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3 AXIS DRAWING MACHINE

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Abstract - This paper discusses design and implementation of low cost 3 Axis Drawing Machine using Arduino controller based on computerized numerical controller (CNC) machine and open source software (G-code and GRBL) for controlling whole operation. Computer numeric control (CNC) machine plays an important role in the field of automation. The main aim of this project is to reduce time consumed and it reduces human involvement which eventually reduces rate of error and also increase the accuracy of the production. The communication between the open source software (G-code and GRBL) and hardware (Arduino and CNC shield) is to be done with the help of USB.

1. INTRODUCTION

CNC Machining is a process used in the manufacturing sector that involves the use of computers to control machine tools. Tools that can be controlled in this manner include lathes, mills, routers and grinders. The CNC in CNC Machining stands for Computer Numerical Control. CNC – Computer Numerical Control – Taking digitized data, a computer and CAM program is used to control, automate, and monitor the movements of a machine. The CNC controller works together with a series of motors and drive components to move and control the machine axes, executing the programmed motions. Open source microcontroller platform Arduino is used for control of the motors, and open source software is used for executing the G code for machining applications.

Several authors have studied the development of such machines on a smaller, low-cost scale. For example,

V.K. Pabolu and K.N.H. Srinivas [4] have designed and implemented a three axis CNC machine using an 8-bit microcontroller. The development is in .Net platform using C# programming language on a Windows XP computer, but the motors have limited power.

T. Andrei and I. Nae [5] have developed a simpler commercial size CNC router running with Mach3 software on a desktop PC, but requiring a parallel port.

P.A. Sherring da Rocha Jr., R.D.S. Souza, and M.Emilia de Lima Tostes [6] have presented a prototype CNC machine under development running on a PC with LabVIEW which has advantage of ease of visual programming tools. The PC is interfaced with low-cost embedded microcontrollers through the serial port. The CNC machine designs above rely on the use of stepper motors of limited power in open loop mode.

Xu, Y. Li, J. Sun, and S. Wang [8] discuss results of research on an open CNC system using Windows PC with a four-axis motion controller.

A major new development in computer technology is the availability of low-cost open source hardware, such as the Arduino micro-controller platform.[10]

1.1 Objectives -

The idea behind the fabrication of low cost 3 Axis Drawing Machine is to fulfill demand of small scale industries. An advantage of open source hardware is that a wide variety of ready-to-use software is available for them on the Web, therefore the prototyping and development times are drastically reduced. Moreover, a wide range of low-cost interfaces, sensors, and accessories such as Arduino shields are also available on the Internet, along with clear instructions, examples, and applicable program code.

In this paper, the development of a prototype 3-axis CNC Router using Arduino-based control system is presented with following specifications:

- Low cost
- Easily operable
- Easy interface
- Flexible
- Low power consumption

1.2 Methodology

Level 1: Component selection and hardware implementation.
Level 2: Testing of hardware.
Level 3: Designing of G code software and testing of software.
Level 4: Burning of software with hardware.

2. BLOCK DIAGRAM

In this idea of project, Arduino Microcontroller platform with Atmega328 core is used. It can be easily interfaced with PC where, as also with the easy drivers and stepper motors too.

