Design and fabrication of a CNC router machine for wood engraving

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Abstract. The purpose of this research was to designing and fabrication a Computer Numerical Control (CNC) based router machine for wood engraving machine. The idea behind this research was to help the traditional woods craft men in Bali to make a craft more productive and more efficient. The router machine that is made is driven by the driver in the form of a stepper motor, with a 3 axis motion so that the results of wood engraving obtained are precision and homogeneous. G-code program used on CAM processing uses MACH 3 software. The workspace of the machine was 800 mm x 500 mm. The stepper motor driven with TB 6600 driver and combined with ball screw on linear bearing to make the motion more precisely. The test result showed that the machine accuracy is about 99.5 percent for X and Y axis and 96 percent for Z axis.

1. Introduction

The wood craft industry is one of the industries that develop in Bali. Nowadays, the processes of producing wood crafts in Bali still use the machine with manual operation. This manually production requires more time and energy, thereby reducing the productivity and profitability of wood craftsmen. Computer Numerical Control (CNC) is the automation of machine tools that are operated by a computer controlled programs to perform a desired product shape. Design and fabrication of milling machine using CNC has been done with ATMEGA 328 micro controllers in an Arduino. The test result showed that the milling machine can be used in acrylic, wood, aluminium with accuracy 0.02mm [1]. Design of A CNC prototype machine was designed, with three Cartesian axes, with 600 mm of length both X and Y axes and 100 mm of length Z axis. The software use Lab VIEW IDE [2]. Study on Computer Numerical Control (CNC) machines for fabrication of rollers also done, various processes like facing, turning, parting, drilling, boring and knurling to improve production in order to decrease the production time and also to increase the efficiency in conventional lathe and CNC machines by writing the program on STC-25 CNC lathe [3]. A mechanical prototype of a CNC Router which is able to draw a PCB layout and wood engraving has been build [4]. The other research of the design, implementation and performance test of CNC has also been done by many researchers using different software. Research about accuracy of CNC feed has been done [5]. Low cost CNC machine for Industrial application and also for engraving machine has been design and build [6, 7]. The designed system is user -friendly one which give accurate results and also flexible to users. Implementation 3-Axis CNC Router for Small Scale Industry and CAM courses has been done [8, 9]. Both of them uses stepper motor and the results showed a good accuracy especially for the depth accuracy which is almost 100%.

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Based on the description above, it is interesting to develop by designing and fabricating a router machine controlled with CNC programs for wood craft. By developing this machine, it can help the craft men producing wood craft more efficient with high accuracy for a large scale of production.

2. Methodology

The development of router machines based on CNC program for engraving machine was divided into two sections, which were design and the fabrication.

2.1. Design

The design of the engraving machines is shown in Figure 1 below.

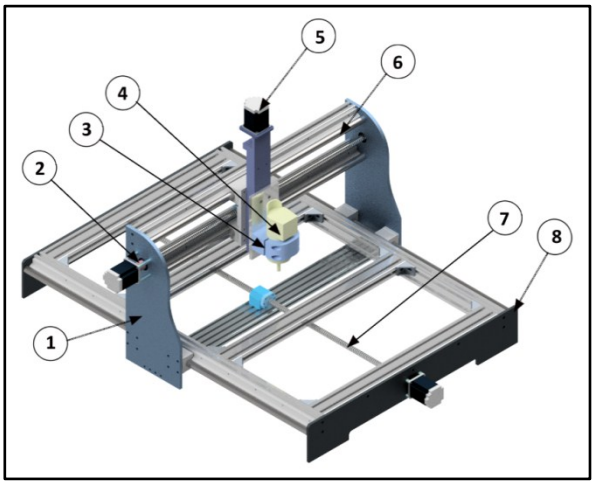

Figure 1. Design of engraving machine.

The router machine that is made will be used for wood engraving with various types of wood with the driver of a stepper motor that moves on 3 axes. This is intended so that the wood craft results can have a good precision and accuracy. The G-code CNC software Mach 3 is used, as in the following Figure 2.

