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Real Time DC Motor Speed/Position Control with Bluetooth Communication

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Abstract: In this study, speed/position control of real time static magnetic Direct Current (DC) motor which can communicate with wireless using Matlab platform and PIC microcontroller was carried out. The study consists of three sections: developing DC motor speed/position unit, developing wireless communication module, and developing Matlab-Gui user interface. In the study, PIC16F876A was used as microcontroller, 2x16 character LCD screen was used as real time user interface, HC-05 Bluetooth adaptor was used for Bluetooth communication, and Matlab-Gui program was used as computer interface. An application card was designed for the user to carry out speed and position control of a DC motor which is in real environment and it was achieved. As a result of the experiments conducted, it was seen that the study is capable of measuring required rotation data with an error less than 1%. Data of position is again obtained from optical encoder. Wireless communication is securely provided and there occurred no data loss. Speed/position control of the wireless DC motor with high resolution and security was achieved with this study..

Keywords: Bluetooth Communication, dc motor, graphical user interface, PIC16F876A.

1. INTRODUCTION

Today, several systems being used in daily life can be inspected using wireless communication. Usage of wireless communication structures becomes widespread in miscellaneous fields like pump control systems for drinking water, short message systems (SMS) being used in automobiles, vehicle identification systems, and robotic transportation and manipulator systems. For example, static bluetooth communication is used for a multi robot exploration [1]. Bluetooth wireless communication network applied in all-software NC system is proposed to diagnose the fault in NC system [2].

In the study, a structure that is convenient to Bluetooth 2.0 protocol and able to communicate in ISM (Industrial Scientific Medical) band. The structure used can broadcast with Bluetooth up to 10 meters using interior antenna and up to 100 meters using external antenna. Data were encoded automatically and modules operate only among themselves as closed in terms of security. The study was carried out to be an example in the places where wireless and secure data transfer is required. General block diagram of the conducted application is seen in Figure 1.

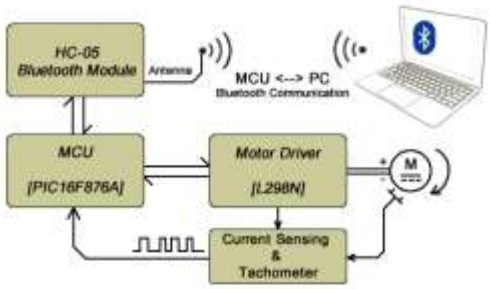

Figure 1. General block diagram of the conducted application

In the study, PIC16F876A microcontroller of Microchip Company was used with the support of HC-05 Bluetooth module SPP (Serial Port Protocol) to be able to communicate with wireless. 2x16 character LCD screen was used to display received and sent data and voltage regulator was used for supply, in application card. L298N is used as motor driver and static magnetic DC motor is used as motor. An adaptor card was prepared for HC-05 module. Design of adaptor card was developed based on HC-05 data pages; Proteus (v7.10) program was applied in Ares module by preparing printed circuit.

Matlab software was used in the study. Reason for using Matlab software is that it serves a ready and strong support for interface, and provides flexibility to the program with toolbox it consists of. User interface provides the ability of easy controlling to the user without requiring to use any terminal program (hyperterminal etc.) and to know any command.

Speed/position control application of the real time static magnetic direct current (DC) motor which can communicate with wireless by using PIC microcontroller and MATLAB platform, in this study. Studies related to the subject recently conducted are existent. For examples; Design and application of DC motor driver and its inspection structure were mentioned in [3]. DC motor speed control was done with PID controller in Matlab in [4]. Study of real time MATLAB interface for speed control of induction motor drive using PIC was conducted in [5]. Simulation and implementation of speed control of dc motor were carried out in [6]. Motor studies continues today [7,8]. Intelligent motor modules are available to be developed [9].

Speed/position control of secure, wireless DC motor having high resolution was done, and user interface and motor inspection were transformed into a more comprehensible and easy state. As conclusion of the experiments conducted, wireless communication was successfully achieved in the desired way without any data loss.

The study consists of four sections. Second section consists of developing speed/position control unit of real time DC motor. Third section explains the design of user interface for application. Results of the application are presented in the fourth section.

