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Stepper Motor Drive For Position Control in Robotic Applications

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Abstract

This project is about making an embedded system in order to control different functionalities of a stepper motor. The main functions of this stepper motor are to control the speed and direction.
This system will actually adapt the requirements of the modern technology. With the help of this system one can control the speed of the stepper motor controller for pick and place robot which is used in material handling in various industries.

Index Terms –Introduction, unipolar stepper motor, bipolar steppermotor,blockdiagram,powersupply,Microcontrollor,drivercircuit,conclusion, references

Introduction

To reduce the human efforts ,To increase efficiency and the most important is to reduce the time in material handling Nowadays a new technology of Robotics is used which can do a specific task. Robotics is used in most of the developed countries like Germany, France, and Japan, USA, CHINA etc. These Robots are controlled with the remote. The Robot is programmed for the specific task. Every task of the robot is defined; stoppage timing of the robot and angle of rotation between the two places is defined by the servo motors. The purpose of the project is to build a stepper motor controller which can perform operations with higher accuracy.

Motors used in this project are bipolar stepper motor for longitudinal traverse and unipolar stepper motor for arm up down motion whereas servomotor is used for gripper application.

Unipolar Motors

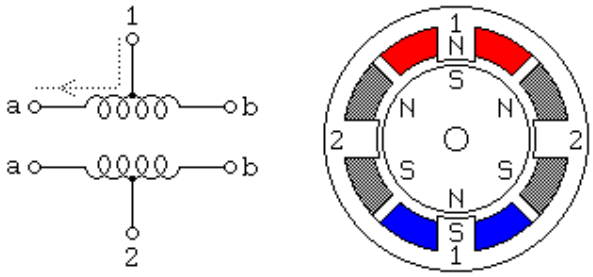


Fig1

In this type of motors a center tap is used on each of the two windings. This center taps of these windings are wired to the positive supply. Whereas, to reverse the direction of the field provided by that winding, the two ends of each winding should be grounded. The motor is moving 30 degrees per step. Two control sequences will spin the motor illustrated as follow.
Winding 1a 10001000100010001000100010001
Winding 1b 00100010001000100010001000100
Winding 2a 01000100010001000100010001000
Winding 2b 00010001000100010001000100010
time --->
Winding 1a 11001100110011001100110011001
Winding 1b 00110011001100110011001100110
Winding 2a 01100110011001100110011001100
Winding 2b 10011001100110011001100110011
time --->
The two halves are not energized at the same time. Combining the two sequences will allow the half stepping.
Winding 1a 11000001110000011100000111
Winding 1b 00011100000111000001110000
Winding 2a 01110000011100000111000001
Winding 2b 00000111000001110000011100
time --->

Bipolar Motors

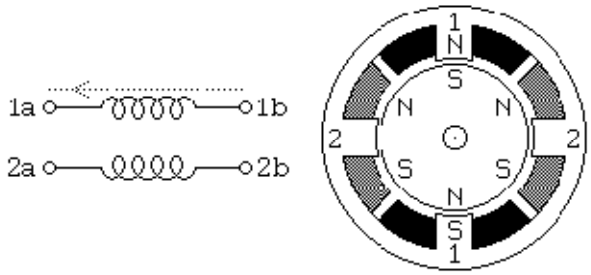


Fig2

They have exactly the same mechanism as is used in the Unipolar Motors with two windings wired more simply and no center tap. The drive circuitry is rather

complicated. It needs an H-bridge control circuit for each winding. The H-bridge will allow the polarity of the power at each end of the windings controlled independently. In the following sequences the + and – signs shows the polarity of the power applied to each terminal.

Terminal 1a +---+---+---+--- ++--++--++--++--
Terminal 1b --+---+---+---+- --++--++--++--++
Terminal 2a -+---+---+---+-- -++--++--++--++-
Terminal 2b ---+---+---+---+ +--++--++--++--+
time --->

Many H-bridge driver chips have two control inputs. One for enable the output and the other is for the direction control. The following sequence using the two such bridges will result in the identical sequence given above.

Enable 1 1010101010101010 1111111111111111
Direction 1 1x0x1x0x1x0x1x0x 1100110011001100
Enable 2 0101010101010101 1111111111111111
Direction 2 x1x0x1x0x1x0x1x0 0110011001100110
time --->

The bipolar motor can be distinguished from other wired motors by measuring the resistance between different terminals. In some motors there are four independent windings, two sets of winding. A high voltage bipolar motor can be achieved by wiring the two windings in each set in series. A low voltage bipolar motor can be achieved vice versa.

