

## PCB Design Machine

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**Abstract :** Printed circuit board (PCB) is the most essential part of every electronic instrument that we use in daily life, be it on any industrial or student level. The machines used in industries for production of PCBs are costly and bulky. In consideration with the Computer Numerical Control (CNC) machine technology used in today's world, we aim to construct portable and cost efficient PCB design machine. This machine automatically draws circuit on the PCB as well as drills it with ease.

**Keywords:** Computer Numerical Control(CNC), G-code, Inkscape, MATLAB, Universal Gcode Sender(UGS)

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### I. Introduction

In today's world, the science and technology is growing rapidly with new inventions, innovations and with advance level of their implementations. These advance technologies can be related to the automation of the huge loaded CNC machines in the industrial section. PCB is the heart of any electronic device. Hence, in contribution with this innovation, the PCB Design Machine idea was proposed. To automate the process of PCB design, the PCB design machine is been used. The PCB design machine is a cartesian XY plotter with two stepper motors for the X and Y axis motion. These motors control the planar motion whereas the Z axis motion is controlled by the servo motor. Hence we obtain the three dimensional motion in the machine. Arduino is used to control the motion of stepper motors and servo motor.

The paths are drawn on zero PCB with the help of Inkscape software. Inkscape is open-source software. It converts the image into G-code file. G-code is a programming language that instructs the machine where and how to move. The G-code file is then uploaded into arduino with the help of Universal Gcode Sender (UGS). With CAMotics, we can simulate 3-axis G-Code programs for CNCs and visualize the results in 3D. CAMotics software is used to verify whether the G-code obtained from Inkscape is able to plot the circuit or not.

Once the circuit gets plotted on PCB, the drilling is done by using MATLAB (Matrix Laboratory) software. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs [6]. The output of the MATLAB is then given to the Inkscape and processed similarly as that done during the plotting.

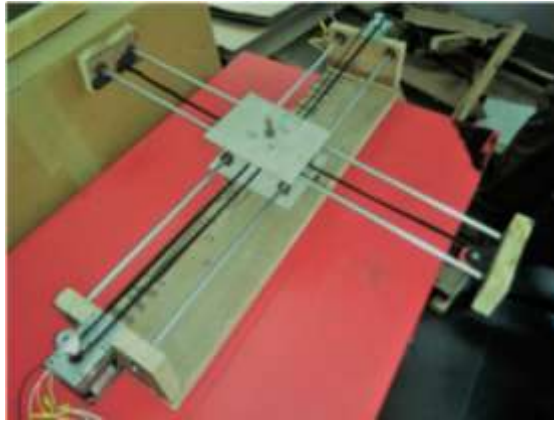
### II. Literature Review

CNC stands for Computer Numerical Control. For CNC machines, computers are used to control machine tools in the manufacturing sector. The usage & utilization of CNC machine in industries are increased due to the rapid growth of technology. In order to reduce cost and complexity of machine, a low cost CNC machine is being implemented. In consideration with this CNC technology and revolutionary change in the world of automation and digital electronics, the idea of CNC based PCB design machine is proposed.

This project aims at making a small PCB design machine which can draw circuit design path on zero PCB and also it can draw any kind of design on the 2D surface. It uses two stepper motors and one servo motor as linear actuators on each X, Y & Z axis for drawing and drilling with proper synchronization of all this three axis. It uses the G-Code directly from supporting software like inkscape.

The G-code interfaced with Arduino converts the code in convenient controller code i.e. serial to USB converter. Hence it interfaces PC and the Controller. This code is further passed to stepper motor by easy drivers and as per instructions the stepper motors moves and plot the circuit path and drill it. So the main objective is to develop a low cost automatic CNC machine for PCB drawing and drilling.

