IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

IJARSCT

Impact Factor: 6.252

Volume 2, Issue 2, February 2022

CNC Machine with Controller

Mr. Bhushan Mahendra Baviskar, Ms. Swarupa Santosh Bhale,
Mr. Abhishek Sunil Adke, Mr. Harshal Kishor Patil
Diploma Student, Department of Electrical Engineering
Guru Gobind Singh Polytechnic, Nashik, Maharashtra, India
baviskarbhushan8007@gmail.com, swarupabhale11@gmail.com
abhishekadke2001@gmail.com, 2003harshalpatil@gmail.com

Abstract: *Computer numeric control (CNC) machine plays an important role in the field of automation. It reduces human involvement which eventually reduces rate of error, and increases processing speed resulting into an efficient system. In this research work universal serial bus (USB) based CNC controller has been designed and implemented using open source software (G-Code) and hardware (Arduino and other mechanical systems) which are easily available and cheaper as compared to commercially available controllers. This paper deals with the design of automatic mini CNC machine for PCB cutting and drilling using controller ATMEGA 328 in an auduino uno.*

Keywords: CNC, Arduino controller, USB, Gcode, Relay with PIC18F4550

I. Introduction

The goal of this project is to design and implement a computer controlled PCB drilling machine. All the mechanical and electronic design are done from scratch to realize the project. There is also a computer program which communicates with the machine electronics. Next chapter reveals the main blocks of the designed project. It gives introductory information about the whole system. Following chapters explain the main blocks of the system separately in detail. The conclusions chapter includes the results of the project and future decisions. References are also added at the end of the project report. Finally, appendices list the source codes and circuit diagrams that are used in this project. 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, machines and grinders. The CNC stands for Computer Numerical Control. Inspiring from this CNC technology and revolutionary change in the world of digital electronics & Microcontroller, we are presenting here an idea of CNC pen plotter using custom built PLC. The idea behind this project is to make a small CNC machine which can draw images or pictures on surface which can be a paper or anything. It uses three stepper motors as linear actuators on each axis X, Y & Z. While printing / drawing, the proper synchronization of all this three axis i.e. stepper motors, is most challenging task. At present the data to draw is given programmatically i.e. hardcoded in program in binary format. A pen touches the surface & prints the pixel for logic 1 and lifts up in air for logic zero & actuator changes it position for next commands execution. As in future plan, it can access the G-Code directly from supporting software like inkscape. Presented plotter is one dimensional 1D plotter.

1.1 Objective

To develop a low cost automatic mini CNC machine for PCB cutting and drilling. This system reduces the cost of machine and increases the flexibility

1.2 Methodology

The G code is interfaced with ATMEGA 328 CNC based controller by FTDI module which is used to convert the code in convenient controller code i.e serial to USB converter. Hence it acts like interfacing module between PC to Controller. This code is further passed to stepper motor by easy drivers which converts the code and as per instructions the stepper motor moves. We need three axises X,Y,Z which operates as follows X stepper motor move left and right Y stepper motor moves front and back and Z stepper motor up and down as per given dimensions these axis’s will move on.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 2, February 2022

II. System Overview

In electronics industry, Printed Circuit Boards (PCB) are designed using Computer Aided Design (CAD) programs. These programs generate a standardized file which is known as Excellon Drill File (Refer to [1] for details). Excellon files define the position of hole locations on the designed PCB. This information is used in Computer Numerical Control (CNC) machines to drill the necessary holes on the PCB.

In this project, the developed software takes the Excellon drill file of the PCB. Than it calculates the necessary parameters and sends the coordinate information to PIC16F877 microcontroller unit (MCU) over RS-232 line. When MCU takes the necessary information, it immediately indexes the stepper motor drivers. Stepper motor drivers turn the stepper motors according to the index pulses applied to them. Stepper motors move the mechanism to accomplish the drilling of the PCBs. Limit switches are used on the drill mechanism to realize axis over range protection. That is, when an axis tries to pass its limits, the switch is pressed and MCU stops the axis movement immediately.

