DESIGN & DEVELOPMENT OF PORTABLE MILLING MACHINE

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ABSTRACT

Increase in the rapid growth of Technology significantly increased the usage and utilization of CNC systems in industries but at considerable expensive. The idea on fabrication of low cost CNC Milling Machine came forward to reduce the cost and complexity in CNC systems. This paper discusses the development of a low cost CNC Milling Machine which is capable of 3-axis simultaneous interpolated operation. The lower cost is achieved by incorporating the features of a standard PC interface with micro-controller based CNC system in an Arduino based embedded system. The system also features an offline G-Code parser and then interpreted on the micro-controller from a USB. Improved procedures are employed in the system to reduce the computational overheads in controlling a 3-axis CNC machine, while avoiding any loss in overall system performance.

KEYWORDS— CNC MACHINE, STEPPER MOTOR, SPINDLE, SPROCKETS, NEMA 17 STEPPER MOTOR.

INTRODUCTION

CNC milling is a specific form of Computer Numerical Controlled (CNC) machining. Milling itself is a machining process similar to both drilling and cutting, and able to achieve many of the operations performed by cutting and drilling machines. CNC machining centers are used to produce a wide range of components, and tooling costs involved have continued to become more affordable. In general, large production run requiring relatively simple designs are better served by other methods, although CNC machining can now accommodate a wide range of manufacturing needs. CNC milling centers are ideal solutions to everything ranging from prototyping and short-run production of complex parts to the fabrication of unique precision of components.

In this work, a low-cost, desktop prototype 3-axis vertical CNC mill is developed for purposes of student experiments in CAD/CAM and CNC programming areas. Open source microcontroller platform Arduino is used for control of the motors, and open source software is used for executing the G code and M code for machining applications.

OBJECTIVE

The objective of the project,

- The idea behind fabrication of low cost CNC milling machine is to full fill the demand of CNC milling machine from small scale to large scale industries with optimized low cost.
- Low cost
- Smaller size
- Easily operable
- Easy interface
- Flexible
- Low power consumption.

METHODOLOGY

The start of the flow work is to understand the fundamental of the Mini CNC machine. After doing some research and study about the Mini CNC machine, the next step that is needed to do is design the machine according to the understanding of the mini CNC machine concept. The designing of the machine including with the wiring connection and the software that is use to generate the program. Develop the machine base of the design that has been drawn.

MATERIALS USED

- Aluminium
- Stainless Steel
- Phosphor bronze
- Acrylic

DESCRIPTION OF COMPONENTS

[1] Outer Covering Plates

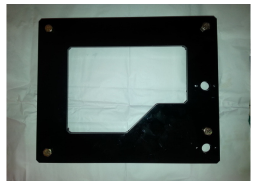

Fig.1. Final Laser Cut of Outer plate

[2] Sprockets

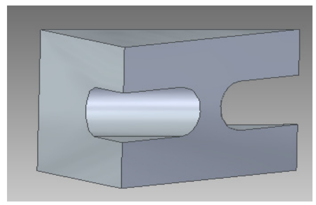

Fig.2 Sprocket

[3] Stepper Motor

Fig.3 Nema 17 Stepper Motor

[4] Stepper Drive

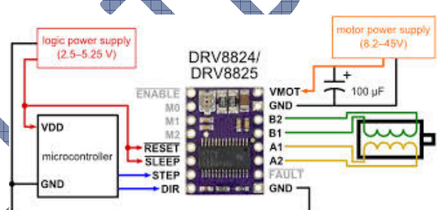

Fig.4. Stepper Drive (A4988)

[5] Ball / Lead Screws

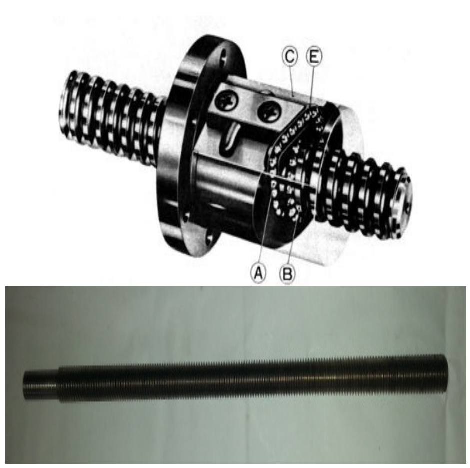

Fig 5. Ball/Lead Screw

A: Steel ball ,B: Screw shaft ,C: Ball nut, D: Seal (both sides of ball nut) ,E: Recirculation parts (return tube, etc.)

