

Mechanical Technology Prototype Innovation of Computer Numerical Control from Electric Apparel as A Medium for Education

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Paper History

Received: 13-May-2018

Received in revised form: 15-July-2018

Accepted: 30-August-2018

ABSTRACT

E-waste is a waste in the form of electronic devices that are not used anymore. One example is the personal computer components (PCs) that have been damaged or already left as an old technology that it can be no longer used. So far, e-waste PCs have not been widely used or recycled for more useful purposes, so its existence tends to be a waste that has the potential to cause pollution. Based on these conditions, it is necessary to do a research for e-waste PC can be processed and reused, one of which can be used as machine prototype computer numerical control (CNC) with three axis which can then be used as a medium for studies. This research begins by designing the physical form of a 3 axis CNC machine with the software Autodesk Inventor device. Then, it was made a prototype machine that part of its components taken from the former PC unused components. As a driving force, the prototype CNC machine used stepper motor combined with Arduino UNO Microcontroller based control system. This machine is then operated with a PC using Universal G-Code Sender and GRBL (Coding Gate) based CNC programming system. With a working area of 42 mm x 42 mm and a 17 mm depth of feed, the prototype CNC machine can eventually be used as a study medium for schools that do not have CNC machines due to their high cost and high maintenance costs.

KEY WORDS: E-Waste, Personal Computer, 3-axis CNC, Stepper Motor

1.0 INTRODUCTION

The acceleration of growth and development of electronic technology has been a revolution towards the world, including Indonesia. On the other hand, with the development of electronic products, the period of usage of electronic goods is shorter than the previous because the newer generation products will appear again. This has resulted in an increasing rate of electronic garbage growth in developing countries.

CNC Machine (Computer Numerical Control) is a machine whose operation process is controlled by the CNC system, which is a controlling process system that uses commands in the form of letters and numbers [1].

To reduce the existing electronic waste, it can be utilized electronic components for the manufacture of CNC machines. This research aims to design and manufacture a prototype CNC 3 axis machine from waste electronic used. Ultimately, this CNC machine can be used as a learning medium for schools that do not have CNC machines because of the extremely expensive machine prices.

2.0 LITERATURE REVIEW

2.1 E-Waste

Formally because E-Waste is categorized as a B3 waste, Indonesia is forbidden to import E-Waste, but in fact illegally can still enter [2]. Electronic goods are usually not used anymore even if they can still operate later in the future by being replaced with the new ones because consumers want new features or old ones inadequate for new services from operators, or just because want to change it [3]. So that these unused electronic items eventually become garbage which is often referred to as Electronic Waste (E-Waste) and still experience a very rapid increase.

2.2 CNC Program

Most of the standard CNC codes used are the first G-code G, coded in 1950 designed by the Massachusetts Institute of Technology at MIT Servomechanisms Laboratory [4]. CNC coding standards in Europe use the ISO 6983 standard, although in other countries use other standards, for example DIN 66025 or PN-73M-55256, PN-93 / M-55251 in Poland [5].

2.3 Stepper Motor

Stepper motors are electromechanical devices that work by converting electronic pulses into discrete mechanical motions. Stepper motors move based on the order of the given pulses. Therefore, to drive the Motor Stepper required Stepper Motor controller that generates periodic pulses. The use of Stepper Motor has several advantages compared to the use of ordinary DC motors. Advantages includes:

1. The motor rotation angle is proportional to the input pulse which makes it more manageable.
2. The motor can directly provide full torque at the start of moving.
3. The position and movement of repetition can be determined precisely.
4. Has a very good response to start, stop and turn (rotation).
5. Very reliable due to the absence of brush in contact with the rotor as in the DC motor.
6. Can produce slow rotation so that the load can be coupled directly to the axis [6].

2.4 Motor Driver

The A3967SLB is a complete micro stepping motor driver with built-in translator. It is designed to operate bipolar stepper motors in full-, half-, quarter-, and eighth-step modes, with output drive capability of 30 V and ± 750 mA. The A3967SLB includes a fixed off-time current regulator that has the ability to operate in slow, fast, or mixed current-decay modes. This current-decay control scheme results in reduced audible motor noise, increased step accuracy, and reduced power dissipation.