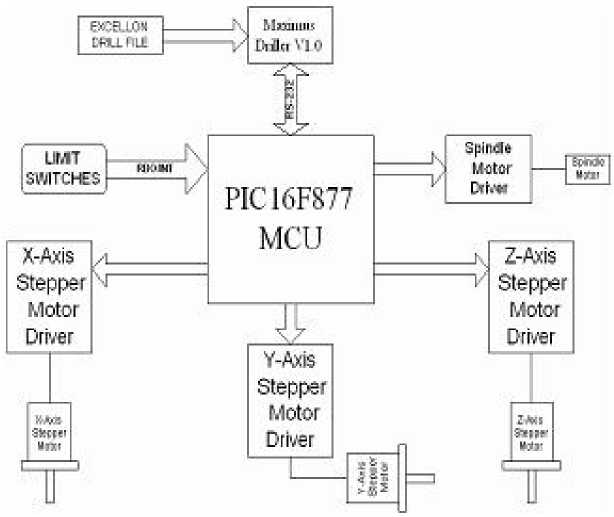

Fig 1: System Overview

III. Mechanics

Mechanical system is the realization of 3-dimensional motion control. Motion Control, in electronic terms, means to accurately control the movement of an object based on speed, distance, load, inertia or a combination of all these factors. There are numerous types of motion control systems, including; stepper motor, linear stepper motor, DC brush, brushless DC, servo, brushless servo and more. The stepper motors are chosen in this study, for the following reasons that they are generally preferred to use with computer controls because they are essentially digital devices and ideal for low cost, open loop control schemes where high torque and rotation speed values are not required. In theory, a Stepper motor is a marvel in simplicity. A stepper motor-lead screw combination is used on all three axis to make axis movements. The shaft of the motors are coupled to lead screws. The screws are beared at two ends by ball bearings. With this mechanism the rotational movement of the stepper motors are converted to linear movements to drive the axises. A 3-D solid model of the mechanical system is designed with AutoCAD 2000 before making the mechanical parts. The design is investigated for various working parameters. These parameters include lightness in weight, low friction, low mechanical cost and low inertia. The system is designed to be driven with NEMA 23 sized stepper motors. (i.e. Motors with 50-100 Ncm holding torque)

By considering these parameters, the mechanical system is constructed as follows:

- 3 axis stepper motor – lead screw linear motion mechanism
- 12mm diameter Inox stainless steel lead screws
- 12mm Inox Nuts
- Kestamid and Polietheleyn nut holders

- 12mm mercury steel shafts for axis support
- 12mm delrin parts for shaft sliders
- Poliethelelyn parts for main body
- Kestamid couplings
- Aluminums motor holders

All parts are done in mechanical workshops by using lathes and milling machines. Appendix 8 shows 3-D solid model drawings of the mechanics.

Fig.2 Mechanics

IV. PC Software

4.1 Program of Instruction

When starting out with CNC, the first thing to do is creating some sort of model, drawing, or representation of the part or object to be machined. Most of the time this is a function of a CAD/CAM systems so they will generate g-code (machine commands).

Computer-aided design (CAD) involves creating computer models defined by geometrical parameters. These models typically appear on a computer monitor as a three- dimensional representation of a part or a system of parts, which can be readily altered by changing relevant parameters. CAD systems enable designers to view objects under a wide variety of representations and to test these objects by simulating real-world conditions. Computer-aided manufacturing (CAM) uses geometrical design data to control automated machinery. CAM systems are associated with computer numerical control (CNC) or direct numerical control (DNC) systems.

