Design & Development Of Portable CNC Machine

[1]**Prof. Varsha Magar,** [2]**Abhishek Nagar,** [3]**Tejas Bagul,** [4]**Pritam Dhamale,** [5]**Jesvin George**

Department Of Mechanical Engineering

[1]HOD, [2,3,4,5]Student Bachelor in SSJ COE, Dombivli.

Abstract :

An Engineer is always focused towards challenges of bringing ideas and concepts to life. Therefore, Software and Computer Techniques must be constantly developed and implemented for Virtual and Economic Analysis. At the same time, we must take care that there is no compromise with the Accuracy of the Techniques used.

The aim of project is to manufacture the design profile by using CNC machine. The profile designed is needed to write a CNC program based on labels, the label mode of program is selected because the programming is too easy even for any material.

CNC's had made revolutionary changes within the manufacturing sector in before days achieving productivity uptothe desired level was not possibilities due to lots of drawbacks like complications of shapes and sizes, lots of wastage and scrap due to unexpected mistakes and low-quality levels and accuracy. By using CNC all drawbacks can be overcome and this was our small contribution to show the performance of mini-CNC.

Initially we got trained about the CNC programming and operations for the period of one month during the training decided to carry our project on CNC, we designed a profile to be manufactured which would be tough to achieve it by conventional machining process and we designed to make use of aluminum material as a work piece of dimension, after the basic selections and decisions the preparation of an program (based on labels) was done and we went for simulation and verified it thoroughly weather the profile achieved by simulation is matching to the designed after lots of observation we went for manufacturing the profile in CNC machine available at the source place and he results we got was smooth finished surface with high rate of accuracy with less machining time which directly increases the productivity and the process would be economical productivity and the process would be economical.

Index Terms – CNC Machine, stepper motor, G-code converter, GRBL Controller.

1. INTRODUCTION

The idea behind development of mini CNC machine is to full fill the demand of CNC machine from small scale to large scale industries with optimized low cost. A major new development in computer technology is the availability of low-cost open source hardware, such as the Arduino microcontroller. 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. In this paper, the development of mini 3-axis CNC milling machine using Arduino- based control system is presented with following specifications: Low cost, easily operable, Easy interface, Flexible, Low power consumption. This project describes the development of the machine and the criteria needed to build the machine.

2.METHODOLOGY

There are three phases in the CNC system development architecture, they are design and fabrication phase, control box design and wiring phase and software development and testing phase . Design and fabrication phase consists of different stages like mechanical design, 3D design of X, Y and Z axis using Solid works, 2D conversion of overall assembly and fabricating the parts. Mainly the structure of the CNC system is created using aluminum profiles. Portable CNC machine works with the help of two software's - Inkspace and Candle software.

Inkscape software is used to generate G codes which are used to run desired operations on the CNC machine. Inkscape software is used to set specific depth, feed rate and penetration feed rate. Candle is a CNC machine control software, and it's often associated with GRBL (G-code Real-time command interpreter for controlling CNC machines). The combination of "Candle" and "GRBL Controller" typically refers to software used to control CNC (Computer Numerical Control) machines that are powered by GRBL firmware.

