Stepper Motor Control using PC

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Abstract— The personal computer, which is used for various software related tasks, can act as a good monitoring and controlling system for the control of electrical and electronic appliances. This type of control of appliances using a PC is one of the major parts of the home automation system, which helps to control the home electricity usage for better energy management. We would like to control the stepper motor, as an example for controlling the electronic appliances through PC, in our paper. In this paper, a software program will be developed to access the serial port of a computer so that one can transfer data between the system and the external hardware. A stepper motor driver IC, a controller will be interfaced with the serial port of the computer. Based on the code written and the user input, the switches in the IC turn on and apply the signal to the stepper motor. This method of Stepper motor control is cheap and useful in robotic applications. Initially the technique of controlling the electrical and electronic appliances using PC will be discussed and using this technique, motion control of Stepper motor will be implemented in the paper.

Key words: Stepper Motor, GMC, DC motors

I. INTRODUCTION

Motion control is a sub-field of automation, in which the position or velocity of machines are controlled using some type of device such as a hydraulic pump, linear actuator or electric motor, generally a servo. It is a very important part of robotics and CNC machine tools, however in these Instances it is more complex than when used with specialized machines, where the kinematics are usually simpler. The latter is often called General Motion Control (GMC). It is widely used in the packaging, printing, textile, semiconductor production and assembly industries. Motion Control encompasses every technology related to the movement of objects. It covers every motion system from micro-sized systems such as silicon-type micro induction actuators to micro-simulation systems such as a space platform. But, these days, the focus of motion control is the special control technology of motion systems with electric actuators such as dc/ac servo motors. Control of robotic manipulators is also included in the field of motion control because most of robotic manipulators are driven by electric motors. Robots make extensive use of electric motor drives as actuators. Electric motors as actuators for robot joint movement score over hydraulic and pneumatic actuators.

In earlier days, DC motors are used as actuators in robots. Though the control of DC motors is simple, it is not preferred due to frequent maintenance and possible hazard because of sparking of brushes. Many robot manufacturers now use AC servomotors in place of DC motors. Fast Digital Circuits have made implementation of complex algorithms feasible. Unlike DC and AC motors the stepper motors, brushless DC motors, are very much useful in applications where precise positioning is more important. Computer controlled stepper motors are a type of motion-control positioning system. They are typically digitally controlled as part of an open loop system for use in holding or positioning applications. In the field of lasers and optics they are frequently used in precision positioning equipment such as linear actuators, linear stages, rotation stages, goniometers, and mirror mounts. Other uses are in packaging machinery, and positioning of valve pilot stages for fluid control systems. They are also used in various types of equipment for accurate rotation angle and speed control using pulse signals.

II. THE PROTOTYPE CIRCUIT

The circuit is a simple assembly of commonly used circuit components. the layout is sown in figure 1. The components have been chosen with utmost care and accuracy so as to keep the design simple and easy to implement.

The various components used in the circuit are Stepper motor, ULN2003 driver, AT89S52 microcontroller, Transformer, Bridge Rectifier, Filter, Voltage Regulator, Push buttons and LCD Display.

Stepper Motors of various ratings are available in the market for different applications. Here we preferred the Unipolar Stepper Motor rated at 12v, 1Amp with 2.5 degree per pulse step rotation.

The function of ULN2003 driver is to drive the unipolar stepper motor and this suitable driver to convert the signal obtained from microcontroller into a pulse which controls the stepper motor.

The AT89S52 is low power, high performance CMOS 8-bit micro controller with 8KB of Flash 256 bytes of RAM, 32 I/O lines, watchdog timer, two data pointers, three 16-bit timer/counter, full duplex serial port, on chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for pertain down to zero frequency and supports two software selectable power saving modes. The idle mode stops the CPU while allowing the RAM timer/counter, serial port, and interrupt system to continue functioning. The power down saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly. Thus the a.c input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Thus, a step down transformer is employed to decrease the voltage to a required level.

The rectifier converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this paper, a bridge rectifier is used because of its merits like good stability and full wave rectification. A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full-wave rectification.

Capacitive filter is used in this paper. It removes the ripples from the output of rectifier and smoothens the D.C.

Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore, a regulator is applied at the output stage.

LCD is very important device in embedded system. It offers high flexibility to user as he can display the required data on it.

III. POWER SUPPLY

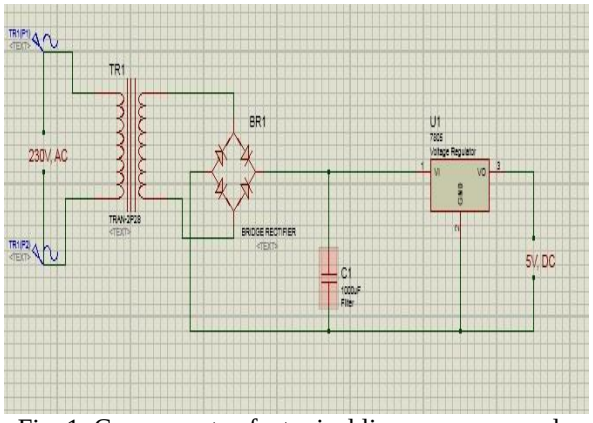

Fig. 1: Components of a typical linear power supply

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage.

IV. CIRCUIT DESCRIPTION

The stepper motor controller is perhaps the cheapest, smallest and simplest. A ULN2003 driver with a 'keil software program in embedded C' is used to control the unipolar stepper motor with a step resolution of 2.5 degree per pulse. The controller is a combination of driver and switching buttons. The driver is the actual circuit that drives the stepper motor and the switching buttons decides how the motor should be driven. So, it is basically perform the switching operations that controls the stepper motor. The switching of these push buttons is controlled by the software via port 3 pins of AT89S52 Microcontroller.