2. Implementation of the Real Time DC Motor Speed/Position Control Unit

In this structure, PIC16F876A is used as MCU (Micro Controller Unit) to process the data coming from computer environment and to send data, 2x16 LCD is used for the user to send data independent from computer, L298 integrated circuit is used as motor speed and position control driver, current monitor is used to measure motor instantaneous current, and optical quadrature encoder is used to measure rotation and position data.

The data coming from computer reach to PIC microcontroller after they have been transferred to the Bluetooth module in circuit from Bluetooth module of the computer. To enable transfer process, initially it is necessary to introduce Bluetooth module to the computer only once and to verify (pairing) it. Bluetooth module is introduced to the computer as Bluetooth Serial Port and a virtual serial port is formed. After this process, the data which will be sent through Matlab environment is caught by the Bluetooth module in application card via virtual serial port and transferred to PIC. After the data coming from the computer is received by the Bluetooth module, they were transferred to hardware serial port of PIC. Serial port located inside USART (Universal Synchronous Asynchronous Receiver Transmitter) module was programmed as to be at 9600 bps baud speed, and 8,N,1 (“8” data bit, “No” parity bit, “1” stop bit) in order to communicate at the same speed with computer. Cutting process is being used to carry out PIC serial port communication. When any data came to the serial port, PIC receives the data recording the work which is currently being done, via cutting, and then it continues its work from the point where it stopped.

Circuit schematic of the application which was drawn in Isis module of Proteus (v7.10) program is seen in Figure 2. As seen from Figure 2, MCU card circuit schematic of real time DC motor speed/position control unit consists of PIC16F876A MCU, ICSP for MCU programming, 2x16 LCD for instantaneous data display, convector for Bluetooth adaptor, and power supply units.

PIC16F876A contains 2 CCP (Capture/Compare/PWM) modules in it. These units called as CCP1 and CCP2 modules are able to operate in one of every 3 modes. In our application, CCP1 module is operated at PWM mode to produce PWM indicator, CCP2 module is operated at Capture mode in order to measure rotation data and catch the data coming from outside.

PIC MCUs process dividing crystal frequency applied from outside into 4. PWM and Capture units need time sources to operate and they consist of timer modules named with Timer which are connected to the time source applied from outside, in PIC. Timer2 module of the PIC is being used for PWM process, and Timer1 module is used for Capture process. PWM frequency is set to 50 kHz with the codes written for Timer2 module. In circuit, 2x16 LCD is used for the coming data or the information measured by circuit to be also seen at the time of application. 2x16 LCD was used in a parallel way at 4 bits mode.

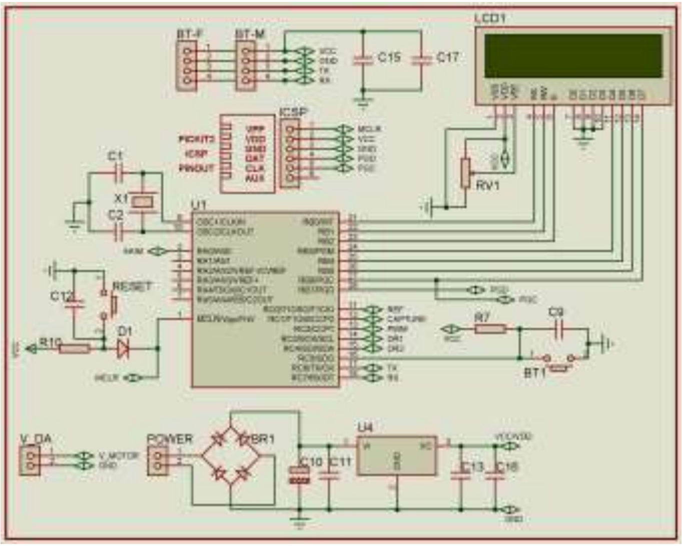

Figure 2. MCU Circuit Card Scheme of Real-Time DC Motor Speed / Position Control Unit

General overview of the circuit belonging to real time DC motor speed/position control unit exists in Figure 3.

