www.ijiarec.com

ISSN:2348-2079 Volume-7 Issue-1

International Journal of Intellectual Advancements and Research in Engineering Computations

Modern Technique Used to Drive and Control the Step Angle Motor

M.Ranjitha [1], K.Gowtham[2], R.Kanakavel[2]

[1]Assistant Pofessor, [2]UG Scholar, Department of Electrical and Electronics Engineering
Muthayammal Engineering College,Rasipuram.

ABSTRACT

This paper describes a control system of microcontroller AT89C51 used in stepping motor. These included the keyboard input and LED display circuit, control circuit, magnifying and driving circuit and the corresponding program flow drawing. This system can be applied in many stepping motor control regions. The experiment showed that the system can be used stably and reliably in control stepping motor and perfect compliance with the requirements of project...

INTRODUCTION

Stepping motors are widely used in electrical and mechanical equipments, which can directly convert electrical pulse signal into angular displacement or linear displacement of the implementing agencies. The pulse signal received by stepper motor drive can drive a stepper motor to rotate a fixed angle in accordance with the directions set, and control the amount of angular displacement by controlling the number of pulses. The stepper motor's speed and acceleration can also be controlled by controlling the pulse frequency. And the output of the angular displacement of stepper motor and speed are proportional to the input of the number of pulses and pulse frequency. Traditional circuit design of the stepper motor's control and drive circuit is not only complex or costly, but also difficult to be modified or adapt to the higher intelligence occasion, and with poor portability after the system is formed. In this paper, AT89C51 microcontroller is used as controller to control the stepper motor. The control system is more simple, reliable and flexible [1-3].

The main utilization of stepper motor is positioning of stepper motor rotor with required precision. Stepper motor is suitable primarily for tasks where the precision is very important factor. Application areas are computer art (hard disks, printers), tool machines, automobile industry, actuators of industry robots and manipulators etc. For stepper motor control it is necessary control unit, which generates steps of motor

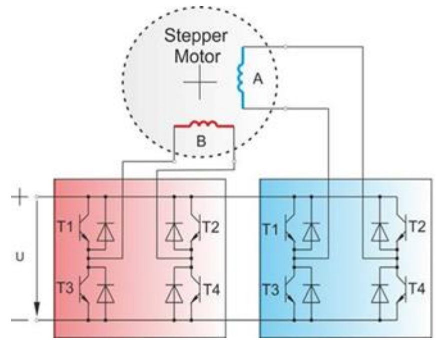
BIPOLAR STEPPER MOTOR

Bipolar stepper motors are composed of two windings and have four wires. Unlike unipolar motors, bipolar motors have no center taps. The advantage to not having Journal of Automation and control center taps is that current runs through an entire winding at a time instead of just half of the winding. The torque of bipolar stepper motor is proportional to the magnetic field intensity of the stator windings, which is proportional to the number of turns and the current in the winding. The motor torque can be increased by increasing of number of turns or by increasing electric current. For bipolar control it is necessary to ensure changing of voltage polarity so, that coil current can flow to directions [4-7].

Author for correspondence:
Department of Electronics and Instrumentation Engineering, Nandha Engineering College, Autonomous, Erode.

center taps is that current runs through an entire winding at a time instead of just half of the winding

The torque of bipolar stepper motor is proportional to the magnetic field intensity of the stator windings, which is proportional to the number of turns and the current in the winding . The motor torque can be increased by increasing of number of turns or by increasing electric current.



CONTROL OF STEPPER MOTOR BY H-BRIDGE

Changing voltage polarity can be reached by H-bridge, see By suitable switching of transistors bases T1, T2, T3 and T4 can stepper motor performs rotational motion. As can be seen on there are necessary two H-bridges. For our purposes will be used circuit L298N which contains two independent H-bridges as well as amplifier. Amplifier is necessary because of microcontroller´s pins can produce electric current roughly 20 - 40 mA. L298 receives control signals from the system’s controller, usually a microcomputer chip, and provides all the necessary drive signals for the power [8,9].

Control of StepperMotor

The usual ways of stepper motor control are wave mode, full-step mode, half-step mode and micro-step mode. Ideally stepper motor is controlled by sinusoidal current. Using full-step mode the motor can exhibit vibration, which are in some applications very ineligible. On the other hand, using full-step mode motor can reach higher torque. It depends on particular application what is more important point.

Thick lines in the denote difference in voltage polarity. By considering   and , the stepper motor control is following: the signal above the thick line represents switching of transistor bases T1 and T4 while T2 and T3 are grounded When the signal falls below thick line the transistor bases T2 and T3 are switched on, while T1 and T3 are grounded.

EXPERIMENT AND RESULTS

The aim of the experiment is to compare full-step mode are just full-step and half-step mode. This way of control is very simply and easy to realizable by any control unit. However, the problems arise in area of resonant zone and motor can lost step. One way how can be this problem solved is to distribute motor step into micro-steps. This method causes better precise in positioning as well as it limits angular velocity pulsation of rotor in the zone of low step frequencies.

The Simulink toolbox contains many libraries of whose elements can be embedded in Simulink block diagrams. Simulink also provides user-defined blocks, in the form of s-function blocks, which can be modified to perform user-defined tasks. Furthermore, every Simulink block allows for a set of “callback functions,” which are executed upon the specific events, when running a Simulink block diagram.

Present library is a bridge between the full capability of the MSK F243 embedded DSP controller, as a closed loop control system on a side, and the functionality of Matlab / Simulink environment, as control unit on the other side.