Candle software provides a user-friendly interface for sending G-code commands to the CNC machine and controlling its operation. It allows users to load G-code files, jog the machine manually, set configuration parameters, and monitor the machine's status.
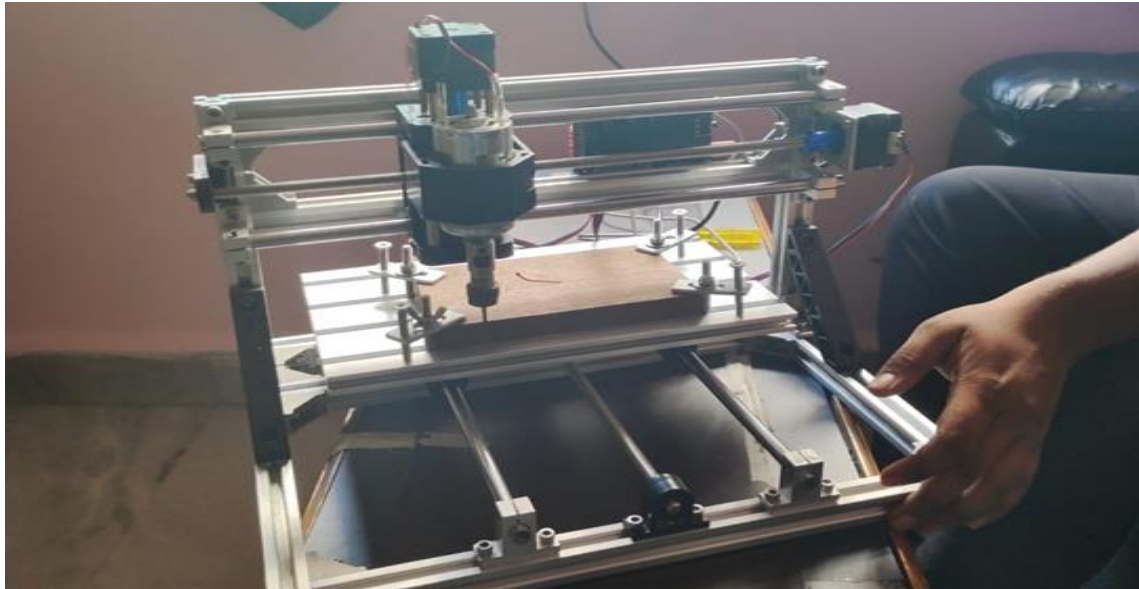
Figure No. 1: Actual model after manufacturing

III. MACHINE COMPONENTS

3.1 Stepper Motor

The 42HS34-13D stepper motor, part of the NEMA 17 series, offers precise angular positioning and ample torque for various applications. With its 1.8-degree step angle, 0.45 Nm holding torque, and bipolar configuration, it ensures smooth operation and easy integration. Widely used in 3D printers, CNC machines, and robotics, its compact size, compatibility, and reliability make it ideal for precise motion control tasks, such as driving print heads in 3D printers.

Figure No.2: Stepper Motor

3.2 Aluminum Profile

An aluminum profile of (2040 & 2080) offers versatility in constructing frameworks for various projects, including robotics, furniture, and industrial equipment. Its lightweight yet sturdy construction, along with modular design, allows for easy assembly and customization

Figure No.3: Aluminum Profile

3.3 Flexible Coupling

A flexible coupling providing flexibility and damping characteristics. It connects the stepper motor shaft to the lead screw shaft, compensating for misalignment and reducing vibration transmission. This ensures smooth and precise motion transmission in the system.

3.4 GRBL Controller

The GRBL (G-code Real-time Boot Loader) controller is a common choice for DIY CNC machines. It runs on Arduino-based platforms and interprets G-code commands to control stepper motor movements. With features like acceleration control and homing routines, it enables precise and efficient operation of CNC systems.