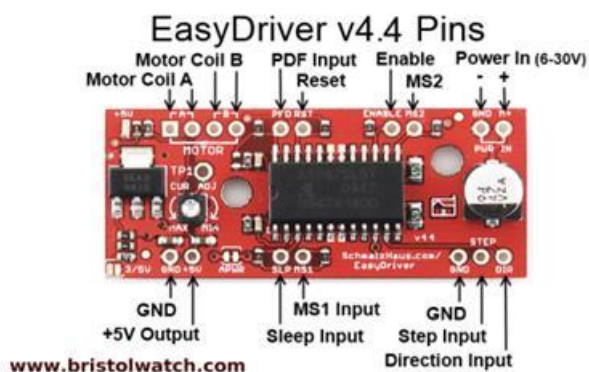


Figure 1: Motor Stepper

2.5. Arduino Uno

The controller used in this machine is the Arduino UNO which contains Atmega 328. This AVR series microcontroller has 14 digital input / output pins with support of 6 pin PWM and 6 analog input / output pins. Arduino is an electronic tool with lots of built-in and open source as well as hardware expansion known

as Arduino shield. This Shield can be easily joined in to enhance the functionality and can be connected with various features such as support from Voice Recognition, Internet Connectivity etc [7].



Figure 2: Arduino UNO

2.6 Power Supply

The Power Supply is a device that can reduce the voltage and change the AC to DC power. In the adapter circuit there is a transformer that serves to raise and lower the voltage. Alternating current (AC) is generated by a generator through a power plant, such as PLTA, PLTU, PLTPB, PLTN, better known as PLN (*Perusahaan Listrik Negara*).



Figure 3: Power Supply

2.7 Software Control

In this research, we will use 2 software to run CNC machine prototypes in order to run well. Software that is used include:

- a. GBRL controller
GBRL controller is a software used to connect or firmware between Arduino with G-Code software that will be used. GBRL controller that is used is GBRL controller r 351. Do not change the contents of coding contained in GRBL because it can make the program become error and cannot processed.
- b. GCAM
GCAM is a very simple and easy to use the software. GCAM is used as the software for drawing 2D or 3D to obtain the numerical code of the created image.

3.0 METHODOLOGY

3.1 Research Methods

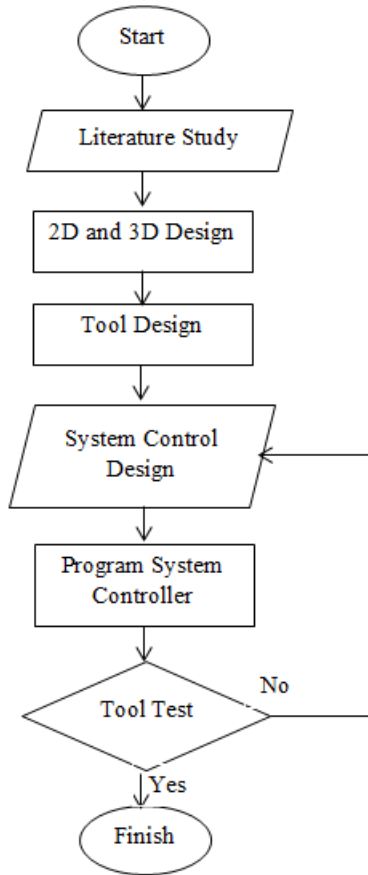


Figure 4: Research Methods

3.2 Mechanical Design

In order for this prototype CNC machine can work well, the design is made by using Autodesk Inventor software. as shown in Figure 5 prototype CNC machine has 3 main parts of X-axis system, Y-axis system and Z-axis system.

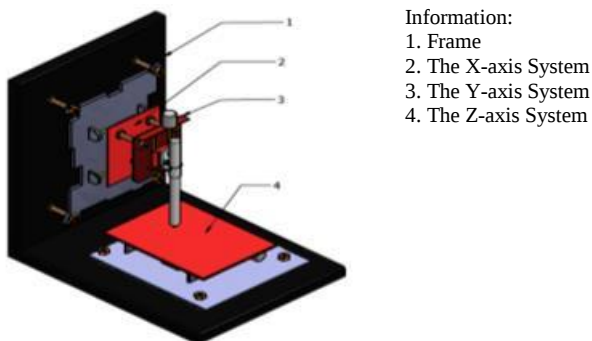


Figure 5: Isometri Inpoten CNC

3.2.1 The X-Axis System

X-axis system is a moving part based on the X-axis that is moving towards the horizontal. This X-axis system is located at the top of the CNC machine prototype as shown in Figure 6.

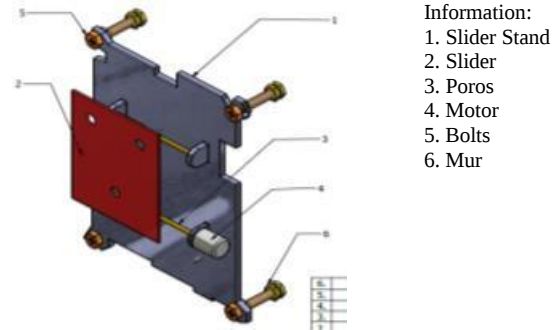


Figure 6: The X-Axis System

This section will be installed with the Y-axis system, because this section serves to move the system Y-axis towards the vertical (top and bottom).