The library blocks are generated as the C MEX S-functions and provide a hardware abstraction layer allowing the access to peripherals of the DSP embedded controller (ADC, PWM, Timer, QEP, SPI, SCI DI, DO). Each of these blocks defines its simulation behavior and provides a user interface for the parameter settling. The blocks can be directly used by Simulink so as the graphical programming and controlling for the target system via Matlab/Simulink becomes possible. The developer does not need to study all details relating to control registers of DSP peripherals. He/she only specifies the fundamental parameters (e.g. the resolution of ADC, the input pin, the conversion time, the mode of operation) and selects high level methods and events to access the peripheral.

The code generated by Real Time Workshop (RTW) for each of these blocks is defined by a Target Language Compiler (TLC) script in a tlc file. During the code generation, a code is generated for each block in the model according with the corresponding tlc file. These programs are combined according to the data flow in the model and finally, a make file is

Real Time Library Control

for MSK F 243 controller - host blocks

Receive data from MSK

serial port of the PC

Send data to MSK

MSK F243 real-time control library target blocks generated from a predefined template.

As a result, the code is build-up and the executable application can be downloaded to the target embedded system. The real time control application is ready for execution on the MSK F243 microcontroller board under the full control of PC host.

To open the MSKlib F243 library, at the Matlab prompt you must type MSKF243. After that, a MSK F243lib window will appear like in Fig 2. The Simulink functional blocks of the library has two icons, one is for the PC host (server) and the other is for MSK F243 target system (client). The library blocks provide a high-level access to the hardware units of the MSK F243 board as is shown in Fig. 3a and 3b, respectively.

- DI port (MSK F243)
- Receive data from PC
- A/D converter (MSK F243)
- DO port (MSK F243)

Measuring stand

The motion of stepper motor is controlled by 8-bit microcontroller ATmega8 with frequency of CPU 16 MHz. ATmega8-16PU controls the motor using dual full bridge driver L298. This circuit was working on DC voltage of 7 V. The measuring of angular velocity as well as position of stepper motor is measured by I/O measuring card MF624 which cooperates with Matlab / Simulink. Frequency of angular velocity measuring is 1 kHz. The measuring chain in the following is shown.

Measuring chain

Example of measured angular velocity is shown in the following .

Example of measured angular velocity using time of phase 1500 μs

From all measured data was removed extreme peak values. Also for all velocities was determined average values. Then analysis were done from these average values.

In the following s there are shown results of measurements.

Angular velocity of stepper motor depending on control phase

As can be seen fromsing half-step mode motor could start with lower value of phase time. Some problems occurred using phase time 1400 – 1900 μs and motor couldn´t work. On the other hand, using full-step mode motor worked using all phase times between 780 – 3400 μs. Step of phase time was 20 μs. Also the angular velocity of motor was higher using full-step mode in comparison with half-step mode.

During measuring of angular velocities there was also measured electric current. The electric power for both modes is shown in the Electric power of stepper motor depending on control phase

Using full-step mode there was used higher amount of electric power. So the motor torque was higher using full- step mode. At the end there is also shown positioning of stepper motor rotor to one round.

CONCLUSION

In the paper was experimentally analyzed bipolar stepper motor SY28STH32-0674A connected to encoder ISC3004 with 360 CPR. Motion was controlled by microcontroller ATmega8-16PU and dual full bridge driver L298 working on 7V. As control method were used full-step mode and half-step mode. Using full-step mode were reached higher angular velocities. Also, rotor was able to rotate using full range of phase time from value 780 up to 3400 µs. Using half-step mode there were occurred some problems using certain phase times from the value 1400 up to 1900 µs and motor was unusable. By measuring of electric current was found out that using full-step mode there is higher electric energy consumption and torque is higher like torque of half-step mode.

Acknowledgement

The authors would like to thank to Slovak Grant Agency KEGA project no. 048TUKE-4/2014 "Increasing of knowledge base of students in area of application of embedded systems in mechatronic systems".

REFERENCES

[1]. M. Kelemen, I. Virgala, Ľ. Miková, P. Frankovský, Experimental Identification of Linear Actuator Properties, Acta Mechanica Slovaca, 19(1), 2015, 42-47.
[2]. M. Dababneh, W. Emar, I. TTrad, Chopper Control of a Bipolar Stepper Motor, International Journal of Engineering, 7(2), 2013, 61-73.
[3]. F. Duchoň, M. Dekan, A. Babinec, L. Chovanec, A. Vitko, Detection of Welds in Automated Welding, Applied Mechanics and Materials, 611, 2014, 519-528.
[4]. Morar, The modelling and simulation of bipolar hybrid stepping motor by Matlab/Simulink, Procedia Technology, 8th International Conference Interdisciplinarity in Engineering 2015, 576-583.
[5]. R. Condit, Stepping Motors Fundamentals, Microchip Technology Inc., 2004.
[6]. T. Hopkins, Stepper motor driving, Application note 2012.
[7]. Stepanov P., Lagutkin S., Nikitin Y., Development of the Algorithm for Definition of Residual Service Life by a Comprehensive Diagnosis of the Electromechanical Drive, Acta Mechanica Slovaca. 19, 2, 52-56.
[8]. P. Stepanov, S. Lagutkin, P. Božek, Y. Nikitin: Comprehensive Approach to Technical Conditions of Electromechanical Units in Mechatronic Systems, American Journal of Mechanical Engineering 2014.
[9]. Kollár, P., Nikitin, Y., Straka, M.: The determination of the shelf mass in the universal shelving stacker by measuring the frequency converter torque generating current of the main drive, Manufacturing technology, 15, (3), 363-366.