Figure No.4: GRBL Controller

3.5 Lead Screw
A lead screw provides high efficiency and self-locking characteristics. Coupled with a stepper motor, it converts rotary motion into linear motion, facilitating precise positioning in CNC routers.
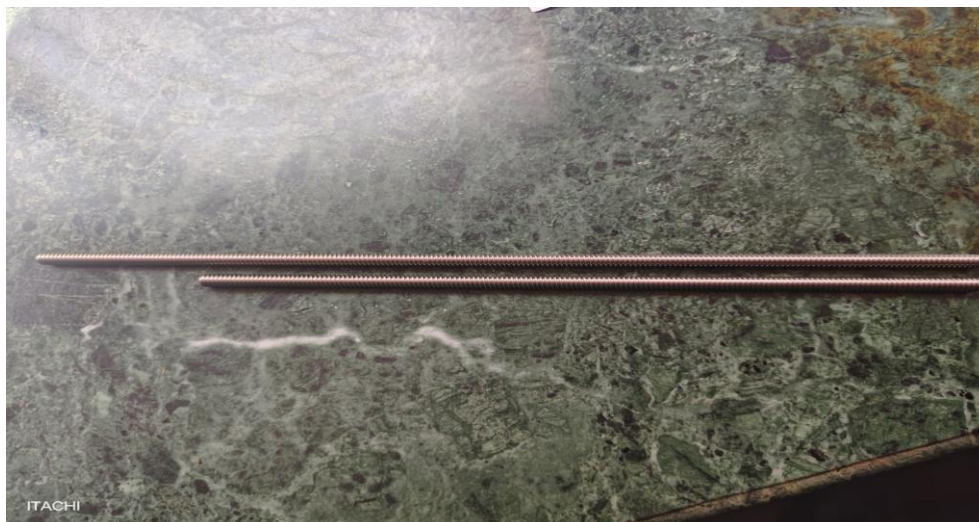

Figure No.5: Lead Screw

3.6 Switched Mode Power Supply (24 V)
DC24V5A , it offers high efficiency and compact size.

It provides stable and regulated power to stepper motor drivers, controllers, and other components in CNC and automation systems.

