

Implementation of PCB Layout using CNC Machine Controlling with Wireless Communication

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Abstract - CNC machine are an important part in mass production field. These machines are fast, more precious and compatible. The objective of this project is developed economically three-dimensional CNC machine for PCB laying which can be monitor through Bluetooth (hc-05). The primary province of this CNC machine is to draw the PCB layout and to connect the personal computer with control machine. There has been an increased demand in market for accurate and province CNC machine for PCB layout controlled through Bluetooth. So our mission is to design low cost computerized numerical control for PCB drawing controlled through HC-05. The main aim of this project is to design cost effective systems. The proposal of system based on Arduino microcontroller and also it maintains precision and reliable required for problematic shapes with ninety-eight percent (98%) accuracy.

Keywords: CNC, machine, draw, layout, PCB, Bluetooth.

I. INTRODUCTION

CNC Stands for computer Numerical control its to automated control of machine appliance by which we can draw, cutting, shaping different types of picture provided by a computer using software in to its controller. That is the stored information by the computer. This means the computer convert the design in to numbers, which the computer used to control because information stored in the computer can be read automatically. The code used to program CNC machines is generally called g-code instructions only part of programming language. The first CNC machines were built in the year 1950's and get a move on from punched tape.



Figure 1: CNC prototype

Later CNC forbid for tremendous grow in production for machine tools. Because the CNC machine can be run automatically without need constant regard for this operator. The CNC machine is a manufacturing suitable for wide variety of industries like construction automated field, aerospace, agriculture, mechanical work and able to produce arranges of product such as bike frames, garden barricade and draft work for wooden door.

II. LITERATURE SURVEY

Venkata Krishna pabolu et al. (2010), discuss the design and implementation of low cost three dimensional computerized numerical control system (CNC) for industrial application. In this paper prototyping an Embedded CNC machine was create Detail description of different modules such as software development. Shaikh Noor Farooque et al. (2015), discuss the Automated PCB Drilling Machine with Efficient Path Planning. This paper proposed on the design of a PCB drilling machine, where the drill holes are automatically detected from an image of the circuit eliminating the need to manually enter the drill hole coordinates. The goal of this project was design and implement an Arduino controlled PCB drilling machine. Further the drilling machine uses path planning method which is used to make the system more stable and accurate. Muhammad Yaqoob Javed, et al. (2015), discuss the Low Cost Computer Numeric Controller Using Open Source Software and Hardware. This paper proposed on the exhibit the plane and creation of Laser fuelled 3-pivot PC numerically controlled CNC machine. which contain the utilized of a graphical UI [GUI] and Arduino small scale controlled to delivered beat width tweak [pwd] yields keeping in mind the end goal to run the stepper engines that will be utilized as a part of this slog have vigorously increment an enthusiasm in future investigations on the outline of body arrangement that can holds an electrical and electronic stage with a cooling framework consequently in this venture the temperature of stepper engines and simple drivers in expanding following a hour and a half of running condition while cooling would build unwavering quality term execution. Anisha Cotta et al. (2016), discuss the wireless communication using hc-05

Bluetooth element interfaced with arduino. This paper discusses the wireless communication victimization the Hc-05 Bluetooth element, the Bluetooth topology and interfacing Bluetooth with arduino. Wireless communication technology refers to a ramification of wireless communication devices and technologies raging from smart phones to computers, tabs, laptop, Bluetooth Technology, printers.

III. PROPOSED METHOD

Fig.2 shows the proposed design and implementation of PCB layout using CNC machine with control Bluetooth (hc-05) through mobile phone.

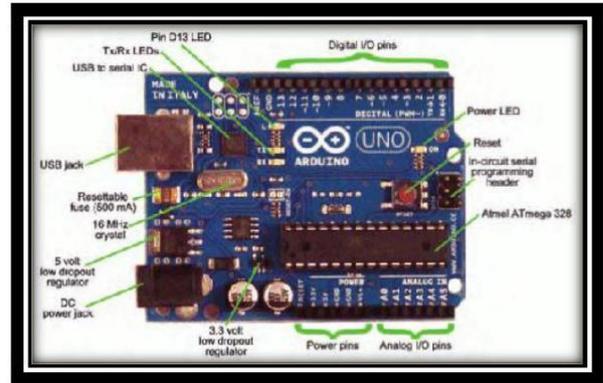


Figure 3: Arduino Uno (refer to slideshare)

