

XY-Drawing Robot using Arduino

Saurabh Sharma¹, Harish², S. B. Nikam³

^{1,2}*Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune-Satara Road, Pune-411043*

³*Assistant Professor, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune-Satara Road, Pune-411043*

Abstract- XY plotter works on the basic principal of Computer Numerical Control (CNC) which is in the control of machining tools (drills, boring tools) and 3D printer by using a computer. A CNC machine holds a bit of material (metal, plastic, wood, fired, or composite) to meet determinations by following a customized code and without a manual. We used acrylic and metal parts used as frame of plotter. It uses two stepper motors which are responsible for X axis & Y axis to move the pen on cartesian plane and a servo motor for up and down mechanism. Arduino Uno is used to take the instructions from computer in form of Gcode. CNC shield V3 is the microcontroller to drive the motors. Stepper motor driver Pololu A4988 is used to power X and Y axis of the plotter which takes instructions from the Arduino and to increase the accuracy and efficiency we use Gcode converter.

INTRODUCTION

Plotter is a 2D Robotic gadget that ideas to create huge illustrations easily and effectively. Pen plotters can draw by moving a pen or we can mount other composition gadgets, over the outside of paper. Our rationale was to make a robot from a scratch which might draw an unrefined picture of some random picture. We needed to plan a programmed illustration machine which could draw vector pictures with wanted precision and speed. Our machine had to be cheap and not as costly as traditional HP or IBM plotters. Our objective was to make a compact device having light weight and which is moveable too. The XY plotter has X and Y axis control and a specially designed mechanism to rise and lower the pen by help of a spring. The plotter works more efficiently, which is used to plot a vector Image on a coordinate system. In this, Arduino compatible main board with two stepper motors for ease moving of pen holder and servo motor is for uplifting the pen.

BLOCK DIAGRAM & WORKING

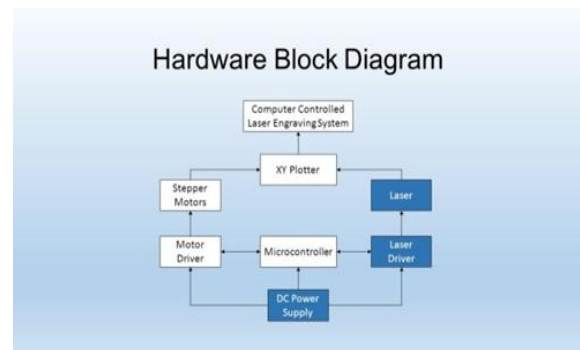


Figure 1: Block Diagram of Arduino Based XY-Drawing Robot

WORKING

XY Plotter is an embedded system which is based on the principle of Computer Numerical Control. XY Plotter basically comprise 2 stepper motors & 1 servo motor, robot plots the given input from the computer in form of Gcode on the paper using CNC shield microcontroller which is connected to Arduino by means of Gcode. The XY plotter has X and Y axis control and a specially designed mechanism to rise and lower the pen by help of a spring. The plotter works more efficiently, which is used to plot a vector Image on a coordinate system. In this, Arduino compatible main board with two stepper motors for ease moving of pen holder and servo motor is for uplifting the pen. For this, we are having the software like Arduino IDE software and Gcode converter. This improves the efficiency which produces large and complex drawings.

TECHNICAL SPECIFICATIONS

Micro Controller CNC Shield:

- Arduino CNC Shield Version 3
- GRBL 0.9 compatible.
- 4-Axis support mechanism (X, Y, Z, A-Can duplicate X, Y, Z or do a full 4th axis with custom firmware with pins D12 and D13)
- 2 x End stops for each axis (6 in total)
- Coolant enabled.
- Uses removable Pololu A4988 compatible stepper drivers.
- Jumpers to set the Micro-Stepping for the stepper drivers.
- Compact design.
- Stepper Motors can be connected with 4 pin Molex connectors or soldered in place.
- Runs on 12-36V DC.