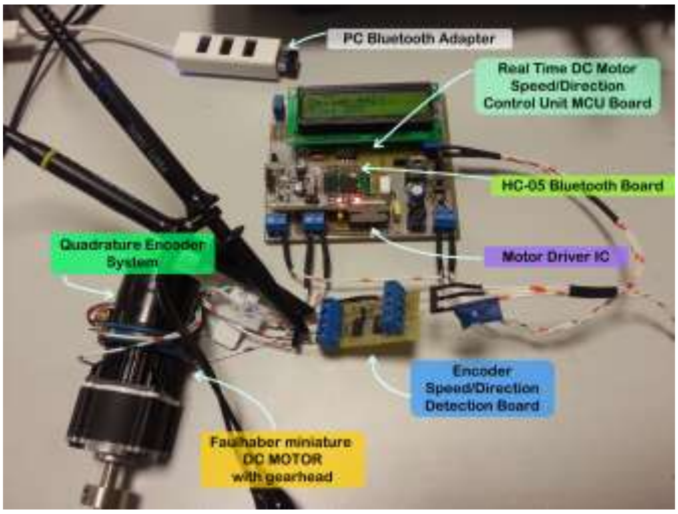

Figure 3. General overview of the circuit belonging to real time DC motor speed/position control unit

3. Design of User Interface for Application

Matlab-Gui is a program interface which provides easiness and interaction to user during the period of running a work or a program. The purpose for using Matlab-Gui in our application is to include strong and flexible Matlab command tools easily into GUI environment and to provide easiness to the user. 7 buttons, 1 convertible text box, and 2 static text box are used for Matlab-Gui interface in our application. After the commands written in GUI were transformed into global state with "handles" prefix; the control of serial port was performed by relating the commands of opening and closing the motor, start, stop, rotate in clockwise/counterclockwise direction commands belonging to the motor, with the help of Instruments Toolbox in Matlab tool and these commands were presented to the user after they were assigned to the buttons.

Data is taken by the user by using changeable text box for duty time belonging to PWM signal to be entered and changed by the user and this data is written on serial port using "Apply" button. Thus, the increase and decrease in motor speed are controlled.

Speed and position controller user interface of DC motor with wireless communication is seen in Figure 4.

Figure 4. Speed and position controller user interface of DC motor with wireless communication

No data is sent to MCU motor driver since initially there is not any data when speed/position control unit of real time DC motor is operated, and motor does not start. MCU becomes ready to receive data by the energized Bluetooth module paired by compute at the same. "Open Serial Port" and virtual serial port formed before are opened. When "Start" command was sent from computer, motor is energized by the duty value determined for beginning in MCU and motor starts to move. Optical quadrature encoder circuit produces signal with same amount as motor's rotation and these information is written on LCD being commented by MCU. Energy which goes to the motor is cut with "Stop" command; motor rotates in clockwise direction with "Turn CW" command, and rotates in counterclockwise direction with "Turn CCW" command. "Duty" value is entered within the interval of 0-100 by the user, duty information is sent to MCU with "Apply" button and speed control was done. Virtual serial port opened before is closed with "Close Serial Port" command and it is deleted. At the same time, after motor control is done, position and instantaneous speed information belonging to motor can be seen on GUI screen.

4. Application Results

A general overview belonging to the study of real time DC motor speed/position control unit exists in Figure 5. After this application, it can be announced that the system performs motor speed and position control within the desired interval, data transfer is carried out in a secure way, error is found to be less than 1% as a result of the measurements done and the system functions without error.

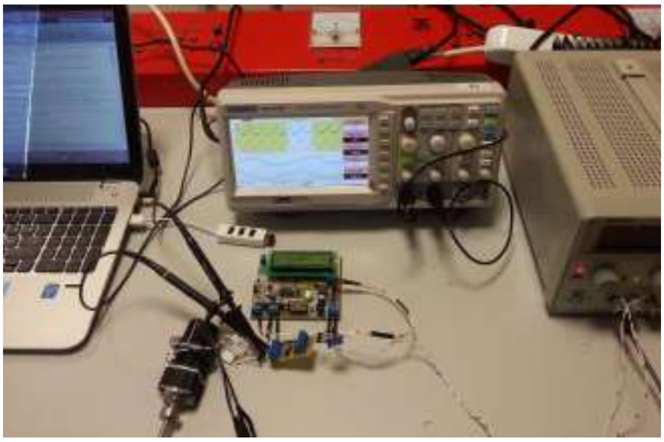

Figure 5. A general overview belonging to the study of real time DC motor speed/position control unit

In the application done, a professional tachometer whose accuracy is high is seen on the left, and application circuit is seen on the right of Figure 6. It is seen that the speed of 11760 RPM is measured on LCD screen of application circuit. On the other hand, digital tachometer actively measures 11784 RPM.

