

Automated Pcb Drilling Machine With Efficient Path Planning

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Abstract: This paper presents 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 is to 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.

Keywords: CNC, NC, PCB, PLC.

I. INTRODUCTION

Making a PCB is an involving process that those who are involved in electronic circuit manufacture have to go through. Not least among its many tasks is the act of drilling the PCB holes which needs both precision and patience. Often, the repetitiveness of the task can lead to countless frustrations among the laborers particularly the beginners. Further, the time taken to drill a PCB can have a significant effect on the production efficiency in mass scale production. Therefore the main goal of this project was to enable beginners in the field to use an automated PCB drilling machine with path planning capability to complete the job efficiently. Nowadays specially in large scale industries the NC and CNC machines are used to in order to drill the PCB hole but such type of machines cannot be preferred by the small scale industries . The aim of this project is to develop a low cost PCB drilling machine such that it can be preferred by the small scale industries and can be helpful to avoid the workload of human. So such kind of project motivates us to develop low cost drilling machine such that it would provide benefits to the laborers as well as the industries. Hence such type of project implementation will be helpful to avoid the use of high cost CNC Machine.

II. PROBLEM STATEMENT

This paper discusses the development of automatic drilling machine for PCB. After etching process, the PCB is placed to this system then it is drilled automatically. The same system has been made but the controller is PC and it uses the pc software to read the text file which is generated by the PCB design software [1]. Another system uses the basic 8051 microcontroller and drilling driver which is designed by relays makes system bulky and does not provide high amount of current in order to drive the motor properly [2].The another method uses microcontroller , the c programming and Vb.net as software. The system consist of three 3 stepper motor and one AC motor for controlling drill . Thus these leads to complication in the system and system become instable[3] The proposed project does not use the path planning method. Further the drilling machine uses a path planning algorithm, which is

capable of estimating an efficient traversing path for the drill bit minimizing the length of travel. The path planning algorithm optimizes the use of the motors and other mechanical paths involved in the process while reducing total time taken to traverse all the drill holes. In this project, the developed software takes the drill hole position of the PCB. Than it calculates the necessary parameters and sends the coordinate information to Arduino board AVR microcontroller unit (MCU) over USB cable. Stepper motors move the mechanism to accomplish the drilling of the PCB.

III. SOFTWARE DESIGN

The design and implementation of these project is divided into two parts hardware design and software design . The main challenges of this project were path planning and obtaining the drill hole coordinates from a PCB layout. We used the MATLAB to write the program and the EAGLE PCB layout development software was used to design the PCB schematic.

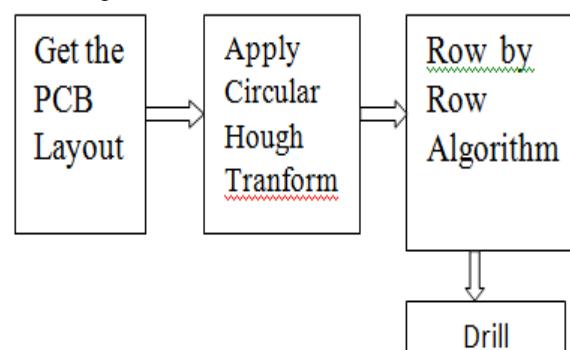


Fig.1. Sequence of obtaining the drill coordinates

A. GET THE PCB LAYOUT

In these propose method the first step in the block diagram is getting the PCB layout. This is simply done by getting an image of the drill plot using a web camera or as a bitmap image produced by the PCB design software. A simple enough task for a beginner in PCB designing as is our goal.

