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Design of a Microcontroller Based RF Remote Control for Stepper Motor Control

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Abstract. This research is about producing an embedded system to test various functionalities of a dc stepper motor. The principal purpose is to control the direction and speed of the stepper motor. The complete hardware system separated into two different parts. First is the transmitter section, and the second side is the receiver section. The transmitter consists of PC, a microcontroller, an encoder, and radio frequency transmitter. For the receiver, there is a radio frequency receiver, a decoder, a microcontroller, a motor driver and a stepper motor. During this research, a wireless concept has been used to improve the stepper motor control. By using this system, the operator can control the operation of the stepper motor controller from a workstation. It also can control the direction of the stepper motor either forward or reverse. GUI application interface has been set up to improve the control of the devices. The interface system is controlled via the computer. The control signal data is sent and received via radio frequency sequentially.

Keywords: Wireless, stepper motor, microcontroller

INTRODUCTION

In the present environment of today technology, many of the manufacturing is too reliant on the automation and computer interface devices. [1] An example of this method is to perform a full rotation into some single steps. One of the examples of such methods is automatic bottle filling system. A stepper motor doesn't operate the continuous motion. It performs in single steps, and these steps can vary from 16 steps per revolution to 1000+ steps per revolution.

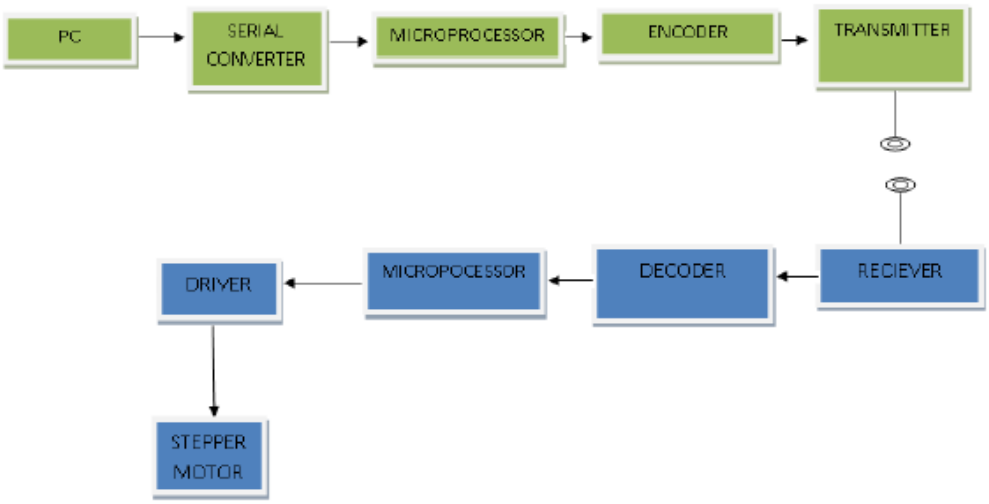

FIGURE 1. System setup for stepper motor wireless control.

The system illustrated in Figure 1; the system is controlled via the computer port interface. The operator will send the control signal from the interface of equipment using specially designed software called Microsoft Visual Basic. Graphical User Interface (GUI) will be employed on the computer so that the operator can control the stepper motor. The control signal will be sent via the encoder, and it will encode the data in a proper format, and after that, it will be pass to the wireless transmitter, which will transmit the data via the antenna. At the receiver section the data will be received by the receiver and sent to the decoder where it will decode, and a motor controller is used to generate the control signal for the stepper motor driver. In our research, we have practice the sequences for example how fast the stepper motor control can move in either clockwise or anticlockwise direction. In this system, the D.C motor parameter such as speed, voltage, temperature winding and current rating is monitored and controlled [5].

RESEARCH PURPOSE

There are four primary objectives of this research.
i. The design is wirelessly being control.
ii Control/monitor the speed variable of the stepper motor.
iii. Control the direction of the stepper motor.
iv. Use all practice and knowledge to do a comprehensive research.