Block diagram:

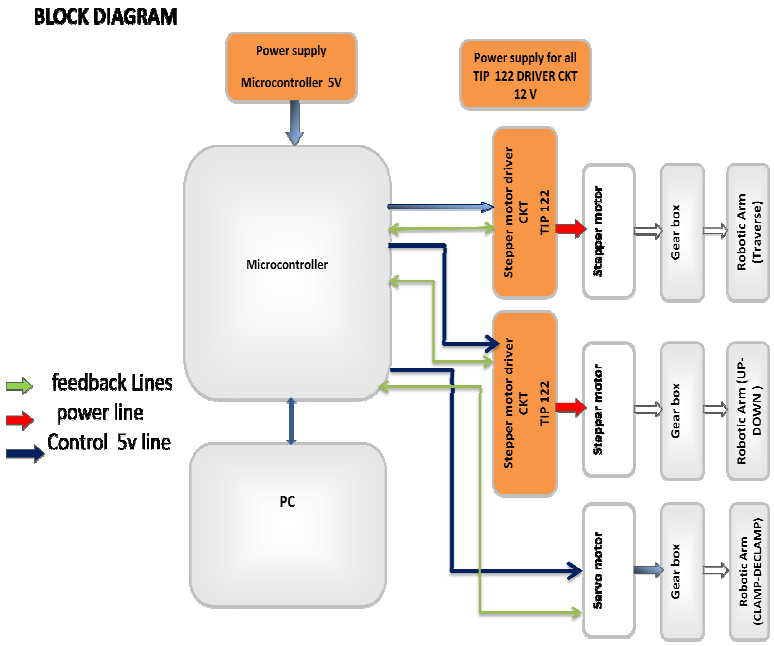


Fig2

As per desired cycle of robot microcontroller is programmed in microvision based keil software.for Traverse of robot four nos of TIP122 NPN transistors are connected to microcontroller terminals 25-26-27-28.changing the sequence of transistor firing through microcontroller, direction of rotation can be controlled for corresponding stepper motor.

Similarly for arm(up/down) motor terminal 21-22-23-24 are used.

A servomotor is used for gripper open close purpose.3 wired stepper motor is connected to +5volt and ground and pulse generator terminal 21 of microcontroller.

Power Supply

7805 IC

Voltage regulator IC's are available with fixed (typically 5, 12 and 15V) or variable output voltages. The maximum current they can pass also rates them. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current (over load protection) and overheating (thermal protection). Many of fixed voltage regulator ics has 3 leads. They include a hole for attaching a heat sink if necessary.

Fig 3- 7805 IC

Typical ICS and Their input output ranges

Part	Output (V)	Input range (V)
LM7805	**5**	**7-25**
LM7806	**6**	**8-25**
LM7808	**8**	**10.5-25**
LM7809	**9**	**11.5-25**
LM7810	**10**	**12.5-25**
LM7812	**12**	**14.5-30**
LM7815	**15**	**17.5-30**
LM7818	**18**	**21-33**
LM7824	**24**	**27-38**

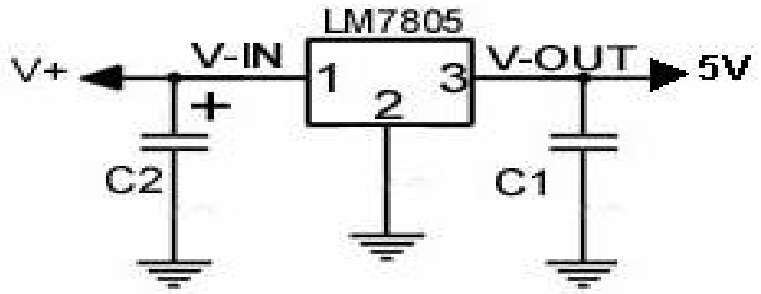


Fig: 4 Circuit connections of 7805

Couple decoupling capacitors (between 10 uf and 47 uf) is required on the input (V-IN) and output (V-OUT) connected to ground.

There are negative voltage regulators that work the same way. They are marked as LM79xx.

NXP P89V51RD2 microcontroller

The NXP P89V51RD2 is a low-power, high-performance CMOS 8-bit microcontroller with 8Kbytes of in-system programmable Flash memory. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer.