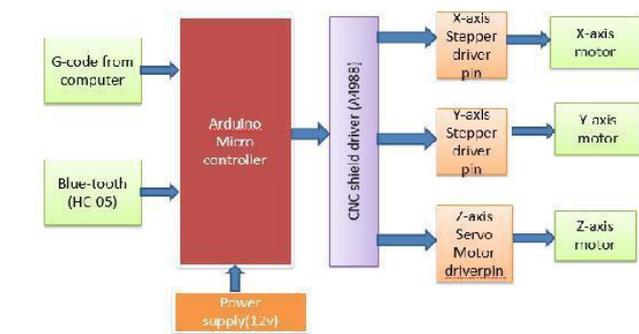


Figure 2: Block diagram

In this method design and implementation of PCB laying using CNC machine control with Bluetooth. Arduino uno (microcontroller) core forum is used in this project. It can be freely interfaced with mobile phone (or computer), driver, stepper motor and servo motor as well. However Bluetooth module used for wireless communication to CNC machine controlled through phone.

The arduino microcontroller necessity for 12volt power supply. The program of Grbl library will be uploaded to the Arduino ide software. Then generate the G-code file on inkscape software. When generate G-code file send in to the arduino and motor driver (CNC shield A4988). The driving circuit is to control the mechanical design and to convey through Grbl software with the computer (or mobile app). The CNC machine is a machine where a system controls the individual axes of machine through motor.

3.1 Arduino Uno Microcontroller

The microcontroller is the brain of our CNC machine. Almost all CNC machine controlled are various controller. In this project based on Arduino microcontroller because it is the most popular board in arduino board family.

The controller is an open-source electronics tribune established on effortless to access hardware and software. In case of the controller is an arduino uno over with an extra board called “shield”.

3.2 Servo Motor (Tower PRO SG90 9G Micro)

The servo motor could be a linear actuator or positioner. It is regulate through the signal wire by transmit a changing with pulse width modulation. There is a minimum and maximum pulse and frequency of repetition. The servo has uniform amount of potential spindle in both clock and anti-clockwise direction. The servo motor placed in to coordinates on Z-axis for up and down gesture of pen (or like marker, bit, laser, drill) through the machine.

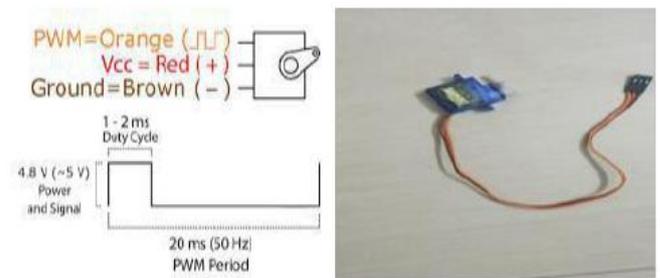


Figure 4: Servo motor and duty cycle

Servo motor connector wire is represent by signal (yellow), +5 volt (Red), ground (Brown) and the maximum voltage fed into the 5 – 6 volt. The speed of the servo motor is 0.1 seconds and torque 2.5 kg-cm.

3.3 NEMA 17 Stepper Motor

A stepper motor stands for “step motor”. It is type of brushless DC electric motor. It is always rotate in discrete steps instead of continuous rotation and provide precise control from motor. They are different type of stepper motor like permanent magnet stepper motor, variable reluctance stepper motor and hybrid synchronous stepper motor. In this

project, we are used in hybrid synchronous stepper motor. The nema 17 is correspondent of common stepper motor. Nema 17 face plate in 17 * 17 inch and it has high torque than other stepper motor. The nema 17 stepper motor has six lead wires, deserve voltage is 12V. It could be work at a minimum voltage, motor does not rotate and torque will drop. It has a step angle 1.8deg in every steps. The motor has a unipolar six wire pattern.

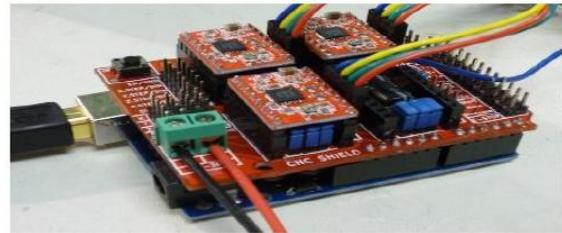


Figure 6: CNC shield and A4899 driver

The CNC shield driver are interfacing three motor. The handle of CNC shield is simple and cost effective. Below the table refer to the micro stepping of driver. The table 1 represent for micro stepping operation.