3.7 Software system
Inkscape software is used to generate G codes which are used to run desired operations on the CNC machine Inkscape software is used to set specific depth, feed rate and penetration feed rate. Later on candle software is used to run these G-codes on the CNC program.
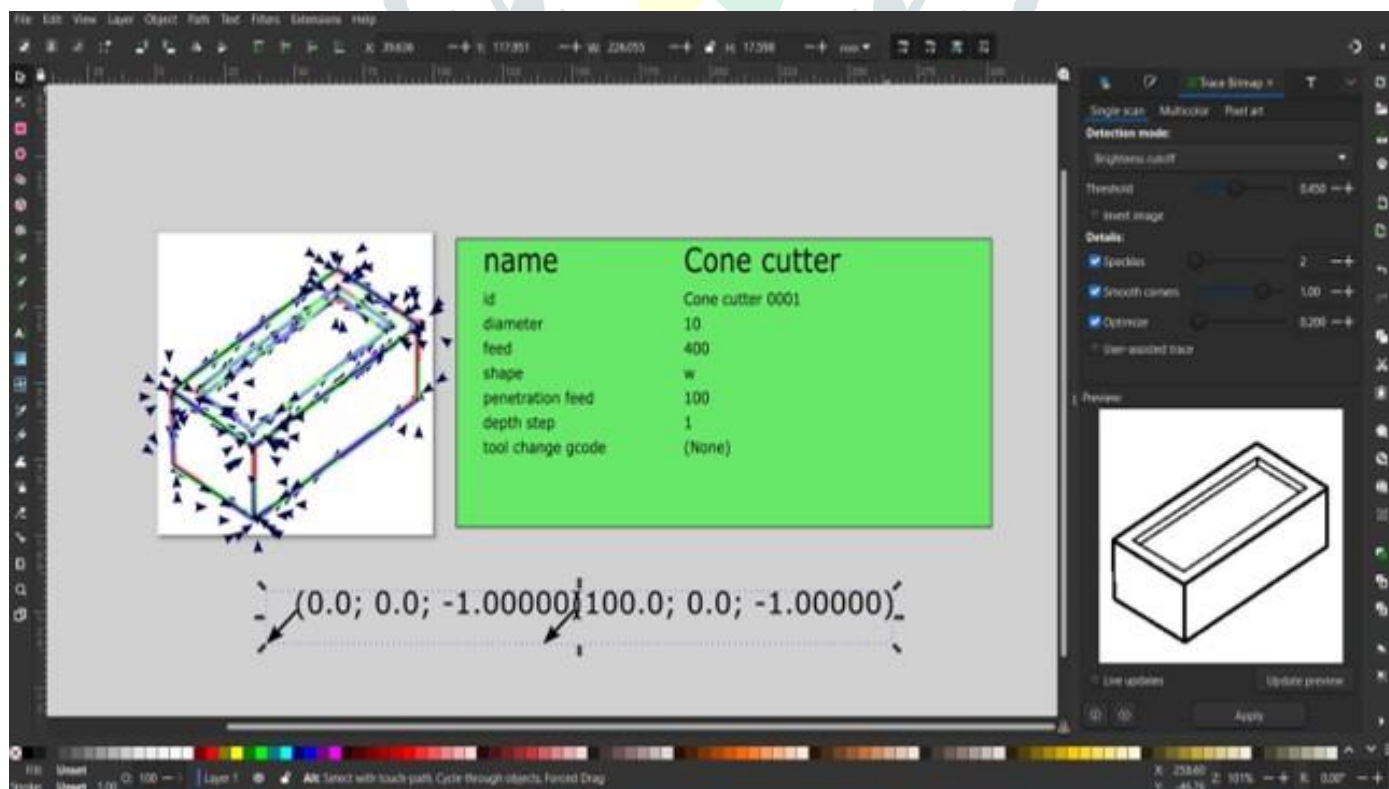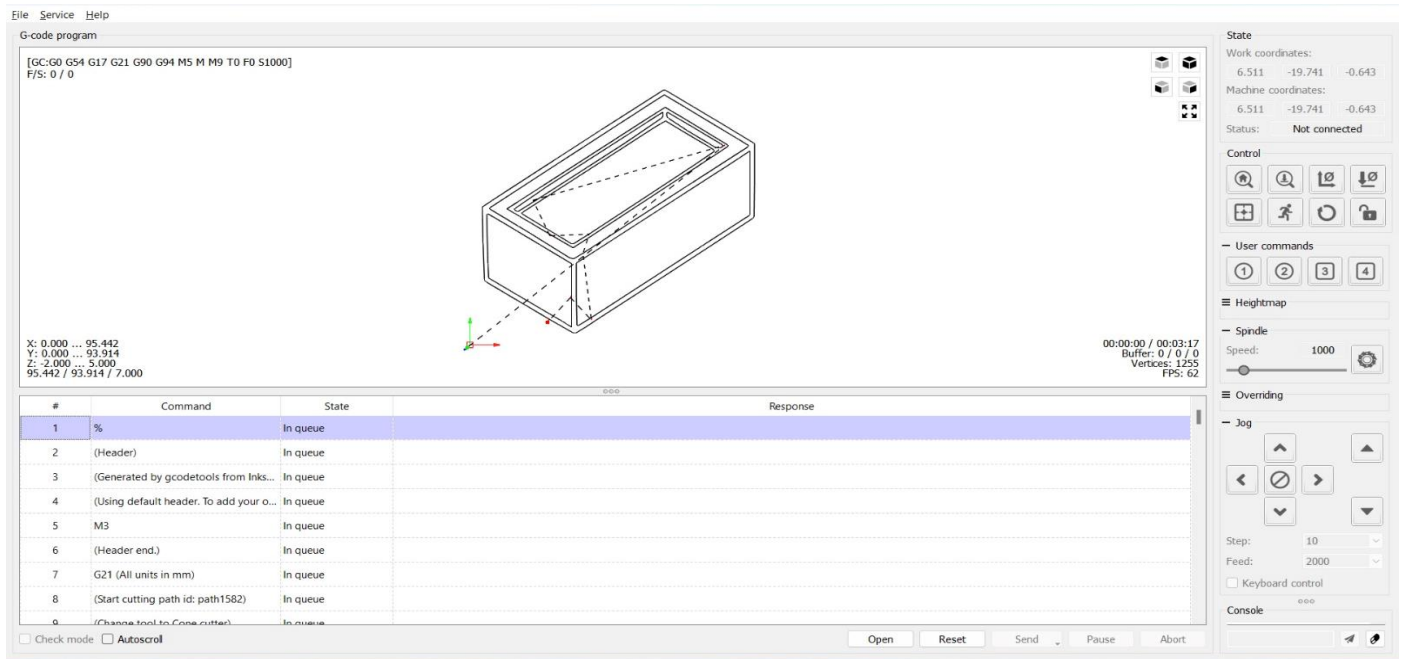

