

LABORATORY STAND FOR REMOTE CONTROL REALIZED ON THE MICROCONTROLLER ARDUINO

Authors: **Aleksandr Federov, Sona Mangasaryan** e-mail: Sonia.sona-1995@yandex.ru, +79532347747

Scientific supervisor: **Sergei Loginov, scientific degree Ph.D**, e-mail: lsyl@mail.ru
Pskov State University, Russia, Pskov, Lenin Square, 2

Abstract. *In this article a research principle of remote control of direct current motor with independent excitation is considered. For studying this problem a laboratory stand was made. This project is realized on the microcontroller Arduino.*

The feature of this stand is the fact that the student needn't be in a university lab, because the stand is designed for remote control through the Internet. Students can see a scheme of the stand on the monitor of their computers and control it by our program.

The advantages of this project are:

- *The increase security for students, the safety of the laboratory stand.*
- *More accuracy when reading motor parameters.*

The results of this work can be used not only for studying, but also for practical use at factories in the future.

Keywords: *microcontroller Arduino, laboratory stand, remote control*

Introduction

Laboratory research is very important in modern education. Students have the opportunity to see apparatus and familiarize with operating principle. It is extremely important for their future work. Many programs are created for this. That allows to carry out laboratory works. But this programs are virtual and don't allow be tangent real appliances. There are real laboratory stands, but they are expensive wherefore the access is limited, also they need specific service. In order to unite all the advantages of the above methods and to get rid of disadvantages, was appeared an idea of creating laboratory stand, which can be controlled through the Internet. The stand is designed for the remote control. It is not necessary to be at the lab to make laboratory work. This allows more students to join the educational process.

Stand development

The stand is designed for the study of a DC motor with independent excitation. The main parts of the stand are DC motor, generator, tachogenerator. Auxiliary elements are rheostat, step motor, transistor, resistors, capacitors. With the help of the laboratory stand students can get the motor mechanical characteristics. The process can be controlled through the microcontroller Arduino. That is why a special program was written.

The structural scheme of the stand is shown in Figure 1.

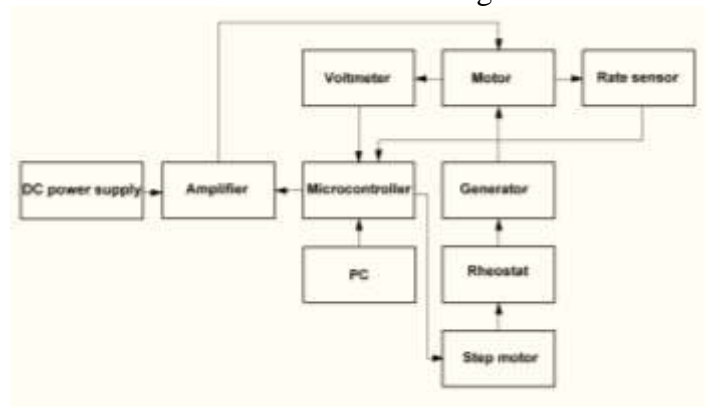


Figure 1. The structural scheme

The microcontroller Arduino is powered from the computer through the USB port, the motor is connected to an independent power source + 15V.

The signal goes through microcontroller to the step motor, the shaft of which is fixed through the coupling to the shaft of rheostat. Due to the stepper motor, we change the value of the rheostat resistance. Rheostat is connected in series to the generator. And the motor shaft is fixed to the generator shaft. Motor is started due to the signal, which comes to it from the processor. This is realized thanks to transistor. Signal of voltage value from the motor through the voltage divider comes to microcontroller. The rate sensor is a tachogenerator (TG). The signal from the TG is transferred to the microcontroller via a voltage divider.

Development of any device begins with computer simulation. For this we use program Proteus. Figure 2 shows a model of the stand, designed in Proteus environment. Also, this program allows create a scheme for printed circuit board (PCB). Figure 3 shows the PCB.

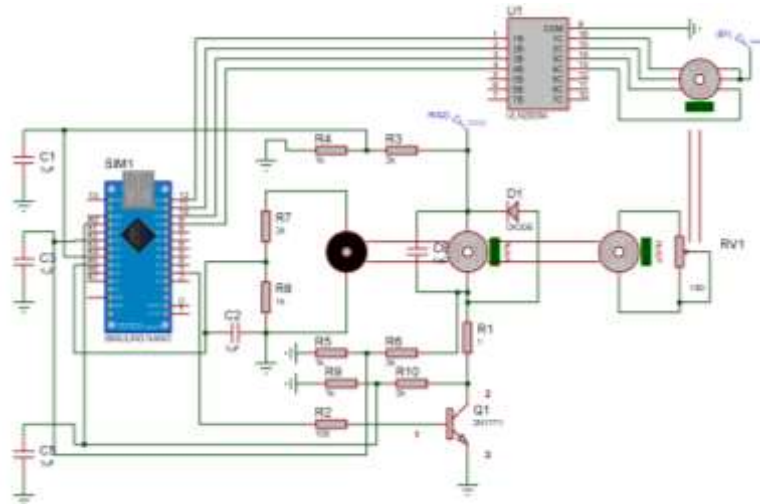


Figure 2. The model of the stand

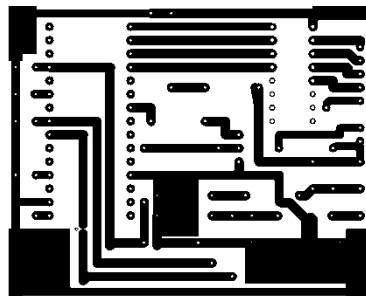


Figure 3. The PCB

DC motors are widely used in industrial, transportation, and other applications that require a wide and a uniform rate control (rolling machines, powerful metal cutting machines, electric traction in transport, etc.). The DC motors with independent excitation for power supply excitation winding uses a separate DC power source. In our case the motor with permanent magnets, and it has the same properties as the motor with independent excitation winding [1]. Figure 4 shows the mechanical characteristic of the motor.

