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Design and Implementation of PCB Using CNC

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Abstract – *Sometime for make PCB, we required more time for designing, printing, etching as well as drilling. Therefore to reduce time and more effort we are design this project. In this paper, the design of a PCB milling and drilling machine, where the drill holes and the layout are automatically find out from an image of the circuit in EAGLE software. This paper focuses on the design and implementation of automatic PCB milling and drilling machine using ARDUINO UNO. Further the drilling machine uses path planning through co-ordinate measurement machine method which is used to make the system more stable and accurate.*

Key Words: CNC, Arduino controller, G-code, PCB, Drill machine, etc.

1. INTRODUCTION

CNC Machine is a generally used in the manufacturing sector that involves the use of computers to control machine tools. Tools that can be controlled in this manner include milling, and drilling. The CNC stands for Computer Numerical Control. From this CNC technology, the biggest change in the world of digital electronics & Micro-controller, we are presenting here an idea of CNC bit plotter using ARDUINO UNO. The idea behind this project is to make a small CNC machine which can draw images or pictures on surface which can be a paper or anything. It uses three stepper motors as linear actuators on each axis X, Y & Z. While printing, the proper synchronization of this entire three axis i.e. stepper motors, is most challenging task. At present the data to draw is given programmatically i.e. hardcoded in program in binary format. A bit touches the surface & prints the pixel for logic 1 and lifts up in air for logic 0 & actuator changes it position for next commands execution. As in future plan, it can access the G-Code directly from supporting software like in scale. Presented plotter is one dimensional 1D plotter.

1.1 Design Idea

The PCB is placed to this system then it is drilled automatically through path planning. The PC provides X, Y, Z co-ordinates and by using the pc software read the file which is generated by the PCB design software. Another system uses the basic 8051 microcontroller and drilling driver are designed by relays makes system bulky and does not provide high amount of current in order to drive the motor exactly. Another method uses microcontroller the c programming. The system consists of three 3 stepper motor and one AC motor to control drill. Thus due this the system is complicated and system becomes instable. The proposed project does not use the path planning method. Further the automatic PCB drilling machine uses a path planning algorithm, which is capable of estimating an exact traversing path for the drill bit. The path planning algorithm optimizes the use of the motors and other mechanical paths involved in the process while reducing total time taken to cross all the drill holes. In this project, the developed software takes the position of the drill hole. Than it calculates the previous and current co-ordinate and sends the coordinate information Microcontroller unit over USB cable. Stepper motors move on the basis of co-ordinate information to accomplish the drilling of the PCB..[1]

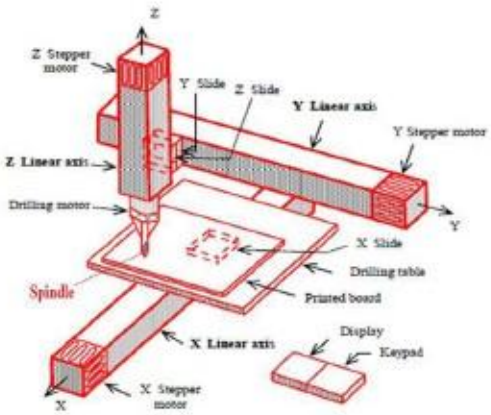


Fig.1 General Structure

1.2 Literature Review

Micromachining operations play an important role in precision production industries. Out of the various machining processes, micro-drilling is used to produce micro holes in fuel injectors, printed circuit board, aerospace materials etc. So in order to achieve the optimum working conditions various research were conducted by different researchers from across the globe. This report reviews some of the journal published by them regarding optimization processes.
Yogendra Tyagi, Vadansh Chaturvedi and Jyoti Vimal [2] have conducted an experiment on drilling of mild steel, and

applied the taguchi methods for determining the optimum parameters condition for the machining process using the taguchi methods and analysis of variance. The work piece used is mild steel (100mm×76mm×12mm) and the tool used is HSS with a point angle of 118° and diameter of 10 mm. Taguchi L9 orthogonal arrays is used here in order to plan the experiment. The input parameters are feed rate, depth of cut and spindle speed whereas the output responses are surface roughness and metal removal rate (MRR).In case of signal to noise ratio calculation, larger the better characteristics is used for calculation of S/N ratio for metal removal rate and nominal and small the better characteristics is used for the calculation of S/N ratio for surface roughness. After the analysis of the data obtained it is found that MRR is affected mostly by feed. Confirmation experiment was conducted using the data obtained from S/N ratio graphs and it confirmed with the results of taguchi methodology. In case of surface roughness analysis same procedure was followed where the significant parameter was found to be the spindle speed. Here too the confirmation experiment was conducted and this confirms the successful implementation of taguchi methods.