3.5 Bluetooth (HC-05)

The Bluetooth module (HC-05) plays for arduino engaging laptop or computer. HC-05 is Wireless LAN technology used in serial port protocol (SPP). The transmitting and receiving data rate of up to 1Mbps. The Bluetooth connection could be point to point or multipoint communication where transfer range is less than 100m and frequency range is 2.45GHZ. This module used in a master or slave configuration. Which means necessitate either operation perform in HC-05 module and computer.



Figure 5: Stepper motor and wiring

These six wires are split into two winding. Due to three color of wire in one winding like black is center tap and other green, yellow are coil winding end, while Red, blue are second coil winding and white is center tap. Then center tap wire is disconnected from motor. The maximum operating temperature is 80 degree Celsius.

3.4 CNC Shield Driver (A4988)

The CNC driver is a heart of our CNC machine. The motor controller is a devices that tend to preside in some predestined manner the achievement of an electric motor. In this project, we are taking from A4988 driver is DMOS micro stepping driver with restate and over current protection are mainly used from the driver. It is developed by allegro micro systems. The driver has a maximum output capacity of 35V and current is 2A. Which is proficient for driving small to mid-size stepper motor like nema 17, nema 14. The current rate of A4899 driver is 3.5A and low cost. The CNC shield is easy to interface from arduino microcontroller. The shield controller is manual or automatic control to select and regulating for start, stop, forward rotation, reverse rotation of the nema 17 stepper motor, regulate and limit torque. It is protecting against overload and electrical fault.

TABLE 1
Micro stepping revolution

MS1	MS2	MS3	Micro step Revolution
Low	Low	Low	Full step
High	Low	Low	Half step
Low	High	Low	Quarter step
High	High	Low	Eighth step
High	High	High	Sixteenth step

TABLE 2
Parameters and specification

Parameters	Specification
Operating voltage	4V to 6V (Typically +5V)
Operating current	30 mA
Range	Maximum 10m
Frequency	2.45 GHZ
Pin 1	State
Pin 2	Receiver
Pin 3	Transmitter
Pin 4, 5	Vin and ground
Pin 6	Enable

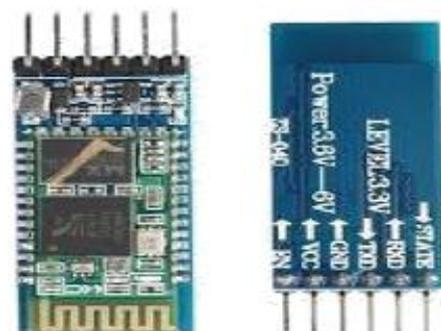


Figure7: Bluetooth module

In this project, Due to master is mobile or laptop sending data to slave HC-05 module which is connected to the microcontroller then controller executes the instructions received from master (laptop or smartphone) which result in CNC machine with control mobile phone. The table 2 represent by pin 1, 2, 3, 4, 5, 6 and state, receiver, transmitter, Vref, ground, enable respectively.

IV. ARCHITECTURE (SOFTWARE)

4.1 Algorithm

- Get input data of PCB diagram or (Required diagram)
- Convert normal files to g-code
- Change input data into machine readable language of coordinates that is send into Arduino board (At mega 328P)
- Serial convey between pc (or mobile) and controller
- Coordination and position of servo and stepper motor through driver controller
- Keeping initial parameter values by initial position value of two stepper motor
- Grbl software used to control the servo motor angle and generate g-code
- Finally draw on the printed circuit board

4.2 Flowchart

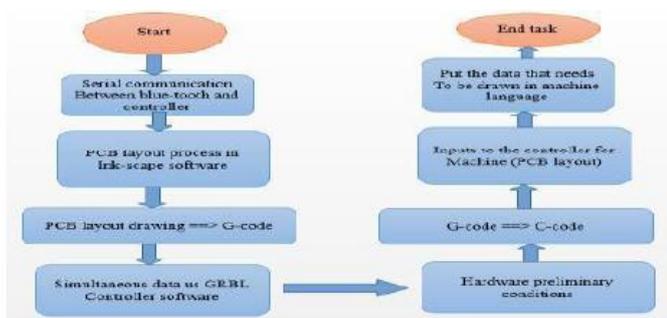


Figure 8: Software Flowchart

V. ARCHITECTURE (HARDWARE)

The simple instruction of G-code command convert to fed on compiler through arduino are provided to the CNC machine. We have interfaced the stepper motor to CNC Shield driver (A4988). The output of the one and all stepper and servo motor driver connected to driver are specific to the respective stepper motor. Due to X-axis stepper motor rotate the required step pulse, the aluminum plate for desire size moves forward and backward side. Due to y-axis stepper motor, the axis of move front and back direction. Due to Z-

axis servomotor, the pen (or like drill, laser) up and down help of servo motor.