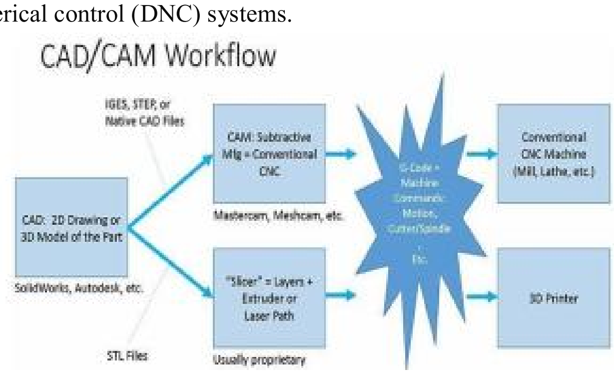

Fig.3. CAD/ CAM Workflow

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 2, February 2022

4.2 G-Code

G-Code or Geometric Code is the generic name for a control language for CNC machines. It is a way to tell the machine to move to various points at a desired speed, control the spindle speed, turn on and off various coolants, and all sorts of other things. It is fairly standard, and is a useful tool. The standard version of G-code is known as RS-274D. Since G-codes are preparatory codes, in a CNC program they begin with the letter G and direct the machine [19]. Typical actions G-code directs include.

- Changing a pallet
- Rapid movement
- A series of controlled feed moves, resulting in a workpiece cut, a bored hole, or a decorative profile shape
- Controlling feed movement, in an arc or a straight line
- Setting tool information

4.3 Drill Movements

When user clicks Drill button on PC, the following steps are executed:

- PC sends an OPENDRILLMODE1 byte to PIC
- PIC responds with a DRILLMODE1ON byte.
- PC calculates the axis displacements from the offset position. It constructs and sends a 10-bytes long data packet to PIC according to displacement values.
- Upon completion of the offset movement, PIC responds with an ATOFFSETPOS byte and starts waiting for Initialize Drill Mode Packet.
- PC constructs a 9-bytes long Initialize Drill Mode Packet according to machine settings and sends it to PIC.
- PIC takes this packet and assigns necessary variables. It returns with a DRILLMODE1INITIALIZED byte.
- When PC receives this byte, it converts holes[i] array elements to exact step numbers according to machine settings. Then it constructs a 5-bytes long Drill Data Packet and sends it to PIC.
- PIC makes the axis movements (i.e. Drill one hole) and responds with a ONEHOLEDRILLED byte. Then it starts waiting for new Drill Data Packet.
- PC counts the number of drilled holes inorder to know whether all holes are drilled. If not, it constructs and sends a new Drill Data Packet to PIC until all the holes on the imported drill file has been finished.
- When all holes are drilled, PC sends a 0 bit in MSB of the configuration byte. This causes PIC to exit from drill mode by responding with a JOGMODE1DONE byte and go to mode selection.

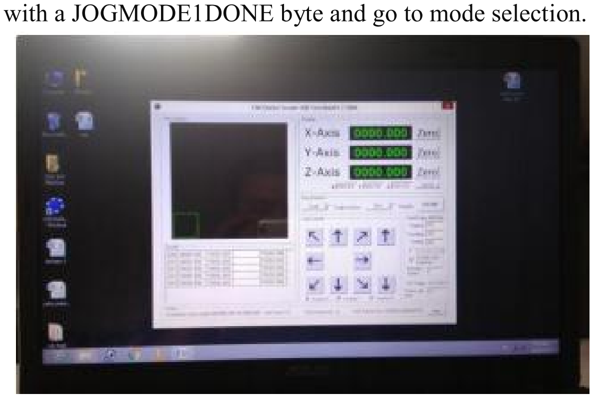

Fig 5 software of cnc

V. Advantages & Applications

5.1 Advantages

- CNC machines can be used continuously 24 hours a day, 365 days a year and only need to be switched off for occasional maintenance.

