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Speed and Position Controlling of Stepper Motor Using ZIGBEE

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Abstract: *Nowadays the remote area is experiencing a great demand for various field of engineering. Stepper motor, one of the most common motor widely used in controlling especially to achieve a precise measuring of a motor's rotor operation. Stepper motor is the best choice to be chosen for certain applications which requires high specification. Hence the aim for this project is to construct a stepper motor controller while enhancing its performance in terms of controlling.*

The purpose of this project is to control the speed and direction of a stepper motor using Zigbee module using wireless controlling method. The aim is to able to control the turn of stepper motor rotor direction clockwise or anti-clockwise and decrease or increase the speed. Instead of using in industrial application such as remote control device, valve operation or any other electrical device operation; the device also can be apply for home application such as camera monitoring.

1. Introduction

A stepper motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor, as long as the motor is carefully sized to the application.

In the modern world of science and technology most of the industry is dependent on the robotics and computer related devices. One of such methods is performing a full rotation into a number of equal steps. One of the examples of such methods is automatic bottle filling system. Stepper motor does not perform the continuous motion. It performs in equal steps. These steps vary from 16 steps/ revolution to 1000+ steps/revolution.

2. Existing System

Stepper motors are a type of electromagnetic mechanical devices which can convert discrete electric impulses into angular displacement or linear displacement. This is because, for high speed repetitive motion, the brushes in DC motors are subject to excessive mechanical wear and consequently lead to a decrease in performance. Also, since there is a winding on the rotor of DC motors, the rotor copper loss and hence the heat does not have a direct path to the outside environment, but instead must be dissipated through the stator. Another important aerospace application of the stepper motors is that, in order to achieve uniform performance throughout the life span of more than 10 years and to avoid unpredictable and intolerable disturbances to the satellite, the stepper motors are required to deliver a constant torque [1,2]. Recently, the positioning systems are being implemented using stepper motors instead of traditionally DC motors [3]. Stepper motors have also some demerits such as step response with overshoot and relatively long settling time. Besides, loss of synchronism appears when steps of high frequency are given. It is thus necessary to develop control schemes to improve the performance of stepper motors [4]. Stepping motors are the ideal choice for those applications where power is small (less than 100 watt) while position control must be sharp and fast, such as in robotics, aerospace applications, machine tools, printers, scanners, and servos [5]. These motors possess all the advantages of standard permanent magnet (PM) synchronous machines while their cost is much lower [6]. Their output angular displacement is directly proportional to the amount of the input pulses, and their speed of rotation is directly proportional to the frequency of the input pulses [7]. Stepper motors have several merits such as great output torque, small inertia, and high frequency response. These features contribute to the wide usage in the industry nowadays, especially in measurement and control applications [7].

3. Proposed Technique:

In this project we have used Zigbee modules in order to control the system wirelessly from a remote area. We have designed hardware with transmitting and receiving capabilities. In order to program this hardware we have used visual basic and 0direction of the stepper motor. The signals are transmitted from the zigbee transmitter after encoding and received by the zigbee receiver and are decoded to get the original command. The stepper motor is then performing according to the given command. It performs in equal steps. These steps vary from 16 steps/ revolution to 1000+ steps/revolution. one of such methods is performing a full rotation into a number of equal steps. One of such methods are used in performing several functions. The Block Diagram of Speed and position control of Stepper motor using ZIGBEE is as shown in fig 1.

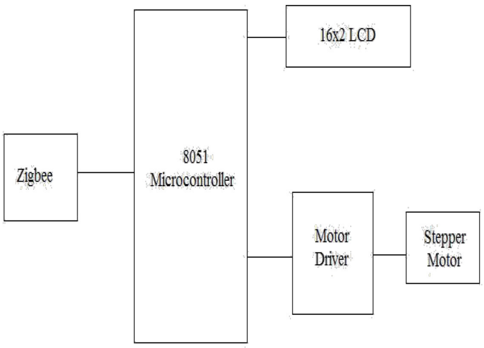

Fig 1: Block Diagram of Speed and position control of Stepper motor using ZIGBEE

3.1 Stepper Motor:

Stepper Motor Switching Sequence

The stepper motor can be operated in two different stepping modes, namely, full-step, half-step.

a) Full-Step

The stepper motor uses a four-step switching sequence, which is called a full-step switching sequence which is already described above.

b)Half-Step

Another switching sequence for the stepper motor is called an eight-step or half-step sequence. The main feature of this switching sequence is that you can double the resolution of the stepper motor by causing the rotor to move half the distance it does when the full-step switching sequence is used. This means that a 200-step motor, which has a resolution of 1.8°, will have a resolution of 400 steps and 0.9°. The half-step switching sequence requires a special stepper motor controller, but it can be used with a standard hybrid motor. The way the controller gets the motor to reach the half-step is to energize both phases at the same time with equal current.