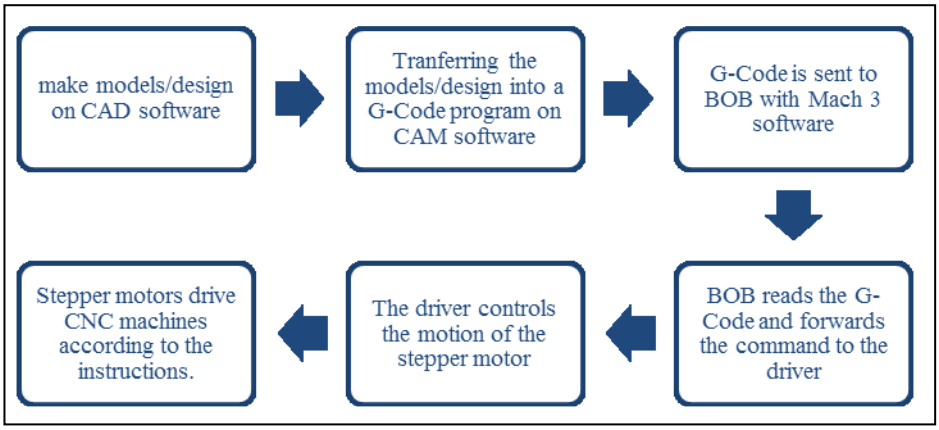

Figure 2. Workflow diagram of G-code.

2.2. Mechanical System

The mechanical systems are the most important part of the engraving machine system that is made. The result of wood craft engraving in the form of accuracy of its shape depends on the precision of the mechanical system. Mechanical systems are made by various components as follows:

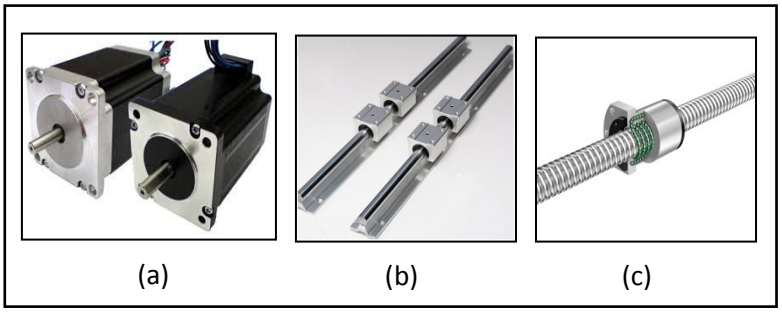

Figure 3. Components of mechanical system: (a) stepper motor, (b) linear guide, (c) ball screw.

2.3. Electrical system

BOB (Breakout Board) is used to connect between PC and various control motors, relays, and other devices that are controlled on CNC machines. In this research BOB Mach 3 are used as the microcontroller. In this research, a 24 V DC is used as the source electricity power for the stepper motors of three axes. Proximity sensors are devices that can change information about the movement or presence of objects into electrical signals, so this device had an important use to detect the presence of objects around it without any physical touch. The stepper motor interprets the step and direction signals given from the BOB and then moved the stepper motor rotate in the right direction with the correct number of steps. The electrical system of the engraving machine shown in Figure 3, Figure 4, Figure 5, and Figure 6 below.

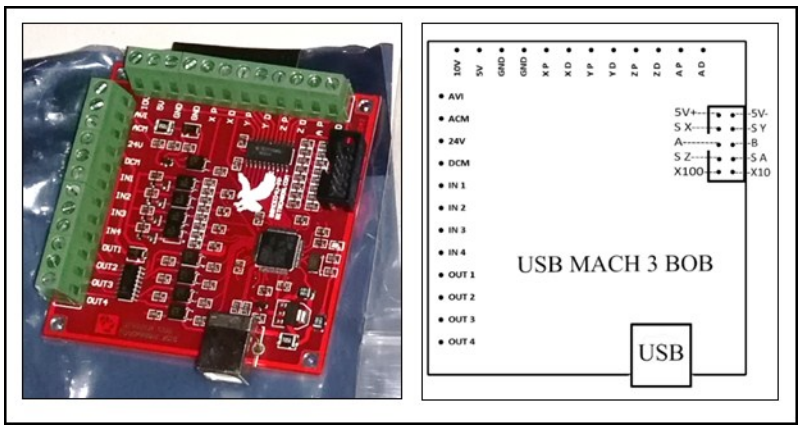

Figure 4. Mach 3 Breakout Board (BOB) and the port.

Figure 5. Power supply.

Figure 6. Proximity sensor.

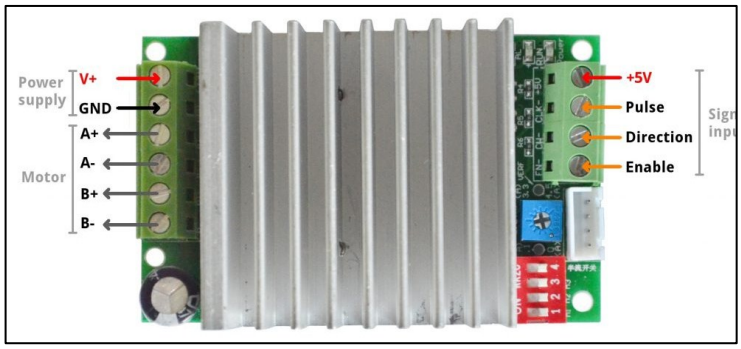

Figure 7. Stepper motor drivers.