[6]Guide Rods

Fig 6. Guide rods

[7]Coupling bush

Fig 7. Coupling bush

[8]Bore plate

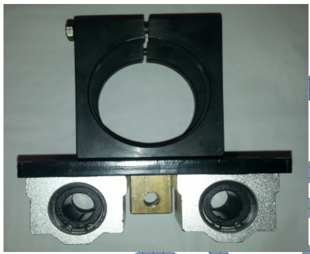

Fig 8. Bore plate

[9]Spindle

Fig 9. Spindle (DMP02-6)

[10]Work table

The worktable is made up of acrylic material. At the backside of worktable ball bearing is fixed through which guide rods for Y-axis slides. During Y-axis motion the worktable itself moves.

[11]Limit switches

A Limit Switch is the simplest type of end stop a simple mechanical switch positioned to trigger when a axis reaches the end of its motion. Limit switches are used to protect the stepper motor and circuit by shutting the motors by triggering the switch when the axis reaches its end. The signal pins from limit switches are connected to the microcontroller board to sense the axes ends.

MACHINE ASSEMBLY

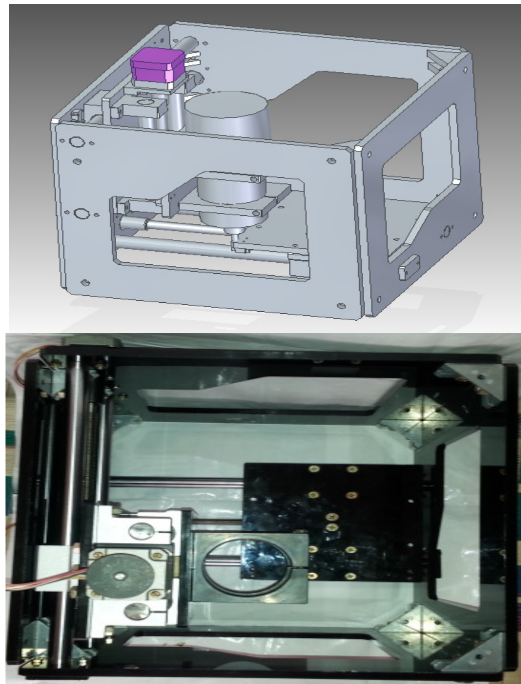

Fig 10. Mechanical assembly

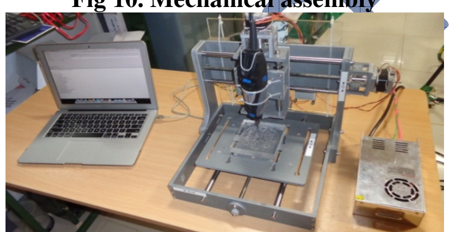

Fig 11. Assembled 3-axis CNC machine

STEPS FOR CNC MILLING PROGRAMMING AND MACHINING

The following is the procedure to be followed in CNC programming and machining. The most important is to verify the programme by test run it on the machine before the actual machining in order to ensure that the programme is free of mistakes.

- Study the part drawing carefully.
- Unless the drawing dimensions are CNC adapted, select a suitable programme zero point on the work piece. The tool will be adjusted to this zero point during the machine setup.
- Determine the machining operations and their sequence.
- Determine the method of work clamping (vice, rotary table, fixtures etc).
- Select cutting tools and determine spindle speeds and feeds.
- Write programme (translate machining steps into programme blocks). If many solutions are possible, try the simplest solution first. It is usually longer, but better to proceed in this way.
- Prepare tool chart or diagram, measure tool geometry (lengths, radii) and note.
- Clamp work piece and set up machine.
- Enter compensation value if necessary.
- Check the test programme. It is a good practice to dry run the programme
    a. Without the work piece.
    b. Without the cutting tools, or
    c. By raising the tool to a safe height.

  It is necessary to correct and edit programme and check again.
- Start machining.

SCOPE FOR FUTURE WORK

- It is planned to scale up the prototype CNC machine in terms of size, use more powerful motors, strengthen the frame and worktable with materials like aluminum or cast iron, and augment the CNC control software with software for simulation ahead of actual run.

- Machines in general and robots in particular, are appealing to youth and children. Therefore, exposure to and experience with DIY robots and mechatronic system projects can render engineering education innovative through playful learning.
- In some industrialized countries, school children are exposed to CNC programming and machining as early as middle school. Therefore, with the power of the Internet, it is also planned to introduce neighborhood school children remotely to Web-based real-time operation of CNC machines, while imparting them basic knowledge of computer-aided art, design, and modeling through open source software such as Google SketchUp

CONCLUSION

This work has presented the results of development of a low-cost three-axis vertical CNC mill suitable for adoption in undergraduate mechanical engineering laboratory setting. The total cost of the developed system is just about 1/20th of the existing commercial CNC machine used currently in the laboratory, though pedagogically our model provides more scope for hands-on learning by the students and therefore better learning outcomes. It is hoped to extend this work in future to low-cost design and development of other CNC machines like lathe, router, and eventually a BYO or customized open source 3D printer.

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