3.2 ZIGBEE:

The explosion in wireless technology has seen the emergence of many standards, especially in the industrial, scientific and medical (ISM) radio band. There have been a multitude of proprietary protocols for control applications, which bottlenecked interfacing. Need for a widely accepted standard for communication between sensors in low data rate wireless networks was felt. As an answer to this dilemma, many companies forged an alliance to create a standard which would be accepted worldwide. It was this Zigbee Alliance that created **Zigbee**. Bluetooth and Wi-Fi should not be confused with Zibgee. Both Bluetooth and Wi-Fi have been developed for communication of large amount of data with complex structure like the media files, software etc. Zigbee on the other hand has been developed looking into the needs of communication of data with simple structure like the data from the sensors.The purpose of this project is to control the speed and direction of a stepper motors using Zigbee based remote control. Stepper motors operate differently from other motors rather than voltage being applied and the rotor spinning smoothly, stepper motors turn on a series of electrical pulses to the motor's windings. Each pulse rotates the rotor by an exact degree. These pulses are called "steps", Hence the name "steppermotor". The degrees per pulse are set in the motor's manufacturing, and are provided in the spec sheets for that motor. They can range from ultra-fine movements of a fraction of a degree (i.e., 0.10 degrees), to larger steps (i.e. 62.5 degrees).

ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power, wireless sensor networks. Zigbee is the set of specs built around the IEEE 802.15.4 wireless protocol. As Zigbee is the upcoming technology in wireless field, we had tried to demonstrate its way of functionality and various aspects like kinds, advantages and disadvantages using a small application of controlling the any kind of electronic devices and machines. The zig-bee technology is broadly adopted for bulk and fast data transmission over a dedicated channel**.**

The system consists of stepper motor interfaced to the microcontroller through ULN2003. The stepper motor direction and speed in each angle will be controlled through wireless communication called ZIGBEE. Motor rotates in different angle depends upon the commands received from the transmitter through push buttons.

4. Hardware Implementation:

The Power supply section provides +5V and +12 V DC, with a capacity of1Amp current. This consists of mainly a bridge rectifier and two series regulators and 7805 & 7812. This power supply can provide maximum 1 Amp current at + 5volt & +12volts. The stepper motor is an electro mechanical device which converts electrical energy into mechanical energy. The specialty of this motor over dc motors that, it is a digital motor so moves in steps, so an accurate position control is possible. The stepper motor rotates on rotation of the bit pattern appearing to its coil. The stepper motor driver provides adequate voltage and current to run the stepper. The driver receives control signal from the controller at CMOS logic level that is at 5 volt and 10 m A. The stepper motor requires sufficient current (0.18A) to drive the motor, whereas microcontroller (10mA) cannot produce sufficient current to drive the motor directly. For that, a stepper motor driver is required to drive the stepper motor. At normal condition, the stepper motor rotates in clockwise direction. The controller designed here configured assured an AT89C51 microcontroller. The Microcontroller on RESET initializes the disk position and coincides with zero angle. Then the controller enter into the control mode where.

In transmitter circuit the 6 push buttons are connected to the microcontroller P1.0 to P1.5 respectively.

The ZigBee is connected to the tx and Rx pins. The reset button is connected to the reset pin of the microcontroller. We get the input to the microcontroller from 7805 voltage regulator which was get from rectifier circuit.

In receiver circuit the components same as the transmitter circuit the reset, oscillator & zigbee pins were connected. Here we interface the LCD and Stepper motor. The LCD was connected to the P2.0. The motor was interface with motor driver called ULN2003. It was connected to the P1.0 to P1.4 pins of microcontroller & motor was connected to the Motor driver. The experimental setup of Speed and position control of Stepper motor using ZIGBEE is as shown in Fig 2.

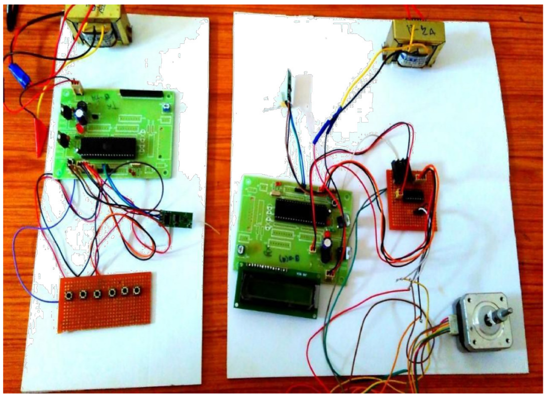

Fig 2: The experimental setup of Speed and position Control of Stepper motor using ZIGBEE.

5. Results and Discussion:

When we press the button 1 logic 0 was occurred at the microcontroller P1.0. Depends upon the program written on the microcontroller it sends the signal to the receiver through ZigBee.
In the receiver circuit the ZigBee receive the signal from the transmitter. The microcontroller sends the signal to the Motor driver then motor driver controls the Motor by make it rotating with 90 degrees step in the rotor. The operation of the stepper motor is discussed in the below tabular form Table1 by taking the signals from the transmitter circuit and signals are transferred to the receiver circuit.

S. No.	Transmitter Signal	Receiver Output
1	Button 1	Rotating with 90^0 step in rotor.
2	Button 2	Slow down with 90^0 step angle.
3	Button 3	Rotates with 45^0 step angle.
4	Button 4	Slow with 45^0 step angle.
5	Button 5	Motor Stops
6	Button 6	Clockwise or anticlockwise direction.

Table 1: The speed and position control of Stepper motor by using ZIGBEE technology.

6. Conclusion:

This paper has done the hardware implementation that one of the most interesting and learning experience to all of us. We have used our knowledge and previous experience to accomplish our goals. We have learned new ways of testing hardware. The results are concluded from this hardware prototype. The microprocessor is receiving the signal with a delay. This delay can be minimized by decreasing the transmitting time. All the requirements have been achieved. The movements of the motor in clockwise and anticlockwise directions are controlled in a specified manner. Some of attributes in speed and direction can also be controlled by some push buttons at transmitter circuit.

7. References

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