Figure 9: Hardware setup

The depth to the pivot is equipped by the Z-axis servo motor. The axis desire to PCB laying on pens, which sketch the actual circuit image in Printed circuit board.

VI. RESULT AND DISCUSSION

Ensuing design and implementing the project, we assure a tendency to acquired result. We make an aptness to control Bluetooth module for build the wireless CNC machine. This machine mainly focused to automatically laying on the PCB board. The output of the project achieving nearly 98 percent.

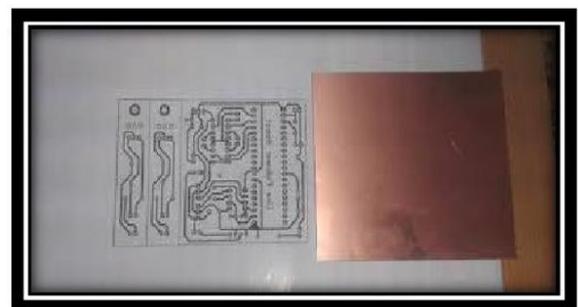


Figure 10: Output image

Table 3 shows the performance analysis of proposed method in terms of elapsed time. The proposed method achieves elapsed time 6.075 minutes.

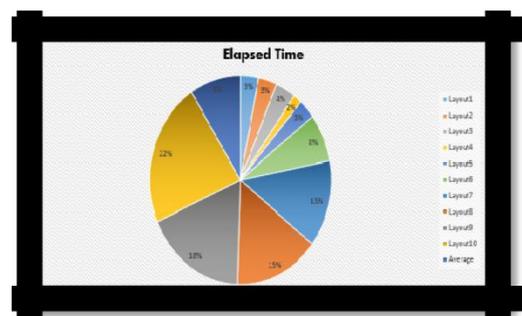


Figure 11: graphical representation of proposed method with respect to elapsed time

TABLE 3
Elapsed time analysis

Circuits	Elapsed time (minute)
Layout 1	2.15
Layout 2	2.2
Layout 3	2.4
Layout 4	1
Layout 5	2
Layout 6	5
Layout 7	9
Layout 8	10
Layout 9	12
Layout 10	15
Average	6.075

Table 4 shows the performance analysis of proposed method in terms of error rate. The proposed method achieves error rate .116%.

TABLE 4
Error rate analysis

Circuits	Error rate (%)
Layout 1	0.02
Layout 2	0.03
Layout 3	0.04
Layout 4	0.08
Layout 5	0.1
Layout 6	0.14
Layout 7	0.15
Layout 8	0.18
Layout 9	0.19
Layout 10	0.23
Average	0.116



Figure 12: graphical representation of proposed method with respect to error rate

TABLE 5
Comparison of proposed method in elapsed time and error rate

Methodology	Elapsed time(min)	Error rate (%)
Proposed method(2020)	2	2
Ghulam dastgeer (2018)	5	4
Shani ranian (2018)	10	5
Mukul gyota (2018)	15	6
Anis hacoatta (2016)	20	7
Average	10.4	5

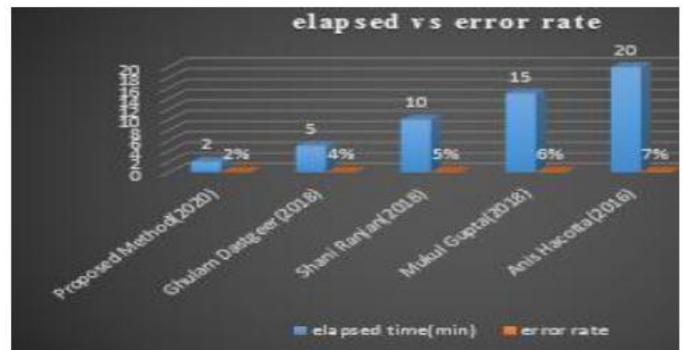


Figure 13: graphical representation of comparison of other proposed methods with respect to elapsed time and error rate

Table 5 shows the performance analysis of proposed method and other reference proposed method in terms of elapsed time and error rate. The proposed method achieves elapsed time 10.4 and error rate 5%.

VII. CONCLUSION

We analysis various group of CNC machine, it is purpose and demand of the manufacturing industries. We develop G-code of printed circuit design using inkscape software and operate on GRBL controller software. Automatic CNC machine is developed for PCB laying controlled with Bluetooth using arduino microcontroller for economically. This proposed method achieves 98% of accuracy.

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