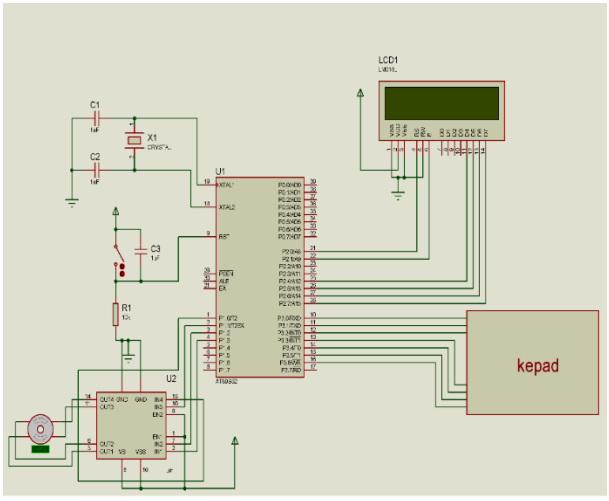

Fig. 2: Circuit of PC- based stepper motor controller

You can control three parameters of the stepper motor: speed, direction and angular momentum. To vary the speed of the motor, you have to vary the pulse repetition frequency. To change the direction of the motor, you have to change the sequences of pulses applied to its coils. By limiting the no. of applied pulses, you can restrict the motor to complete the desired no. of steps.

A. Specifications of The Stepper Motor:

Stepper motors of various ratings are available in the market for different applications. Here, the unipolar stepper motor rated at 12V DC with step resolution of 2.5 degree per pulse. The motor has two coils inside and four terminals for external connections. Stepper motors rated at 12V, 1Amp of current and different step size and we preferred 2.5 degree per pulse in the circuit and control software.

B. Operation:

Specific sequences of pulses are given to the two coils to rotate the motor either in clockwise or anticlockwise direction.

C. Direction Control:

For controlling the direction of the motor, '0' indicates the low logic and '1' indicates high logic. We know that the current flows from high to low. Changing the direction of rotation is nothing but changing the direction of current that flows through the coils.

D. Speed Control:

To vary the speed, you have to vary the pulse repetition frequency. The pulse repetition frequency of 36Hz means 36 pulses will be given to the stepper motor in one second. Since the step resolution of the motor is 2.5 degree per pulse and in the stepper motor there are 4 phases and the motor will rotate 36*2.5*4=360 degrees one complete revolution.

E. Number of Rotations:

The step resolution of 2.5 degree per pulse means if you apply only one pulse, the motor will rotate by 2.5 degrees, if you apply 18 pulses and motor contains 4 phases, the motor will rotate 180 degrees. So if you limit the number of pulses applied to the motor, you can stop it at any angular position (multiple of 2.5) after completing the desired number of full revolutions. Thus if you apply only 38 pulses, the motor will complete one full revolution and rotate further by 90 degrees and stop.

F. Applications of Stepper Motors:

Stepper motors have wide range of applications ranging from low power applications like wrist watches to high power applications like robotics. Here are some of the fields of applications of stepper motors where precise positioning is more important.

1) Industrial Machines:

Stepper motors are used in automotive gauges and machine tooling automated production equipment.

2) Security:

The new surveillance products employ stepper motors for the applications where security is most important.

3) Medical:
Stepper motors are used inside medical scanners, samplers, and also found inside digital dental photography, fluid pumps, respirators and blood analysis machinery.
4) Consumer Electronics:
Stepper motors are used in cameras for automatic digital camera focus and zoom functions.
All these functionalities are possible because of accurate positioning and control of stepper motor through suitable drivers and microcontrollers.

V. RESULT

After dumping the program in microcontroller through PC, insert the microcontroller in the circuit board. For achieving the different modes of operation of stepper motor we used push buttons. We have assigned the names for every push button and when we push the button it shows different angular rotations and speed increments and decrement modes can also be obtained in either clock or anti-clock directions.

VI. CONCLUSION

This type of motion control of stepper motor is very much useful for various types of applications. Our paper best suits for the applications like robotics, where the precise movement of the robot is desired and industrial applications, where the accurate positioning of the objects is necessary. Robotics like surveillance robots needs precise movements to track the images of the surroundings. The systems like smart phone and personal computers can act as good monitoring systems for such type of control. This paper not only focused on the motion control of stepper motor but also gives a brief idea of controlling multiple electrical and electronic appliances, monitoring their status and much more. In other words, we can say that this paper acts a small division of home automation system and industrial automation system. All these applications involve embedded systems, control systems and electrical machines which can best define Electrical and Electronics Engineering.

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REFERENCES

[1] "Stepper Motor Basics and Control-How it works", tutorial presented by 'Texas Instruments' for the use on 'http://DIYInventor.com'
[2] "How to Use the ULN2003A Darlington transistor Array with Examples", presented by 'Lewis Loflin' in 'Bristol Watch' group.
[3] "Generalized Theory of Electrical Machines", by 'P.S. Bimbhra', published by 'Khanna Publishers.'
[4] The 8051 Microcontroller and Embedded Systems by M.A Mazidi &J.G Mazidi
[5] The Microcontroller Idea Book by John Axelon
[6] Digital design by Morris Mano
[7] Linear integrated circuits by Roy chowdary.