3.2.2 The Y-Axis System

The Y-axis system as shown in Fig. 7 is a moving portion based on the Y-axis. This Y system is located at the top of the CNC Machine Prototype.

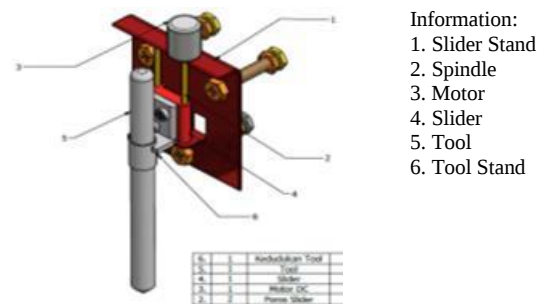


Figure 7: The Y-Axis System

3.2.3 The Z-Axis System

The Z-axis system as in figure 8 is the part where it moves on the Z-axis. The Z-axis system is located on the cross section of the machine where the workpiece is placed. This cross section has a workspace size 42 mm x 42 mm.

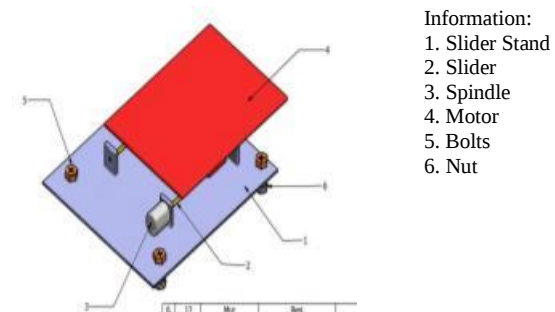


Figure 8: System Z-axis

4.0 RESULTS AND DISCUSSION

4.1 Design Results

This prototype CNC machine is made using personal electronic computer (PC) waste as the main material. The production use components of waste components of this PC component in order to utilize electronic waste into something useful and can be used as a medium of learning.

a. Frame Creation

The CNC frame manufacturing process uses 2 pieces of used components of the personal computer (PC) CD room cover, arranged in accordance with the design drawing and into the system holder X, Y, and Z-axis.



Figure 3: Main Frame

b. System Creation of X,Y and Z-axis.

Movement system on X and Z-axis use stepper motor from CD room, while for movement on Y-axis use stepper motor from floppy.

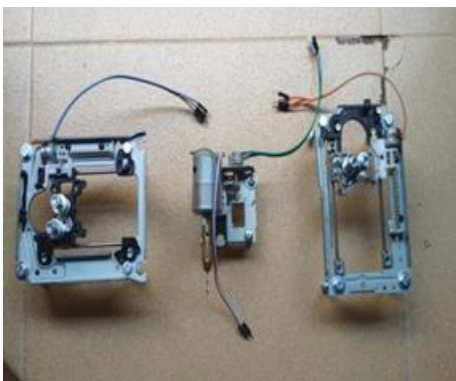


Figure 4: System X, Y and Z-axis.

4.2 Electronic Circuits

In this manufacture of prototypes CNC machine, it is certainly not separated from the existence of electrical system. Therefore, to get the electrical system in accordance with the needs of the design needs to be done. In here includes the design of the installation of power supply, assembling the driver circuit for stepper motors, installation of stepper motors and other supporting components.

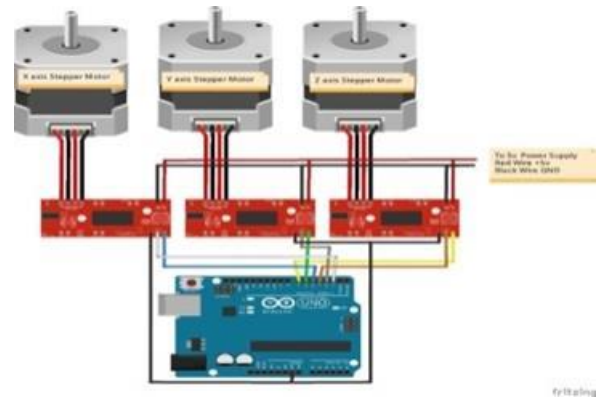


Figure 5: Electronic Circuits

Power supply serves as the source of the voltage required by CNC machine prototypes. The output produced by the power supply is 12V DC. The output power of the supply power is connected with the Arduino so that it can process the program that has been created with G-Code software. The program includes motor driver programming.