The technical specification of woods engraving machine are shown in Table 1 below:

Table 1. Technical specification of wood engraving machine.

Part	Specification
Dimension	1150 mm × 830 mm × 760 mm
Workspace area	800 mm × 500 mm
Z-axis	130 mm
Maximum load	20 kg
Spindle	440 Watt, DC, 1200 rpm
Stepper motor drivers	TB6600 4.5 Ampere
Stepper motor torsion	2.8 Nm
Software control	Mach 3
Breakout board	CNC USB Mach 3 100 KHz

3. Results and Discussion

3.1 Fabrication wood engraving machine

Based on the design and the specification above, a medium size of wood engraving machine has been build. The dimension of workspace area of the machine was 800 mm × 500 mm, so the machine can use to make a medium size of woodcraft. The machine is shown in Figure 8 below:

Figure 8. CNC-based wood engraving machines.

The G-code for controlling the CNC was made using Mach 3 Software. Before the CNC can be running the G-code must be installed first. The set-up and user interface of Mach 3 software shown in Figure 9 below:

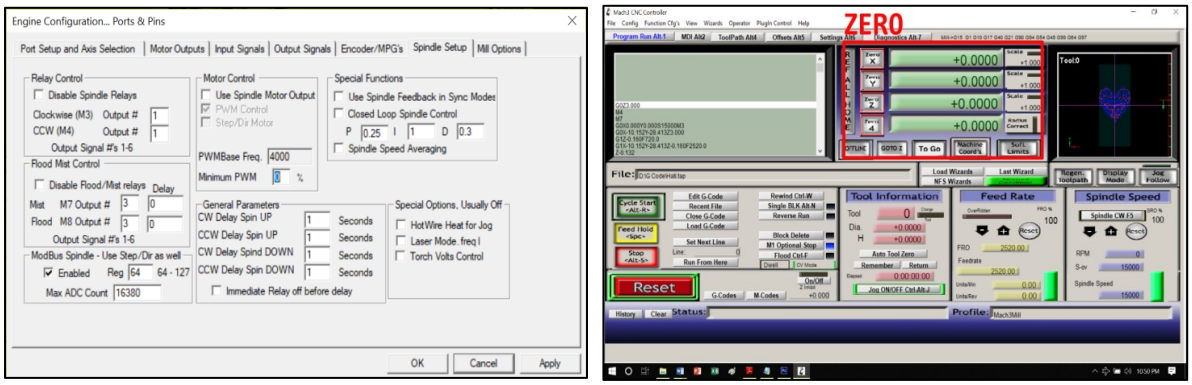

Figure 9. Set-up and UI of Mach 3 software.

3.2 Machine Test

The machining test was carried out to observed and analyse the abilities of the wood engraving machine that has been builds. The test was carried out on different wood type with different shape of model to find the accuracy of the machine. The test of wood engraving accuracy shown in Table 2 below.

Table 2. Measurement of machine test.

Test	Design/model			Measurement		
	X (mm)	Y (mm)	Z (mm)	X (mm)	Y (mm)	Z (mm)
1	35	35	8	35.1	35.4	8.4
2	40	30	8	40	30.2	8.3
3	20	10	8	20.2	9.9	8.4
4	20	20	8	20.2	20.1	8.3
5	92	92	8	92.05	92.3	8.2

From the test result, the measurement of wood engraving shows a good accuracy. The X axis accuracy about 0.11 mm, the Y axis accuracy about 0.18 mm and the Z axis accuracy about 0.32 mm.

The average accuracy of the machines is around 99.5 % for X axis, 99.6 % for Y axis and 96% for Z axis as shown in Figure 10.

Figure 10. Result of wood engraving.

4. Conclusions

In This research, a medium size of router machine for wood engraving has been build. The router machines that has been build was controlled by CNC program using Mach 3 for the software. The mechanical systems of CNC machine build with low-budget material with a good quality. Experiment test result of the machine shown a good accuracy of the machine, where the average accuracy is about 99.5 % for X and Y axis and 96% for Z axis. It can be concluded that the development of a router machine with CNC programs can uses as a wood engraving for wood craft.

5. References

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