### III. Model

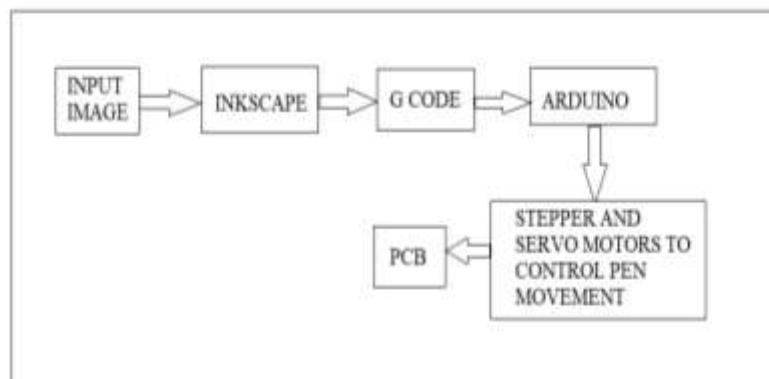


**Fig. I** Mechanical Structure

Figure I shows the mechanical structure of PCB design machine.

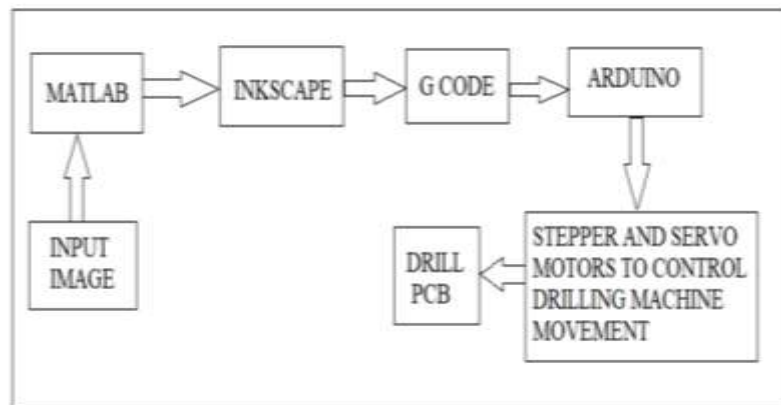
### IV. Methodology

Fig. II shows the block diagram of PCB drilling machine. Circuit paths are drawn on zero PCB with the help of Inkscape software. The circuit which is to be plot on PCB is imported into Inkscape software. It converts the image into G-code. G-code is a programming language that instructs the machine where and how to move. The G-code file is then uploaded into arduino with the help of Universal Gcode Sender. The arduino controls the stepper and servo motor. Stepper motors are used to control the movement in x-y direction. Servo motor controls the movement of pen or drilling machine. Once the circuit gets plotted on PCB, pen is replaced by the drilling machine.



**Fig. II** PCB Plotting

Fig. III shows the block diagram of PCB drilling. Drilling is done by using MATLAB software. The code is written into MATLAB for detecting the holes. The output image of the MATLAB is then given to the Inkscape software. Inkscape software converts the image into G-code. This code drives the movement of stepper and servo motor. Servo motor controls the drilling machine.



**Fig. III** PCB Drilling

### V. Advantages

- Less skilled/trained people can operate CNCs unlike manual lathes / milling machines etc. which need skilled engineers [7].
- Modern design software allows the designer to simulate the manufacture of his/her idea. There is no need to make a prototype or a model. This saves time and money [7].
- One person can supervise many CNC machines, as once they are programmed they can usually be left to work by themselves. Sometimes, only the cutting tools need replacing occasionally [7].

### VI. Disadvantages

- CNC machines are more expensive than manually operated machines, although costs are slowly coming down [7].
- Fewer workers are required to operate CNC machines compared to manually operated machines. Investment in CNC machines can lead to unemployment [7].

### VII. Future Scope

The pen of the machine can be replaced by a laser to make it work like a laser engraving or cutting machine. Engraving machine can be used on wood [1]. The servo can be replaced by stepper motor and the pen with the 3D pen to make it 3d printer [2].

### VIII. Conclusion

The setup of hardware with a combination of G-code and other software gives better accuracy and reduces the work load. G-code makes it easy to find the information of location of motors moving, as the status of the moving motors is directly seen on computer, hence, the machine can be start or stop whenever needed. Making a small machine brings flexibility to do work [3].

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