Figure 6. Measurement results with application circuit and digital tachometer

Relative error rate is calculated using equation (1).

$$Error = \frac{true\ value - Measured\ value}{true\ value} * 100 \quad (1)$$

$$\frac{11784 - 11760}{11784} * 100 = 0{,}00203 * 100 = \%0{,}203$$

As it is seen when relative error is calculated; speed value of the motor can be measured with an error of 0.203%.

For position application, speed/position signals obtained from encoder position and speed detection circuit whose circuit schematic was given in Figure 5 were monitored in oscilloscope and transferred to computer environment at the same time. The images belonging to the transferred signals are seen in Figure 7 and Figure 8. Duty rate is around 5% in Figure 7, and it is around 50% in Figure 8. There is not position change in both figures.

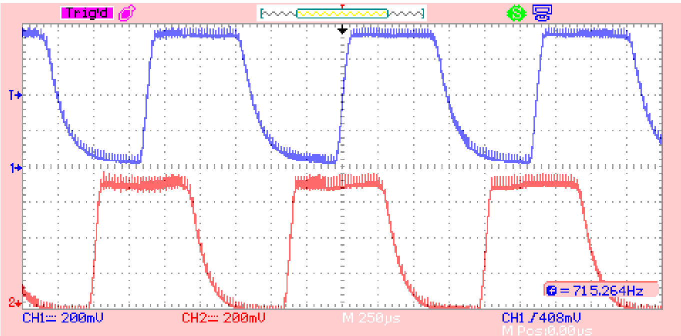

Figure 7. Encoder speed detection (Duty:%5)

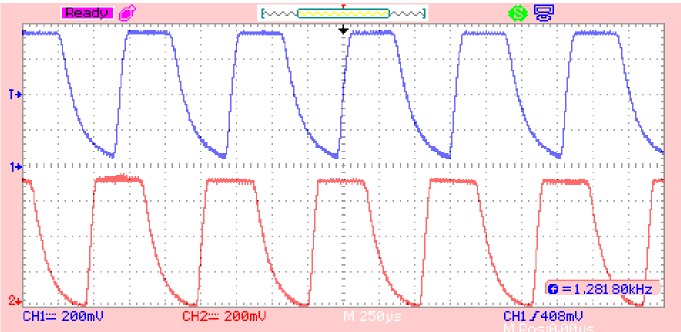

Figure 8. Encoder speed detection (Duty:%50)

On oscilloscope in Figure 9 and Figure 10, there exists a phase difference of 90 degree between the signal seen at Channel1 and the signal at Channel2. Quadrature encoders take their names from this 90 degree phase difference. Whether the motor is rotating in clockwise or counterclockwise direction can be said by looking this phase difference. The signals produced by encoder for different rotation positions are seen in Figure 9 and Figure 10.

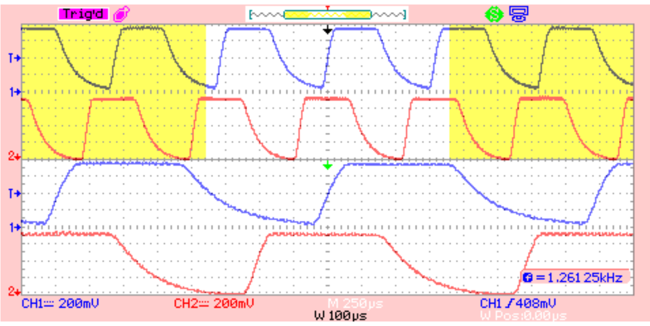

Figure 9. Encoder position detection (motor is rotating in clockwise)

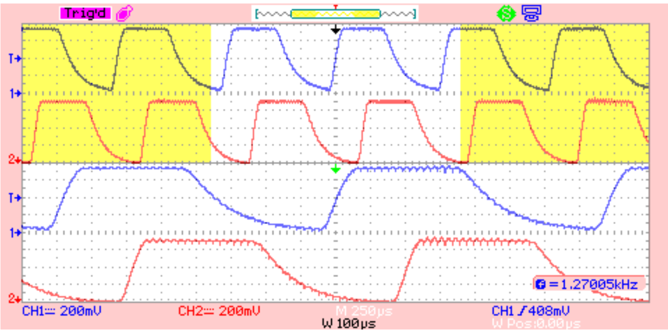

Figure 10. Encoder position detection (motor is rotating in counterclockwise)

As the signals in Figure 9 and Figure 10 can be detected with a software approach, they were detected with a hardware approach with the circuit in Figure 6, in our application.