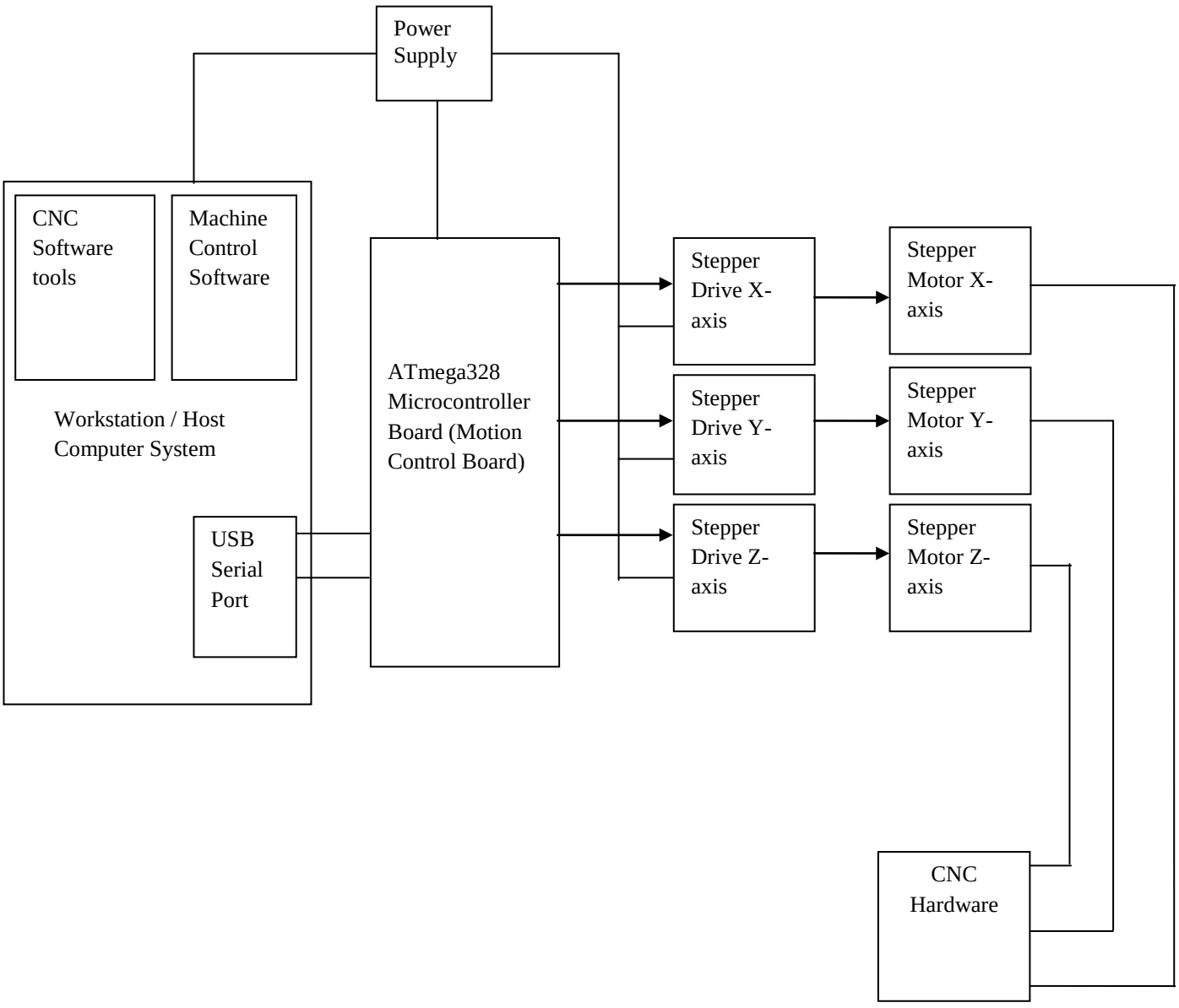


Fig -1: Block diagram of 3 Axis Drawing Machine

2.1 G code:

G-Code is the language used to describe how a machine will move to accomplish a given task, using numerical control (NC) --- it is the most widely used NC programming language

2.2 Arduino:

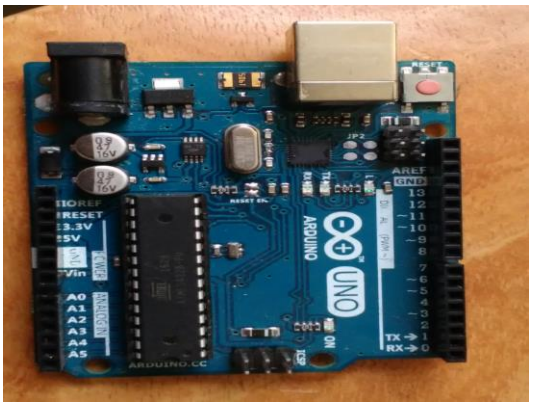


Fig -2: Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. The Atmega328 has 28 pins. It has 14 digital input/output pins of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The Atmega328 has 32K of flash program memory and 2K of Internal SRAM. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

- Pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that uses the AVR, which operate with 5V and with the Arduino, due that operate with 3.3V. The second one is a not connected pin that is reserved for future purposes.
- The last pin is the RESET pin. This allows a program to be rerun and start over.

2.3 Stepper Motor:

Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate, one step at a time.
With a computer controlled stepping you can achieve very precise positioning and/or speed control.
For this reason, stepper motors are the motor for many precision motion control applications.