STEPPER MOTOR:

A stepper motor is a brushless DC electric motor which is appeared in the fig.2. It parts a full pivot into an equivalent number of steps. We can move the stepper motor in any direction by giving commands from Gcode sender and stop it any of the steps with no_feedback sensor (open-loop controller), as long as appropriate type of motor is chosen for the application by keeping in mind the torque and speed. This is an easy, but a powerful stepper motor with a 4-wire cable. This is a Hybrid_Motor which means it can behave unipolar as well as bipolar.



Figure 2: Stepper motor

MOTOR DRIVER:

A stepper driver is the circuit that controls how the stepper motor operates. Stepper drives send current through various phases in pulses to the stepper motor.

Stepper motors are made such that direct current can't be supplied to them so we use drivers to operate them. We are using Pololu's A4988 driver which is cheap and best suited for this project.

Features:

- Minimum operating voltage: 8V
- Maximum operating voltage: 35V
- Continuous current per phase: 1 Amp
- Maximum current per phase: 2 Amp
- Minimum logic voltage: 3V
- Maximum logic voltage: 5.5V
- Micro step resolutions: Full, 1/2, 1/4, 1/8, and 1/16
- Reverse voltage protection: No

We use Microstepping by making MS1 MS2 MS3 pins as high or low. We did make all the pins as high by using Jumpers. We achieved 1/16 micro-stepping which means steps per rotation increased by 16 times but torque also decreased significantly. We set the VREF on the stepper driver by using following formulas:

$$I_{TripMAX} = V_{REF} / (8 \times RS)$$

$$I_{Trip} = (\% I_{TripMAX} / 100) \times I_{TripMAX}$$

RS is given as 0.1 (default) and we took %I_{TripMAX} as 77.8% (Mentioned in Pololu A4988 Datasheet).

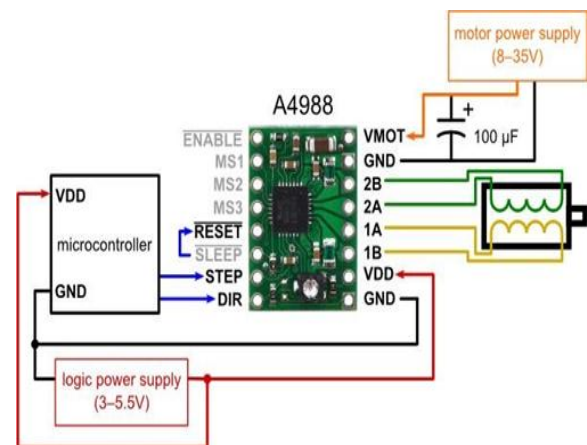


Figure 3: Drivers connection with Stepper motor

SERVO MOTOR:

Servo motors are an easy way to add motion to electronics projects. We utilized GRBL controller to give position and speed feedback to our servo. In the least complex case, just the position is estimated. If the output position differs from that required, an error

signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.



Software Used

Inkscape

- Drawing: pencil tool (freehand drawing with simple paths), pen tool (creating Bezier curves and straight lines), calligraphy tool (freehand drawing using filled paths representing calligraphic strokes)
- Embedded bitmaps (with a command to create and embed bitmaps of selected objects)
- Clones ("live" linked copies of objects), including a tool to create patterns and arrangements of clones.
- Node editing: moving nodes and Bezier handles, node alignment and distribution, etc.
- Converting to path (for text objects or shapes), including converting stroke to path
- Boolean operations
- Path simplification, with variable threshold
- Bitmap tracing (both colour and monochrome paths).

Universal-G-Code-Sender

Universal G-Code Sender is a Java based, cross platform G-Code sender, compatible with GRBL and TinyG/g2core. Use this program to run a GRBL or TinyG/g2core controlled CNC machine.

- JSSC or JSerialComm for serial communication

- JogAmp for OpenGL
- Built with Netbeans Platform
- Developed with NetBeans 8.0.2 or later

ARDUINO IDE:

Arduino was created at the Ivrea Interaction Design Institute as a straightforward instrument for quick prototyping, for students with no foundation in hardware, electronics and programming. When it reached in different types of academic areas, the Arduino board changed strategies for adjusting to new needs and difficulties, separating its idea from basic 8-bit boards to items for 3D printing, IOT applications, wearable and implanted situations. There are numerous sorts of Arduino boards accessible in market which are opensource totally, engage users to construct them freely and in the long run adjust them to their specific needs. The Arduino IDE is open-source too, and a large community of independent programmers and researchers offer their contributions.