Figure No.6: Inkspace Software

Figure No.7: Candle Software

IV. RESULTS

4.1 Results on material Wood & Acrylic.

Table 4.1: Result on material Wood

Sr No.	RPM	FEED	DEPTH(mm)	TIME
1.	1000	500	0.1 0.2 0.3	4:19 4:22 4:26
2.	3000	750	0.1 0.2 0.3	3:38 3:40 3:43
3.	5000	1000	0.1 0.2 0.3	3:14 3:18 3:23

Table 4.2: Result on material Acrylic

Sr No.	RPM	FEED	DEPTH(mm)	TIME
1.	1000	500	0.1 0.2 0.3	4:19 4:22 4:26
2.	3000	750	0.1 0.2 0.3	3:38 3:40 3:43
3.	5000	1000	0.1 0.2 0.3	3:14 3:18 3:23

Conclusion

With the increasing demand for small scale high precision parts in various industries, the market for small scale machine tools has grown substantially. Using small machine tools to fabricate small scale parts can provide both flexibility and efficiency in manufacturing approaches and reduce capital cost, which is beneficial for small business owners. In this thesis, a small scale three axis CNC machine is designed and analyzed under very limited budget.

From this project, we learned the principle of CNC machine. We gained better understanding in the modes of operation of CNC machine. There is various type of modern CNC machines use in industry. Automatic generation of different preparatory (G codes) and miscellaneous function (M codes) is used in CNC part programming for completing a successful CNC program.

Specifically, CNC machine works with a computer numerical control that writes and read G-code instructions to drive machine tool to fabricate components with a proper material removal rate. G-codes are commands for CNC machines to follow so that they can operate on their own without human control. Zero set up is very important step to obtain an accurate geometry of the work piece

REFERENCES

1] "A knowledge-centric Machine Tool Design & Development Process Management Framework", International Journal of Production Research, 2014, vol. 52, no20, 6033-6051, by Linyanliu, Barrets s.calwell, Huifen wang, Ying li

[2] "Design and Implementation of Three-dimensional CNC machine", International Journal of Computer Science and Engineering, Nov.2010, vol 02, 2567- 2570, by Venkata krishna pabalu, Prof.k.n.h.shrinivas

[3] "Fabrication of Low cost 3 axis CNC Router", International Journal of Engineering Science Invention, ISSN (online):2319-6734, ISSN (print) 2319-6726, vol 3 issue6, june2014, by Dr.J.B. Jayachandraiah, o vamsikrishna, P.abdullah khan,R.ananda Reddy

[4] "Improvement on CNC Gantry Machine Structure Design for Higher Machining Speed Capability", International Journal of Mechanical, Aerospace, Industrial and Mechatronics Engineering, vol 9, Nov: 2015, by Ahmed a.d.sarhan, S.r.besharaty, Javed akbaria, m.hamdi

[5] "Prototype Development of Milling Machine Using CAD/CAM", International Journal of Science And Research, ISSN 2319:7064, vol.4 issue 8 2015, by Nikita r saharkar ,Girish m dhote

[6] "Low cost build your own three axis CNC mill prototype", International Journal of Mechanical Engineering and Robotics, ISSN 2321-5747, vol,2 issue1,2014 by Sundar Pandian, Raj Pandian.

[7] "Design Optimization of CNC Vertical Milling Machine Bed", Indian Streams Research Journal, vol.2, issue 7, 2012 by B.Malleswara swami, K. Sunil ratna kumar, C.H Ramakrishna

[8] "An Investigation Effect of Machining Parameters on CNC Router", IJEDR, ISSN: 2321-9939, vol. 2, issue 2 ,2014, by Mr.Dhruv H. Patel, Prof. V. N. Patni