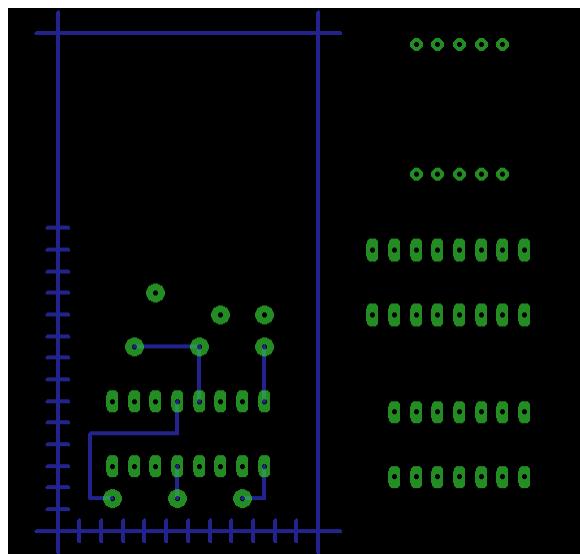


Fig.2. Original pcb layout

B. EXTRACTING THE DRILL COORDINATES

Once the image is obtained it is loaded into the MATLAB program which will extract the coordinates for plotting. The logic used is to find all the connected points using the circular hough transform and then to find the centroids of each point as the point of drilling. The Hough transform (HT) can be used to detect lines, circles or other parametric curves.

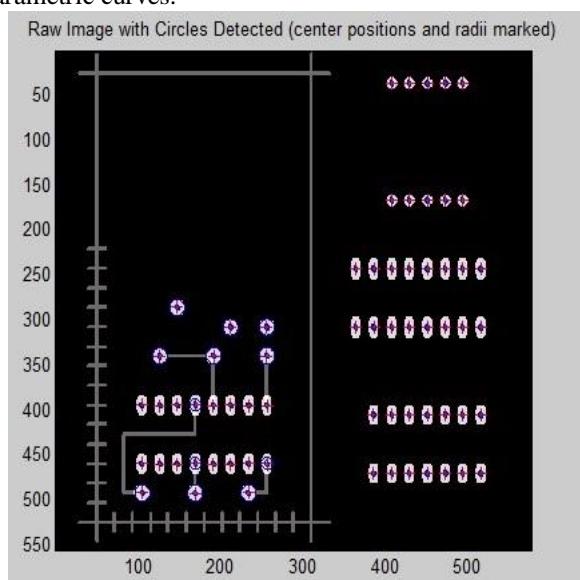


Fig.3. Image with circles detected

C. ROW BY ROW SCANNING METHOD

In this algorithm the pointer moves up along the y axis keeping the x coordinate zero from the smallest y coordinate in the array up to the largest. As it reaches each y coordinate the pointer will move along the x axis keeping the y coordinate constant until it reaches each point corresponding to that y coordinate. It will then return back to the y axis after it has covered all the points having that particular y coordinate. In this way the pointer will reach each point by moving sequential up the y axis and along the x axis much like a type writer

IV. HARDWARE DESIGN

The system is controlled by using Arduino Uno board in order to achieve the control over the movement axis. Several motor drivers are made, two for stepper motor (X- and Y-axis), one for DC motor (Z-axis) and one for the drill. The drivers use optocoupler to isolate the digital system from the analog one.