The the NXP P89V51RD2 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the NXP P89V51RD2 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

Pin Diagram of NXP P89V51RD2:

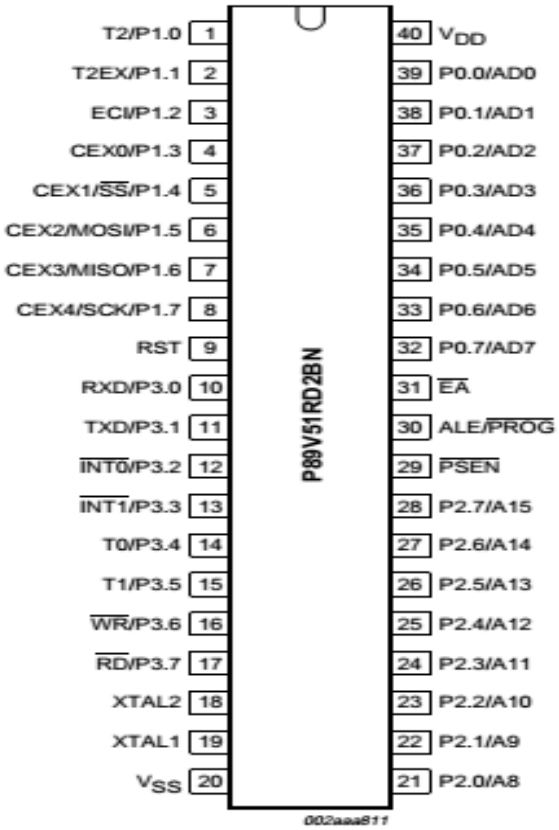


Fig 5

Stepper motor driver

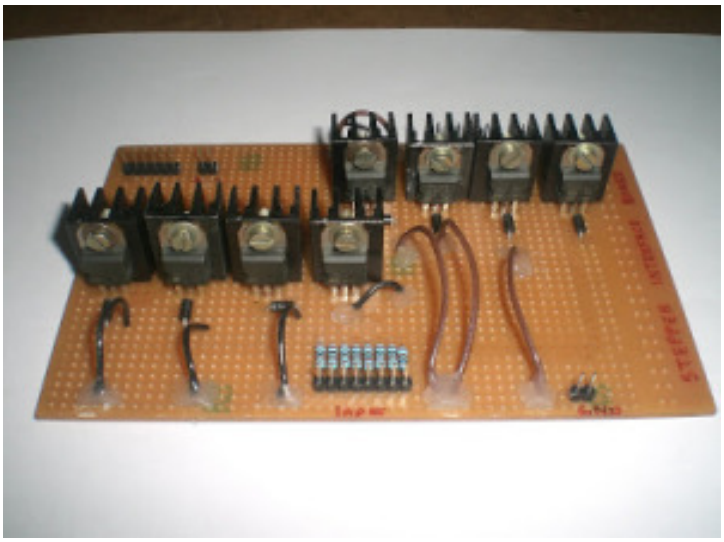


Fig 6

Stepper motor driver

Darlington transistors or Darlington pair is two transistors connected together so that the current amplified by the first is amplified further by the second transistor. The overall current gain is equal to the two individual gains multiplied together.

A darlington pair behaves like a single transistor with a very high current gain. It has three leads (B,C and E) which is equivalent to the leads of a standard individual transistor. To turn on there must be 0.7V across both the base-emitter junctions which are connected in series inside the Darlington pair, therefore it requires 1.4V to turn on.

The driver circuit must withstand the voltage and current required by the stepper motor. The stepper motor which i used required 12volts and 1.5A to provide good torque, so i selected using TIP122. Driver for each wire include a TIP122, a 1k ohm resistor and a diode. The resistors are used for limiting the current and the diodes are used to avoid back EMF. The circuit is shown below:

The common terminal of both the winding are shorted and connected to motor supply. When logic 0 input is provided to the base of TIP122, the corresponding motor will remain floating as the impedance between collector and emitter of TIP122 is very high. So no current flows through that motor winding. When logic 1 input is provided to the base of the TIP122, its collector and emitter get shorted as a result the motor wire will be grounded resulting in current flow through the corresponding coil.