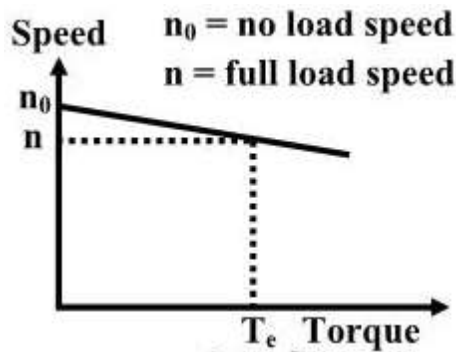


Figure 4. The mechanical characteristic of the motor

The essential property of the stepping motor is its ability to translate switched excitation changes into precisely defined increments of rotor position ('steps'). Stepping motors are categorized as doubly salient machines, which means that they have teeth of magnetically permeable material on both the stationary part (the 'stator') and the rotating part (the 'rotor') [2].

In our project, step motor rotates the rheostat, which is connected in series with the generator. By changing the resistance of the rheostat, we change the torque on the generator shaft. Decreasing of load when resistance increases, due to that the speed decreases. A speed mechanical characteristic can be obtained by reading the motor current and velocity. Torque can be calculated if current is known. Data records in Table 1.

Table 1

Mechanical characteristic of DC motor

Measured value	1	2	3	4	5
I, A					
M, N*m					
W, Rad / s					

Torque is calculated from equation (1):

$$M = C_e * \Phi * I, \tag{1}$$

where

C_e – coefficient

Φ – magnetic flux

I – current

Laboratory class includes getting the mechanical characteristics at reduced voltage. It needs the changing of the PWM signal that comes from the microcontroller [3]. The data records in Table 2.

Table 2

Mechanical characteristic of DC motor at reduced voltage

Measured value	1	2	3	4	5
I, A					
M, N*m					
W, Rad / s					

In order to realize the remote control of the project it is used a microcontroller Arduino nano.

Arduino is a hardware – software platform that is designed for creating digital devices and interactive objects that can sense and control physical devices. The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output pins that can interact to various expansion boards and other circuits. The boards feature serial communication interfaces, including USB in some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an IDE based on a programming language named Processing, which also supports the languages C and C++ [4].

In this project the microcontroller Arduino Nano is used. Nano is a microcontroller board based on the ATmega32U4. It has 20 digital input/output pins (7 of which can be used as PWM outputs and 12 as analog inputs). It contains everything needed to support the microcontroller; simply connect it to a computer with a micro USB cable to get started. It has a form factor that enables it to be easily placed on a breadboard.

Microcontroller controls rheostat and speed of motor by PWM signal, also it reads data from stand by analog input pins. Microcontroller itself is controlled by computer, that is sends data through COM-port. Program, that is installed on computer, is developed by means of SFML and Visual Studio in C++ language.

Microsoft Visual Studio is an IDE from Microsoft, used to develop computer programs. Visual Studio uses Microsoft software development , also it includes a code editor supporting IntelliSense as well as code refactoring.

SFML is a cross-platform software development library designed to provide a simple application programming interface to various multimedia components in computers, written in C++ [5].

Microcontroller exchanges data with the computer constantly. Each iteration of the data exchange begins with the computer. It sends a signal about the new state: amount of changes, then pairs of pins and values for PWM's signals, and/or signals to turn on/off the stand. If amount of changes is equal to zero, Arduino conserve its current state. After processing the data, Arduino gives a respond. The parameters, that are read from the motor, are coded into signal. Unlike the control signal, the answering signal always has the same size, because it transmits instant parameters of the motor. After getting all the parameters, the program displays them on the screen, the user works only with graphic interface of the program.

Before the beginning of the work the user must install connection with COM-port. In this case COM-port is used for exchanging the data. Thanks to constantly data exchange, program monitors the status of the connection, and in case of unsanctioned disconnection informs the user about arisen problem. Also, if Arduino is disconnected, the motor turns off automatically. Signals from the computer and microcontroller differ by the first bait of message, that take value 'C' if it is sent by the computer and 'A' if it is sent by Arduino. At any time the user can reset COM-port, in that case or in case of closing, the program stand turns off automatically. At the active-state the user inputs values of the speed of the motor and angle of the rheostat by keyboard. This data is converted to the signal with a range from 0 to 255 and the signal is sent to Arduino. Reading parameters of the motor with a range from 0 to 1023 are converted by the program itself.

Summary

The equipment of remote control laboratory stand was developed. It lets get mechanical characteristics of DC motor of different values of voltage supply. The key feature of this stand gives a possibility to control the stand from a distance via the Internet. The modernization of the stand will allow to broaden its functional possibilities and to use it by training the students of the Pskov State University on the subjects “Electrical motors” and “Standard Electro drive”.

Bibliography

1. Voldek A. I. Electrical machines. 2-nd edition, St. Petersburg, pub. "Energy", 1974, 840p.
2. Poul Acarnley. Stepping motors a guide to theory and practice. 4-th edition, pub. the institute of electrical engineers, 2007
3. Hirak Patangia, Sri Nikhil Gupta Gourisetti. A Novel Strategy for Selective Harmonic Elimination Based on a Sine-Sine PWM Model. MWSCAS, U.S.A, Aug 2012
4. Jeremy Blum. Exploring Arduino. Tools and Techniques for Engineering Wizardry, ISBN 978-1-118-54936-0, 2013, p.336
5. Massimo Banzi. Getting Started with Arduino. First Edition, pub. O'Reilly 2008