Schematic Diagrams

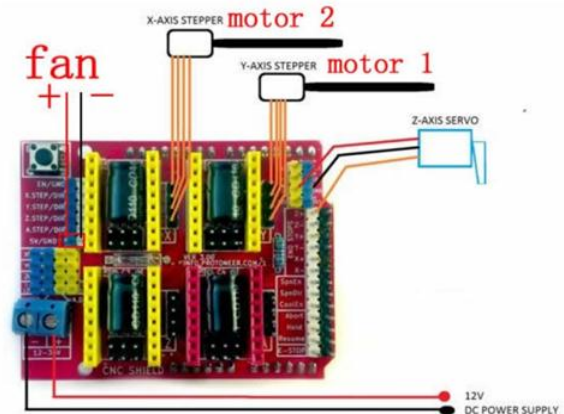


Figure 7: Schematic diagram of motor drivers, servo motor and stepper motor with Arduino

RESULTS & ANALYSIS

Start Arduino IDE and upload GRBL to the firmware. Open Universal Gcode Sender and connect to the serial port to which Arduino is connected. Generate Gcode using Inkscape and start drawing



Figure.9: Resulted dr

In this section the fig.9 shows the result obtained on the cardboard fit with a sheet and a pen is used to draw the picture. The fig.10 shows the physical view of our project Arduino Based XY drawing Robot which shows the interfacing of Arduino with the components used.



Figure.10: Physical View of Arduino Based XY Drawing Robot

CONCLUSION

The Arduino based XY drawing Robot using CNC Shield is used in the Arduino board which is used to draw fast and efficient drawings or pictures which can be taken from source converted to scalar vector graphics (SVG) format given as an input. The input is fed in to the input port of the micro controller.

Stepper motors are used to set the position of the pen to the origin and a servo mechanism used to lift and lower the which displays the output on the paper.

REFERENCES

- [1] Venkatram Ramachandran, Evaluation of Performance Criteria of CNC Machine Tool Drive System, IEEE Transactions on Industrial Electronics, Vol. 45, No. 3, June 1998, pp. 462-468.
- [2] Jae Wook Jeon and Young Youl Ha, A Generalized Approach for the Acceleration and Deceleration of Industrial Robots and CNC Machine Tools, IEEE Transactions on Industrial Electronics, Vol. 47, No. 1, February 2000, pp. 133-139.
- [3] Allen G. Morinec, Power Quality Considerations for CNC Machines: Grounding, IEEE Transactions on Industrial Electronics, Vol. 38, No. 1, January/February 2002, pp. 3-11.
- [4] Dr M Shivakumar, Stafford Michahail, Ankitha Tantry H, Bhawana C K, Kavana H and Kavya V Rao, Robotic 2D Plotter, International Journal of Engineering and Innovative Technology (IJEIT), Volume 3, Issue 10, April 2014, pp.300-303.
- [5] Venkata Krishna Pabolu et al., Design and Implementation of a Three Dimensional CNC Machine (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 08, 2010, pp. 2567-2570.
- [6] Mrs. R. Dayana, Gunaseelan P, Microcontroller Based X-Y Plotter, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Special Issue 3, April 2014.
- [7] Ahn Luong, Willis Lutz, Jared Springle, Ashton Snelgrove, Computer numerical control 3 axis plotter, University of Utah, Computer Engineering.
- [8] Hassam Salamah, Ja'far Yasin, PCB CNC Machine, An-Najah national University, Computer Engineering.
- [9] W Durfee, Arduino Microcontroller Guide, University of Minnesota.
- [10] Steve Krar, Arthur Gill, Computer Numerical Control Programming Basics.
- [11] Instuctables.com
- [12] Wikipedia.com