ADVANTAGES AND APPLICATIONS

At the end of this project following advantages can be achieved.

i. Accurately and precisely control.
ii. Control from a remote area.

iii. Low-cost system.
iv. More efficient and convenient than manual system

In this project, RF modules are used to control the system wirelessly from a remote area. The implementation of RF (Radio Frequency) has become an emerging area of research in recent years [2]. The hardware is created for transmitting and receiving capabilities. Visual Basic and C++ languages are used to program this device. The USB port of the computer is used to control the speed and the direction of the stepper motor. The PC signals are transmitted from the RF transmitter after encoding and received by the RF receiver and are decoded to get the original command. The stepper motor is then performing according to the given command.

SYSTEM DESIGN

There are some components used to build this kind of system. To know the function of each the components, we need to investigate all the elements that are used to create this system. All the components are presented in the block diagram and will be explained as follow:

STEPPER MOTOR

Firstly we need to know how the stepper motor works. As we are aware, stepper motors are described as the electric motors without commutators. The commutator is an electrical rotary switch in certain sorts of electric motors or electric generators that regularly reverses the current direction between the rotor and the external circuit. A commutator is a standard feature of direct current rotating machines. In all the windings in motors is a part of the stator. [3] The rotor is a permanent magnet or a toothed block of part of the magnetically soft material. The controller will handle all the control signal. A Stepper motors commonly used in simple open loop systems, fitting for the systems running at low accelerations.

The stepper motor is a brushless motor, an electric motor that can split a full rotation into a several numbers of steps. The motor's coordination can be controlled precisely without any feedback mechanism. Stepper motors are similar to switched reluctance motor (which are large stepping motors with a minimize pole count and are closed-loop commutated). Stepper motors have many toothed electromagnets arranged around a central gear-shaped piece of iron. The electromagnets are energized by an external control circuit, such as the microcontroller. To able the motor work, the electromagnet will supply electric power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth.

When the gear's teeth are adjusting to the first electromagnet, they are insignificant offset from the next electromagnet. So when the next electromagnet is turning on, and the first is turning off, the gear rotates insignificantly to align with the next one, and from there the process is repeated over and over. Each of rotations is called as the step, with a

several numbers of steps make a full motor rotation. In such way, the stepper motor can be turned into a precise angle.

STEPPER MOTOR CHARACTERISTICS:

Stepper motors are constant power devices. As stepper motor speed increases, torque will decrease.(most motors show maximum torque when stationary). However, the torque of a stepper motor when stationary (holding torque) defines as the ability of the motor to maintain the desired position while under external load). The torque characteristics may be lengthened by applying current limiting drivers and increasing the driving voltage. Steppers motor show stronger vibration from others, as the discrete step, tends to snap the rotor from one position to another (called a decent). The vibration will make stepper motors noisier than DC motors. etc. The vibration can behave quite poor at some speeds and can make the motor to lose torque or lose direction. This is due to the rotor is acting holding in a magnetic field which functions as a spring. On each step of the rotor overshoots and bounds back and forth,"ringing" at its resonant frequency. If the stepping frequency equals the resonant frequency, then the ringing increases and the motor comes out of synchronism, resulting in the positional error or a switch in direction. At worst case, there is a total loss of control and holding torque, so the motor will simply overwhelm by the load and spins almost freely. The impact can be alleviated by accelerating instantly through the problem speeds range, physically damping (frictional damping) the system, or using a micro-stepping driver. Motors with a greater number of phases also exhibit smoother operation than those with fewer stages; this can be performed with the use of the micro stepping drive.

FIGURE 2. Unipolar – 5V Stepper Motor

The stepper motor that is used in this project is the unipolar type refers to Figure 2. It is a smaller stepper motor suitable for an extensive range of applications. This type of stepper motor is suitable to be used for bi-directional purposes.