Timur Canel,A. Ugur Kaya,Bekir Celik [3] studied the laser drilling on PVC material in order to increase the quality of the cavity. Taguchi optimization methods were used to obtain the optimum parameters. The material used in the experimental setup is PVC samples with dimensions of 5mm×85mm×4.5mm. Surelite Continuum Laser is used to form the cavities. The input parameters are wavelength, fluence and frequency and the output response are aspect ratio, circularity and heat affected zone. Taguchi L9 orthogonal array is used to find the signal to noise ratio. Smaller the better characteristics are used for HAZ, larger the better characteristic is used for aspect ratio and nominal the better characteristic is used for circularity. Variance analysis is performed using Project Report 2013 the calculated S/N ratio to conclude optimum stage. It is found that most effective parameter for aspect ratio is frequency, second is wavelength and last is flounce. For circularity it is found that the most effective parameter is wavelength, flounce and frequency. For HAZ it is found that the most effective parameter is wavelength, second is frequency and last is flounce. The experimental results are compatible with Taguchi method with 93% rate.

Thiren G. Pokar,Prof. V. D. Patel[4] used grey based taguchi method to determine the optimum micro drilling process parameters.[5]

2. PROPOSED METHOD

In this paper, ARDUINO UNO board uses ATMEGA 328 microcontroller. It can be easily interfaced with PC and also it can be used as drivers to drive stepper motors.

The basic block diagram is as shown in Fig.2 The explanation of all parameter is as follows:[6]

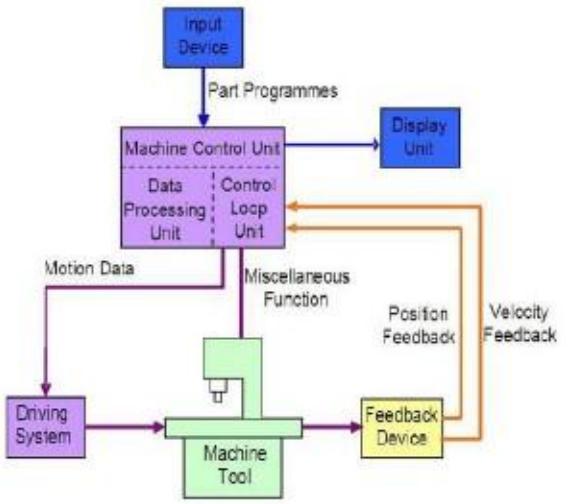


Fig -2: Block diagram

2.1 Arduino

Fig. 3 Arduino Uno Board

For this project, the Arduino Uno is used to control the stepper motor and initialize sensor. Arduino Uno is a microcontroller board based on Atmega328. The Arduino Uno was chooses rather than other Arduino such as Arduino Diecimila and early Duemilanove because it use Atmega328 which is suitable to control stepper motor. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

2.2 G code from PC

G code is nothing but a language in which people tell computerized machine tools 'How to make something'. The

How is defined by instructions on where to move, how fast to move, & through what path to move.

2.3 ATmega 328 Controller

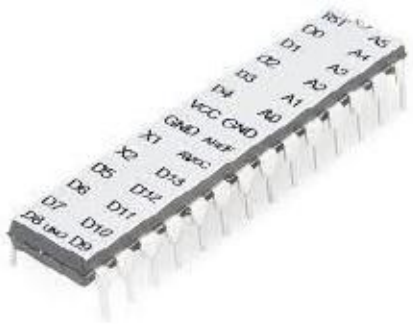


Fig -4: Pin out of ATmega328

This system uses Arduino controller platform with ATMEGA 328 core. The ATMEGA 328 is a single chip controller which is created by Atmel and it belongs to MEGA AVR series. It is 28 pin IC and it is of 8 bit. It is based on RISC (Reduced Instruction Set Computer) architecture. It has 26 I/O pins, 32 working registers, 32Kb of flash memory, 2Kb RAM and 1Kb EEPROM. The maximum operating frequency of ATMEGA 328 is 20 MHz It has external and internal interrupts. Each pin of microcontroller provides 5 Volts, 40mA current. It has 16 digital and 8 analog channels. If we want more than 16 digital channels then we can convert the analog channels to digital channels by using in build ADC by writing the proper code.

3. METHODOLOGY

This paper analyzes hardware and software implementation of a CNC to drawn PCB layout and drill holes. The system consists of a electro-mechanical setup of that can move in X, Y and Z directions, a computer, a driving stepper motor and a software program. The driving circuit is developed to control the mechanical setup as well as to communicate with the computer through software. The software program is developed to control overall operation of the machine. In this initial work, we have design PCB layout designing to demonstrate that the machine can produce a trace line on a single layer PCB board and drill holes on both ends of the trace line.
The mechanical setup has a flat layer on X-axis where PCB is put on it for further process. Above the X-axis, there is a drill that can move along Y and Z axis. The drill can also move up and down for a specified amount of distance through Z-axis. There is a bit connected to the bottom of the drill for milling and drilling. Both layout and holes are produced using this bit. To produce a trace line on a single layer PCB. We then send start coordinate of a trace line to the arduino uno board. Upon receiving this signal, arduino uno board moves the drill to the location of coordinate. During this movement, the drill is at up position. When the drill receives the specified location, PCB machine puts the drill at down position, starts drilling and move continuously according to the coordinates sent from computer. The coordinates have to belong to edges of a trace line that is to be drawn.
Hence the trace line is separated from the remaining part of the copper on the PCB when the process is completed. In order to drill a hole on the same PCB, we let the machine to finish up the tracing, and then readjust. After that, we specify coordinates and let the drill go to those positions and perform drilling one at a time.

