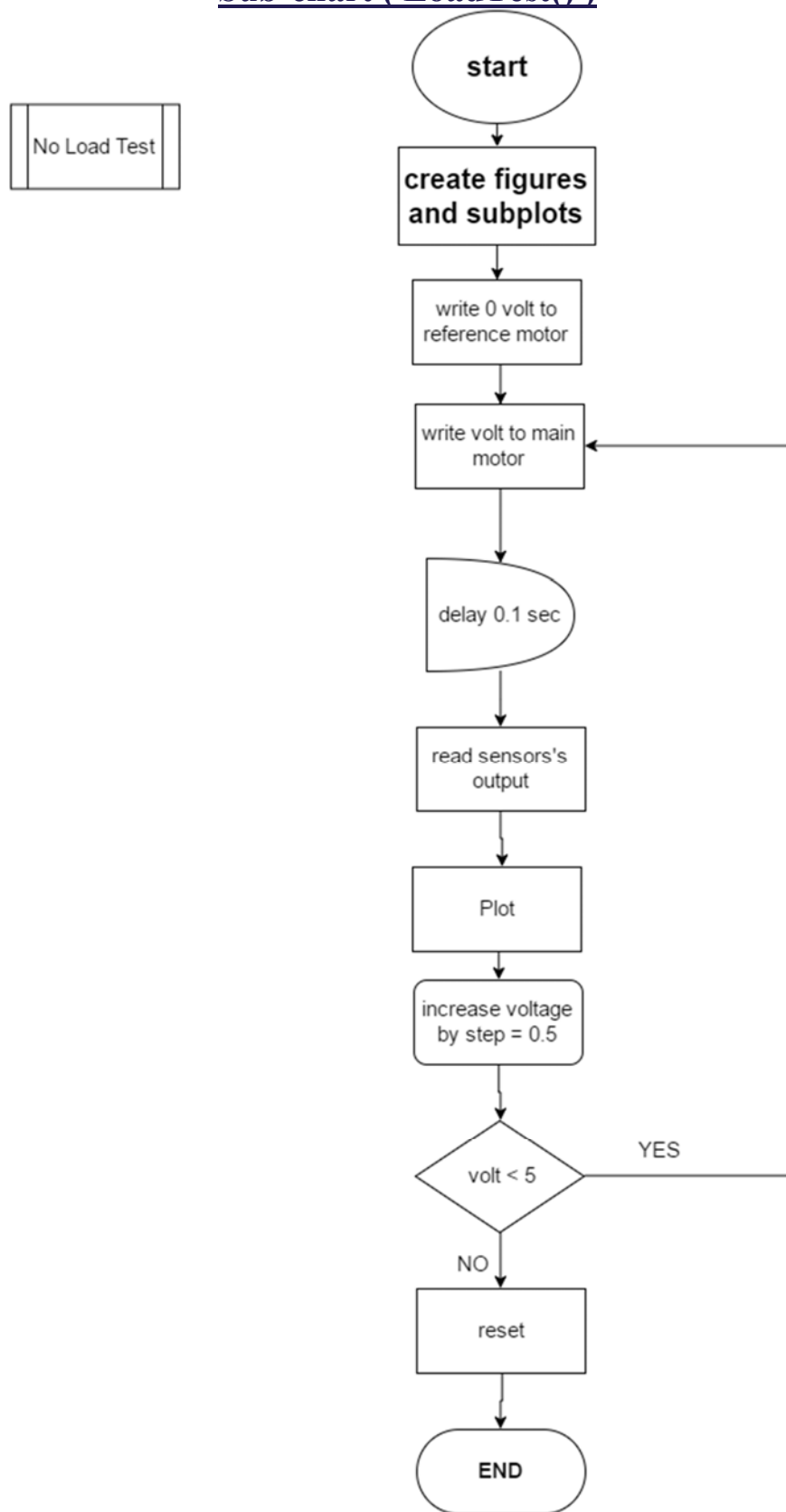
Main Chart



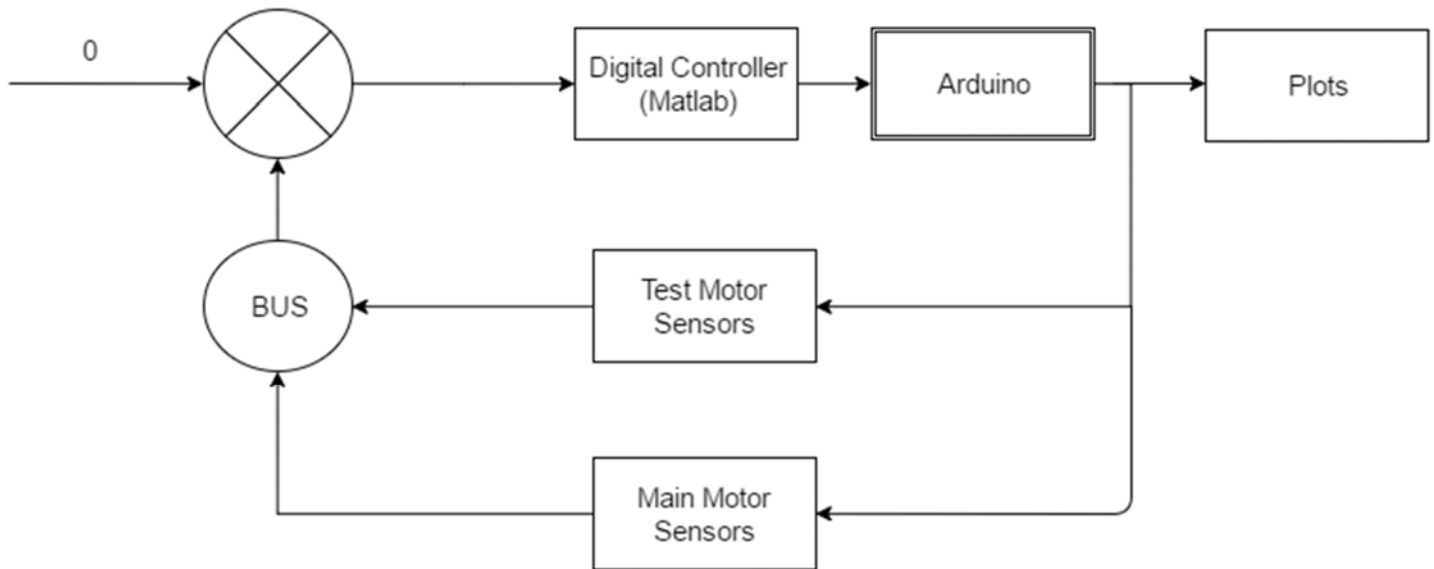
Sub-chart (NoLoadTest())



Sub-chart (LoadTest())



7. Block Diagram



This block diagram represent the process the controller go through to obtain the motor characteristics.

Note that Arduino is only a middle man between Matlab which is the Controller and the motor, sensor and what like.

8. Code

A copy of the source code is attached with this file. Also, code is available on GitHub via the link below.

<https://github.com/mahmoudShaheen/motorTestBench>