STEPPER MOTOR DRIVER

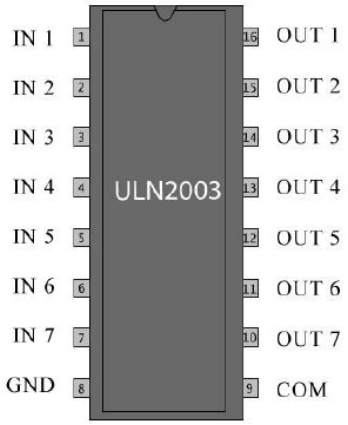

FIGURE 3. ULN 2003 Pin configuration

As we acknowledged, the ULN2003 (**FIGURE 3.)** is a monolithic high current and high voltage Darlington type transistor arrays. It builds with seven open collectors Darlington pairs with common emitters. A Darlington set is a composition of two bipolar transistors. ULN2003 belong to ULN200X series of to the I Cs family. This type of ICs used when driving an extensive range of loads and usually used as relay drivers. We can observe from the figure 2 above from pin 1 to 7 on the left side is for the input channels, and the pins 1 to 7 on the right side are for the output channel. Pin 8 and 9 are for the ground pin and the typical freewheeling diodes.

MICROCONTROLLERS

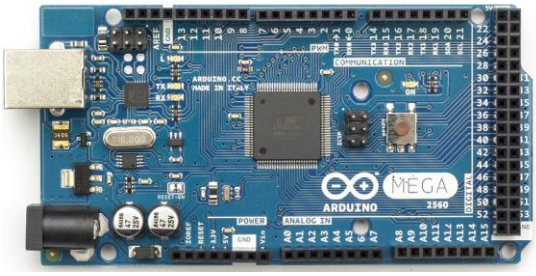

FIGURE 4. Microcontroller board.

Arduino microcontroller illustrated in Figure 4, being implemented in this system due to features capabilities especially interface with the computer and the microcontroller. Arduino can communicate with other Arduino boards. The board provides four hardware UART TTL (5V) serial communications. The microcontroller has UART TTL serial communication (Transmitter & Receiver). Build in on the board for the serial interface through USB which appears as a virtual communication port. The board did not need any

external drivers as the firmware uses the standard USB communication driver. The Arduino also has serial monitor, which allows data to transmit and receive from the Arduino board. One can use any digital pin for serial communication by using software serial library.

TRANSMITTER AND RECEIVER

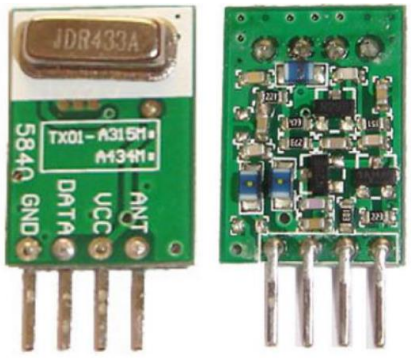

FIGURE 5. STT-433 RF transmitter

Radio frequency transmitter for a low cost and long range is used to support this type of system. Hence STT-433 RF transmitter (Figure 5.) is placed for transmitting the signal. It is an ideal transmitter for remote control applications. It operates from a supply of 1.5 to 12 volts. It employs a stabilized oscillator, ensuring accurate frequency control for best range performance.

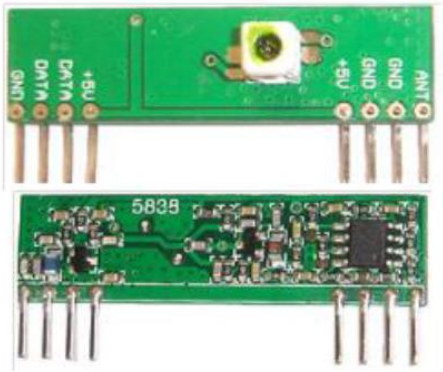

FIGURE 6. STR-433Mhz Receiver

The transmitter STT-433MHz (Figure 6.) is used in this project, and we need to use the receiver that has the same frequency which is RF STR-433MHz. STR-433MHz is very suitable for the short range remote control application. It is low cost and does not need

any external RF components except antenna. It does not generate any emission virtually, so it is under the law of FCC in USA and ETSI in Europe.

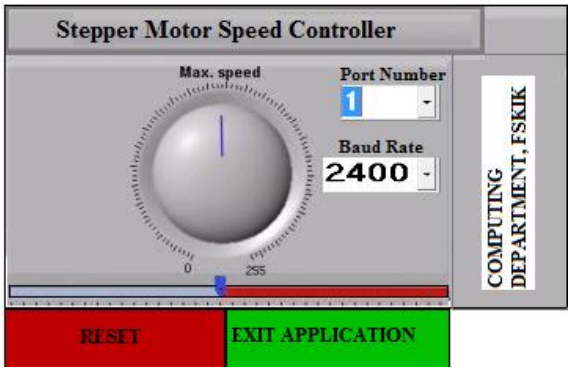

FIGURE 7. Graphic User Inteface (GUI) using Visual Basic.