The motor driver is used as a rotary controller to be generated by the three stepper motors. Each stepper motor contained in the CNC machine prototype is connected to the motor driver, thus each part of the CNC machine prototype can move according to the design output provided by the GRBL software.

4.3 System Control Software

In this research, we will use 2 software to run CNC machine prototypes in order to run well. Software that is used include:

1. GRBL controller

GRBL controller is a software used to connect or firmware between arduino with G-Code software that will be used. The GRBL controller used is the GRBL controller 351. Do not change the contents of coding contained in GRBL because it can make the program become error and cannot run. GRBL can be shown in Figure 12.

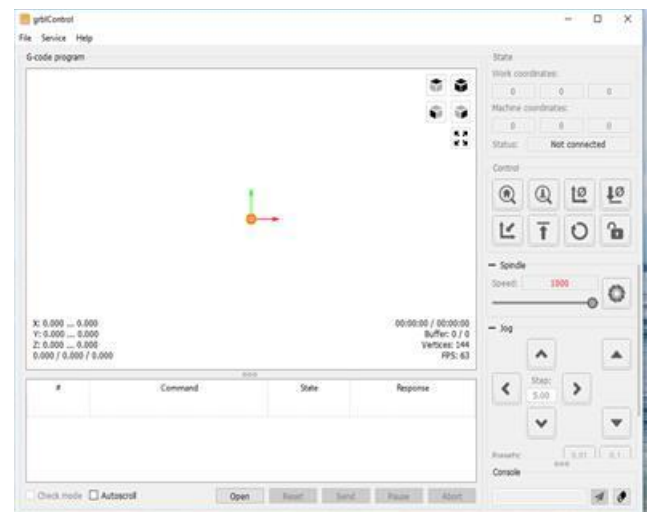


Figure 6: GRBL controller

2. GCAM

GCAM is a very simple and easy to use the software. GCAM is used as the software for drawing 2D or 3D to obtain the numerical code of the created image.

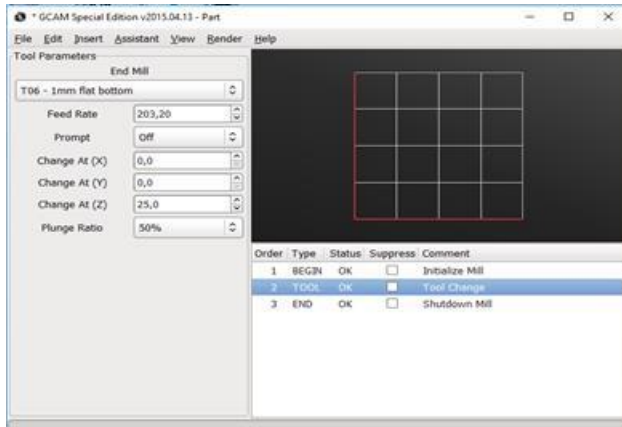


Figure 13: GCAM

5.0 CONCLUSION

The prototype of the numerical control computer (CNC) three-axis machine can be used as a learning media. The manufacture of prototypes of machines that part of its components is taken from former PC components that are not used.

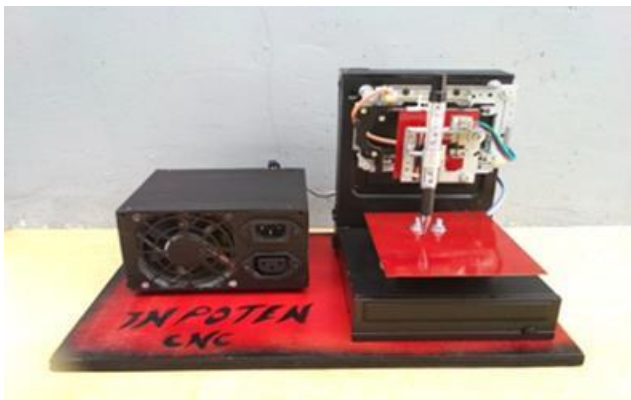


Figure 14: INPOTEN CNC

As a driver, the prototype CNC machine is used stepper motor combined with Arduino UNO Microcontroller based control system. This machine is then operated with a PC using Universal G-Code Sender and GRBL (Coding Gate) based CNC programming system. With a working area of 42 mm x 42 mm and a 17 mm depth of feeding, ultimately this prototype CNC machine can be used as a learning medium for schools that do not have CNC machines due to expensive prices and high maintenance costs.

ACKNOWLEDGEMENTS

The authors would like to present a great appreciation to Directorate General of Learning and Student Affairs of the ministry of research and higher education Indonesia for funding and supporting this Student Creativity program.

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