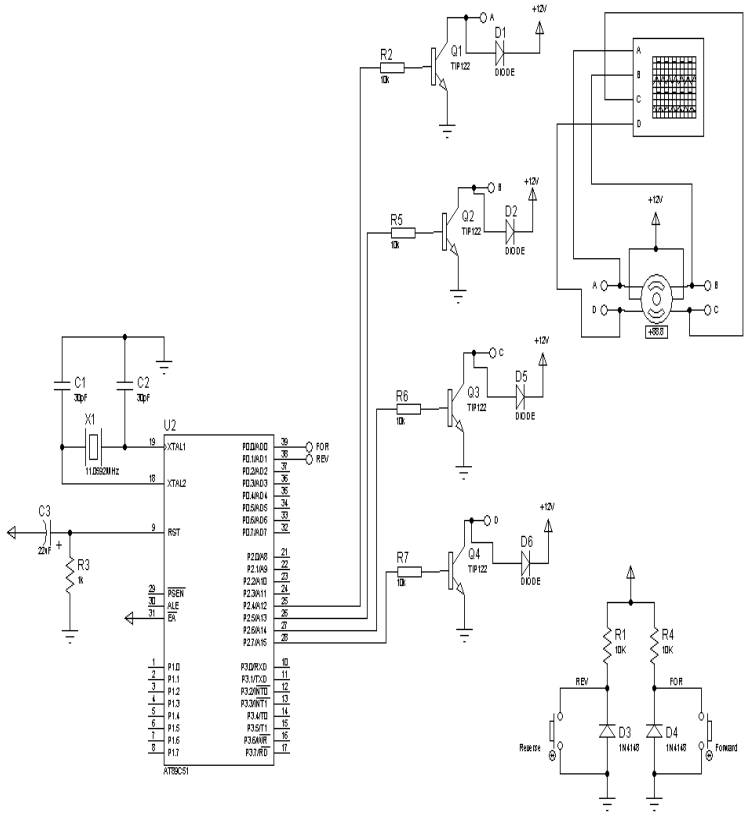
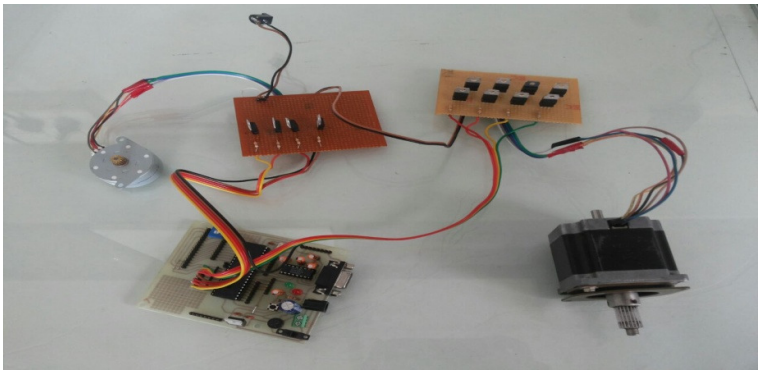


Fig 6
Connection diagram of stepper Motor to Microcontroller

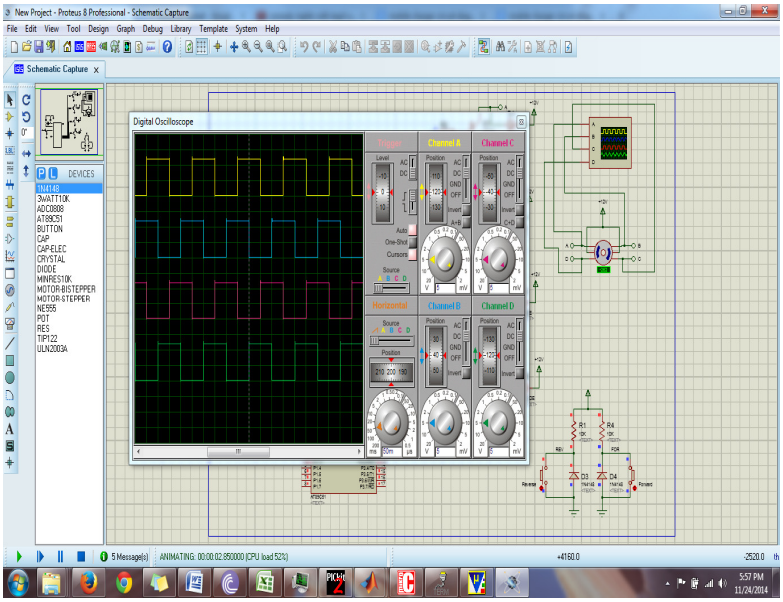
CONCLUSION:

This project presents the development of an efficient and versatile stepper motor drive system. This drive system can provide precise control of a stepper motor and hence is apt for robotic applications. This drive system allows the movement of the stepper motor to be controlled by selecting options of half or full step, forward or reverse movement and the speed in RPM or the fixed number of steps that the motor should move.

HARDWARE CIRCUIT



RESULT



REFERENCES

[1] 2012 IEEE International Power Engineering and Optimization Conference (PEOCO2012),
Stepper Motor Drives for Robotic Application.
[2]. KRISHNAN R. : 'Electric motor drives: modelling,analysis and control' (Pearson Education, India, 2003)
[3]. RASHID M.H. : 'Power electronics: circuits, devices and applications' (Pearson Education, India,2004)
[4]. NED MOHAN, TORE M. UNDELAND, WILLIAM P. ROBBINS: 'Power Electronics', Third
Edition, John Wiley and Sons, New Delhi.
[5]DUBEY G.K. : 'Power semiconductor controlled drives' (Prentice Hall, New Jersey, 1989)