- CNC machines are programmed with a design which can then be manufactured hundreds or even thousands of times. Each manufactured product will be exactly the same.
- Less skilled/trained people can operate CNC's unlike manual lathes / milling machines etc... Which need skilled engineers?
- CNC machines can be updated by improving the software used to drive the machines.
- Training in the use of CNC's is available through the use of 'virtual software'. This is software that allows the operator to practice using the CNC machine on the screen of a computer. The software is similar to a computer game.
- CNC machines can be programmed by advanced design software such as Pro/DESKTOP®, enabling the manufacture of products that cannot be made by manual machines, even those used by skilled designers / engineers.
- Modern design software allows the designer to simulate the manufacture of his/her idea. There is no need to make a prototype or a model. This saves time and money.
- One person can supervise many CNC machines as once they are programmed they can usually be left to work by themselves. Sometimes only the cutting tools need replacing occasionally.
- A skilled engineer can make the same component many times. However, if each component is carefully studied, each one will vary slightly. A CNC machine will manufacture each component as an exact match.

5.2 Application

- Drilling device
- Punching device
- Grinding device
- Laser cutting device
- Water jet cutting device
- Industrial robot
- Electro discharge device

VI. Future Scope

- Current system can be improved to reach higher axis speeds.
- Variable spindle speed control mechanism can be easily incorporated to the system.
- The developed system can be built up for milling PCBs.
- We propose to use servo or DC motors instead of stepper motors that provide more precision.

VII. Conclusion

In this work, we got familiar with one of the famous industrial technology which is Computer Numerical Control. After a hard work for creating a working CNC prototype we have gained skills in electronics and software development as well as carpentry since we have built the mechanical part by our selves. In electrical part, we have studied the stepper motor mechanism, and its control theory, we used the TB-6550 stepper motor driver. These motors were very helpful in our project since they are easy to use because they are controlled with open loop control system .Beside that, we acquired the knowledge of the Python programming language to develop Graphical User Interface applications that runs under Raspbian OS (Linux-based) to stream the g-code file to the microcontroller. Also, we learned how to program in Node.js environment and deploy the web application we developed using the bootstrap framework to be accessible via network. The results produced by our CNC are satisfactory after such a hard work; we finally got good result with a huge treasure of knowledge and skills in electronics and software development.

References

[1]. Safety measures for "Two wheelers by Smart Helmetand Four wheelers by Vehicular Communication" Manjesh N 1, Prof. Sudarshan raju C H 2 M Tech, ECEDSCE, JNTUA, Hindupur International Journalof Engineering Research and Applications (IJERA) ISSN:2248-9622 NATIONAL CONFERENCE on Developments, Advances & Trends in Engineering Sciences (NCDATES-09th & 10th January 2015)

[2]. Peter Smid, "A comprehensive Guide to Practical CNC Programming: CNC Programming Handbook", Book, 2003.

[3]. Dr. Benzekri, Adel MESSAOUDI and Billal BELHOCIN, "Implementation of Low Cost Three Axis CNC Machine with Network Control" Final Year Project Report Presented in Partial Fulfilment of the Requirements for the Degree of MASTER In Electrical and Electronic Engineering, People's Democratic Republic of Algeria Ministry of Higher Education and Scientific Research, University M'Hamed BOUGARA – Boumerdes.

[4]. Dr. Ugur Baysal, Alper Yildirim, "Cnc Printed Circuit Board Drilling Machine" Hacettepe University Department of Electrical and Electronics Engineering ELE 401 – ELE 402.

[5]. Kajal J.Madekar, Kranti R. Nanaware, Pooja R. Phadtare, Vikas S. Mane, " Automatic mini CNC machine for PCB drawing and drilling" International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 02 | Feb-2016.

[6]. C.R. Zhang, SH. Cheng, and H. Wang, "Design and Realization of G Code Interpreter for CNC System," Journal of Shan Dong University (Engineering Science), vol. 32, no. 6, pp. 564-568, Jun. 2002.

[7]. J. Bai, X. S. Qin, W. D. Wang and Z. X. Wang, Global Design to Gain a Competitive Edge, 2008.