Since the commands will be the interface from the computer, a user-friendly Graphical User Interface (GUI) is designed using Visual (Figure 7.) Basic programming language. All the function of the project is included. We have identified the main functions of the systems which are speed and direction function. Speed and direction can be controlled by attenuate the button speed or decreasing the button. As far as the direction control is concerned, the direction can be either clockwise or Anti-clockwise. We set the initial speed of the stepper motor. So the stepper motor starts with a fixed initial speed. To enlarge the speed, we toggle the speed up button.We have added drop-down menus are the port numbers and the Baud rate. There are eight ports included in the drop-down menu. In the Baud rate menu, we added three rate. Among which our stepper motor is running on 2400. Baud is synonymous to symbols or pulses per second. Baud rate is also known as symbol rate. In other words, Baud rate is referred to as data transmission rate (bits/second).

RESULTS AND CONCLUSION

This system has been one of the most exciting and learning experience. We have used our knowledge and previous experience to accomplish our goals. We have learned new ways of the testing the system. Following results can be summarized from this project are;

GUI Interface is made from Visual Basic which is a very powerful language. This GUI can be more efficient by making the borders are invisible. Since it was not our main concern, we just make it simple and efficient. The microprocessor is receiving the signal with a delay. This delay can be reduced by decreasing the transmitting time. The control signal can be interface even being blocking by setting an obstruction between the two sides, i.e., transmitter and receiver sides. All the setting requirements have been achieved. The movements and of the motor in clockwise and anticlockwise directions are controlled in a specified manner. Some of the attributes in speed and direction can also be controlled by some buttons from the keyboard or mouse. The direction and the speed can be

observed by attaching a weight at the end of the motor. Finally, it was a successful project, and we did our best to make it as perfect as possible.

DISCUSSION AND FUTURE WORK

This research project consists of three separate parts namely the Graphic User Interface (GUI), the hardware equipment and its connection to other parts and the programming of the microcontrollers. As far as the physical equipment is concerned, we have chosen the suitable equipment. The only equipment that can be substituted with another is the antenna. The antenna that we have used is the handmade antenna which has a very limited range, and this range can be extended with the use of a good company made antenna. Another development that can be made to increase the range is the use of a proper battery or adapter instead of a computer used as a power source using USB cable. The GUI can be made more attractive and professional by removing the borders between different functionalities. Another development that can be made in future to make this project more professional is to make it usable for more than one stepper motor. One can make it so that there can be an option in the programming to select one of the stepper motors if more than one motor is attached at the receiving end. Another development that can be made is that a digital display can be added to show the speed of the motor. At the current moment, we can only see the rate by the increase in the movement of the speed. After the addition of the digital display, one can see the actual speed of the motor. This project can be made as a more professional project if one can provide more time and financial support.

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REFERENCES

[1] Perez-Pinal, Nunez, C., Alvarez, R., Cervantes, I., "Comparison Of Multi- Motor Synchronization Techniques Industrial Electronics Society", 30th Annual Onference Of IEEE Volume: 2, Pp 1670 – 1675, Vol. 2 23, May 2005'

[2] Ramya, C.M.,Shanmugaraj, M. ; Prabakaran, R.,"Study on ZigBee technology" Electronics Computer Technology (ICECT), 2011 3rd International Conferenceon Volume: 6, April 2011

[3] D. Manojkumar, P. Mathankumar, E. Saranya and S. pavithradevi, "Mobile Controlled Robot using DTMF Technology for Industrial Application", International Journal of Electronics Engineering Research, 2010, 2(3), PP. 349-355.

[5] Ramazan BAYINDIR, Mehmet ŞEN, "A Parameter Monitoring System for Induction Motors based on zigbee protocol", Gazi University Journal of Science. GU J Sci 24(4):763-771 (2011)

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