5. CONCLUSIONS

In this application, access of a interface prepared with GUI in Matlab environment to hardware ports of computer was done, Bluetooth communication was selected for wireless data transfer. In the application, PIC16F876A microcontroller produced by Microchip Company was used, H-bridge driver microchip was used for driving DC motor, a LCD screen was used to display instantaneous data independent from the computer, and a Bluetooth adaptor was designed from us and used for Bluetooth communication. Serial port protocol (SPP) was chosen in Bluetooth communication. Computer and microcontroller perceive the Bluetooth signals as the signals coming from serial port. Thus, communication and encoding algorithms were considerably simplified. Data transfer between the application circuit and computer was not carried out over 8 m distance in practice since Bluetooth communication was done with PCB type antenna. Antenna addition to the Bluetooth module is required for using more active distance. However, Bluetooth communication being self-encoded with respect to radio frequency communication and being cheaper than Wi-Fi adaptors provides a more preferable structure.

As the results of the experiments conducted, it was seen that the study is able to measure required rotation information with the error less than 1% (%0.2-0.6). Position information is again obtained from optical encoders. Wireless communication is securely provided; it is done without any data loss. Therefore, speed/position control of the secure wireless DC motor of high resolution was carried out with this study.

Proportional PWM was used for speed control of the motor, in the study. This application will later provide opportunity to make inspection using P, PI, PID, and artificial intelligence and it was designed as to be open for further improvements.

Application circuit was done for low powered motors to be controlled however it has the capacity which can provide opportunity of development for the criterions having industrial importance like encoder selection and production for motor's position and speed detection, and sudden braking and starting to rotate, as to be applied to the larger motors.

REFERENCES

[1] Kovacs T, Pasztor A, Zoltan I, A multi robot exploration algorithm based on a static Bluetooth commumication chain. Robotics and Autonomous Systems 59, 2011, 530-542.

[2] Kunqi Wang, Peng Wang, Yanan Wang, The Research of Bluetooth Wireless Communication Network in NC System, nswctc, vol. 1, International Conference on Networks Security, Wireless Communications and Trusted Computing, 2009,pp.766-769.

[3] Wang H., Design and Implementation of Brushless DC Motor Drive and Control System. International Workshop on Information and Electronics Engineering (IWIEE),2012, 2219-2224.

[4] Singh A.P., Narayan U., Verma A. ,Speed Control of DC Motor using PID Controller Based on Matlab. Innovative Systems Design and Engineering. Vol 4, No 6,2013,22-28.

[5] Arulmozhiyal R, Baskaran K, Devarajan N, Kanagaraj J, Real Time Matlab Interface for Speed Control of Induction Motor Drive using dsPIC 30F4011. International Journal of Computer Applications vol 1, No 5,2010, 71-76.

[6] Raval P R, Mehta CR, Modelling, Simulation and Implementation of Speed Control of DC Motor Using PIC 16F877A. International Journal of Emerging Techonology and Advanced Engineering , vol 2, Issue 3. ,2012,146-151.

[7] Asha K R, Suhada Tasleem P, Ravi Kumar A V, Mallikarjuna Swamy S, Rekha K R, Real Time Speed Control of a DC Motor by Temperature Variation Using LabVIEW and Arduino, 2017 International Conference on Recent Advances in Electronics and Communication Technolog, 16-17 March 2017,pp:72-75. Bangalore, India

[8] Rafael Núñez Rodríguez, Omar Pinzón Ardila ,Robust Control QFT Position for Brushed DC Motor, Power Electronics and Power Quality Applications (PEPQA), 31 May-2 June 2017,pp:1-6. Bogota, Colombia
[9] Takashi Tokuda, Shigeki Doi, Intelligent Motor Modules System, 2016 IEEE 5th Global Conference on Consumer Electronics, 11-14 Oct. 2016, pp:1-4, Kyoto, Japan.

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