2.4 Stepper Motor Driver

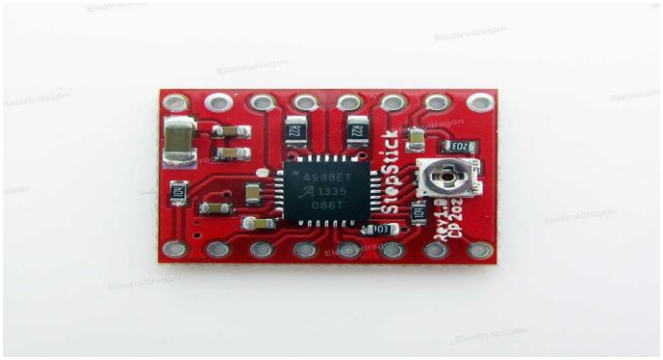


Fig – 3: Stepper Motor Driver

The A4988 is a micro-stepping driver for controlling bipolar stepper motors which has built-in translator for easy operation. We can control the stepper motor with just 2 pins from our controller, or one for controlling the rotation direction and the other for controlling the steps. The Driver provides five different step resolutions: full-step, haft-step, quarter-step, eight-step and sixteenth-step. Also, it has a potentiometer for adjusting the current output, over-temperature thermal shutdown and crossover-current protection. Its logic voltage is from 3 to 5.5 V and the maximum current per phase is 2A if good addition cooling is provided or 1A continuous current per phase without heat sink or cooling.

2.5 Process Description:

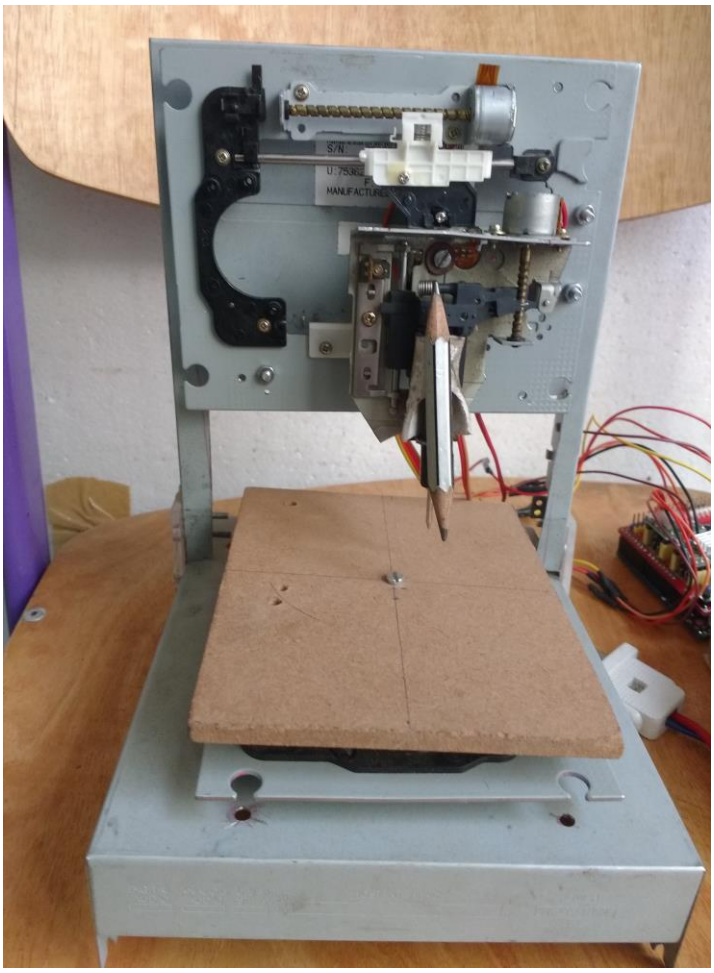
Main block diagram of this system consists of power supply, Arduino UNO (ATMEGA328), 3 stepper motor drivers each connected to stepper motors X, Y, Z. From power supply we get two voltages i.e. +5volt and +12 volt. 5 volt power supply is required to Arduino, and stepper motor drivers whereas +12 volt supply is required to stepper motors. RESET is connected to 5v supply through 10k ohms resistors to pull up the voltage thus it act as a pull up resistors. We have used here 16MHz crystal oscillator connected to ATMEGA328 with two capacitors of 22pF.

The G-code from computer is interface with Arduino by using program as a USB-to-serial converter. The output of ATMEGA328 is given to three stepper motor drivers.

Stepper motor driver consists of 16 pins from which we are using only 9 pins in our project. Four pins are used for two stepper motor coil. Two pins for input 5 volt supply i.e. VCC and GND. Three pins are used for STEP, DIR; GND. STEP is

used for micro stepping. DIR is direction input pin which will move stepper motor according to the given dimensions. Third pin is directly grounded.

3. Hardware Implementation:



3. CONCLUSION

This paper has presented the results of development of a Low cost three-axis drawing machine suitable for drawing letters and images with better accuracy. This setup of hardware with a combination of software reduces the work load. G code make easy to find the information of locations of all stepper motor moving, as the status of our moving motor are directly seen on computer hence we can start or stop the machine whenever we needed. Making a small machine brings a flexibility to do work.

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