4. HARDWARE DESIGN

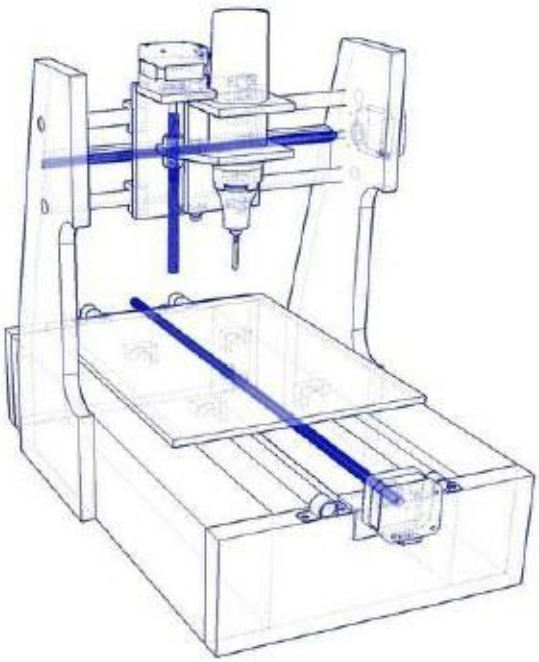
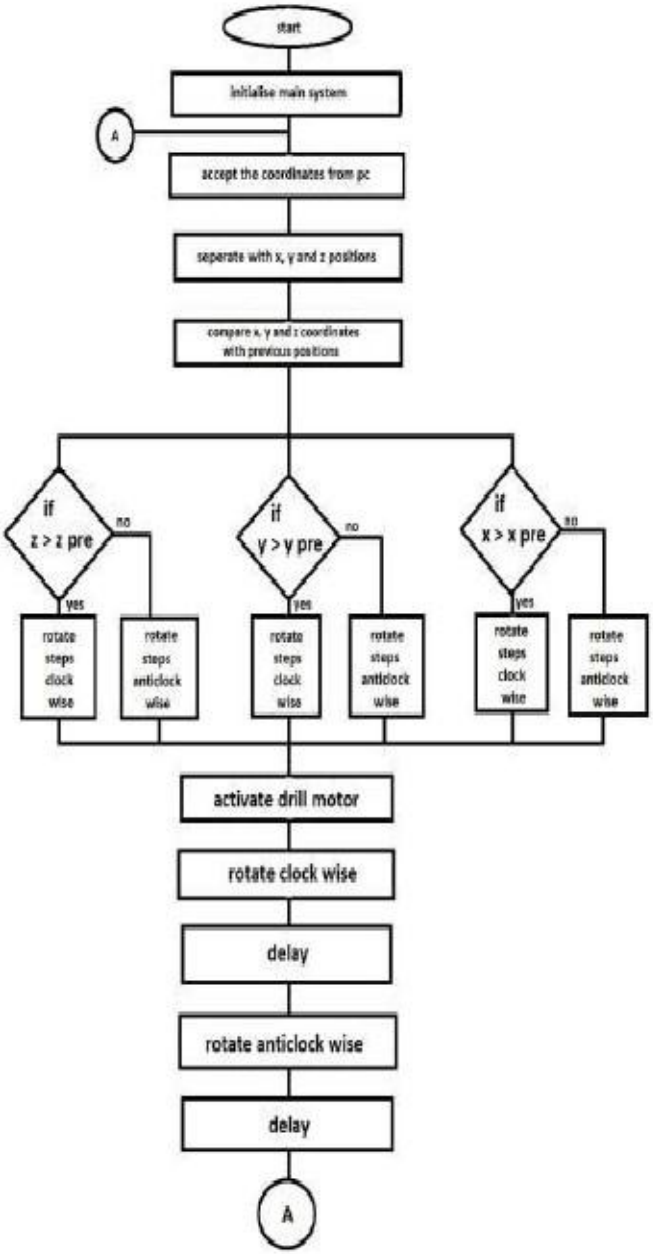


Fig -5: Project Hardware design

4.1WORKING

The machine designed based on co-ordinate measurement machine, therefore the machines have designed with three coordinate, X, Y and Z as shows in Fig. The PCB is moved along the X and Y axis and Z co-ordinate is used to move the drill machines up and down. Then withdrawn and translated to another place. Drill co-ordinates are extracted using ARDUINO UNO.
Working of our project is described in term of flow chart are as follows: [7]



5. RESULT

Thus, by using ARDUINO UNO and PCB making software we are designing PCB from layout milling and drilling according to on PCB layout

6. CONCLUSIONS

By using this setup with a combination of Eagle software, G-code arduino software for smooth operation and give better accuracy for design PCB. This setup is used to reduce the process of etching and drilling. G-code makes position from layout design to move with proper position. Whenever require to start and stop whole process will depend on you. By using arduino uno board, the setup is flexible and reduce work load for make Printed Circuit Board (PCB).

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