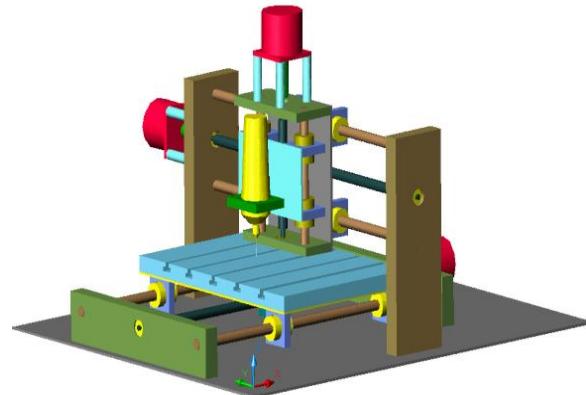


Fig.4. Proposed model of system

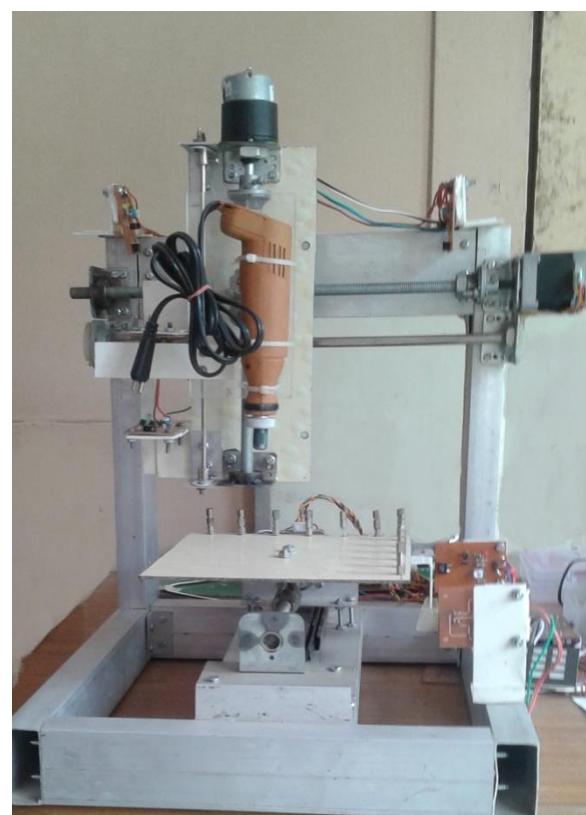


Fig.5. Hardware setup

The machine has been designed with three movements coordinate, X, Y and Z as shown in Fig. 5. Hole position consists of X-Y coordinates, and Z coordinate is a parameter to move the drill machine up and down. The drill is moved horizontally to X-Y coordinates of a hole, moved down in Z direction to make the hole, then withdrawn and translated to another place. Drill coordinates are extracted using matlab and sent to arduino uno board.

A. CONTROLLER SECTION

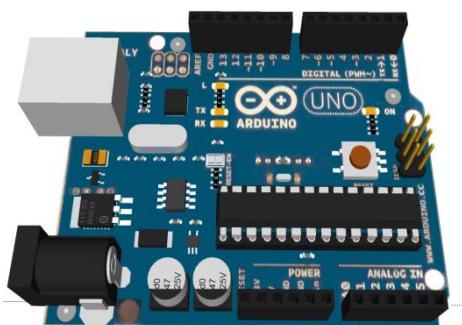


Fig.6. Arduino Uno Board

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 chosen rather than other Arduino such as Arduino Diecimila and early Duemilanove because it uses 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.

V. INNOVATIVE AND USEFULNESS

The purpose of implementing this project is to avoid the use of CNC machine and robotics arms. The machine implemented by another method needs knowledge of making PCB drilling machine. Thus by using the concept of mechanical system and electronics it would not be possible. Hence in order to achieve more effective results, Optimization system and path planning method is required in drilling machine. Row by Row scanning method used to make the project in more efficient and systematic way. The usefulness of such type is to provide cost effective manufacturing process to the small scale industries for the development of the products. Hence such type of system can also be applied to certain learning institutions. Errors that might occur in manual drilling are totally eliminated with the 3-axis precise control of the drill head movements. So, drill bit positioning on a pad or breaking of tools is no more a problem. In addition, PCBs can be drilled with this machine before the etching process. This provides smooth drill faces causing better solderability on the final PCBs. Also with the help of a chemical process, this system can be used to produce two-sided and through-hole plated printed circuit boards. Therefore the main goal of this project was to enable beginners in the field to use an automated PCB drilling machine with path planning capability to complete the job efficiently.

VI. COMPARATIVE ADVANTAGE

Thus these project will fully eliminate the workload of the worker often, the repetitiveness of the task can lead to countless frustrations among the laborers particularly the beginners. Hence it can be achieved in small scale

industries and medium scale industries. It can also be used in teaching institutes where actually the design and manufacturing process of PCB are taught to them.

Thus the advantage of implementing such type of system was used in overcome the NC and CNC machine used in the industrial areas in order to decrease the cost for mass production of the product. It is also advantageous thereby replacing the Robotic Arms used in certain large scale industries. Certain kind of complexity in the system can be avoided. Thus it also reduces the cost of equipment that is used by the industries for their mass production.

VII. FUTURE SCOPE

The PCB Drilling Machine can be replaced the high cost CNC and NC machines in order to reduce the cost for mass production. Thus by using the path planning the machine drills in a more systematic way. Hence further development can be made in future in order to achieve more accuracy.

In the future,

- Current system can be improved to reach higher axis speeds.
- Variable spindle speed control mechanism can be easily incorporated to the system.
- The developed system can be built up for milling PCBs.

VIII. CONCLUSION

This setup of hardware with a combination of MATLAB gives better accuracy and reduce the tolerance. In addition to that the use of MATLAB makes it easy to get the information of holes (position of holes with respect to X & Y coordinates).

REFERENCE

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