# Designing of Mini VMC Machine

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*Abstract*— Due to the rapid growth of technology the usage & utilization of VMC machine in industries are increased. The fabrication of low cost VMC machine is used to reduce cost and complexity of machine. This paper contracts with the design of automatic mini VMC machine for PCB drawing and drilling. The Idea behind our project is to design and drill PCB based on low cost VMC system the lower cost is achieved by incorporating features of PC with ATMEGA 328 controller in an Arduino. We have use an G code for whole system operation G code is nothing but a language in which people provide instructions to computerized machine tools "To make something in desired format'. The instructions define where to move & how fast to move. we know that computer numerical control is a very broad term that encompasses a variety of types of machines— all with different sizes, shapes, and functions. But the easiest way to think about VMC is to simply understand that it's all about using a computer as a means to control a machine that carves useful objects from solid blocks of material. Our Project mainly deals with implementation of a desktop-sized 3- Axis VMC machine One of the target of this project revolves around low-cost Printed Circuit Board manufacturing and essentially making it available for and end user who can create their own custom PCBs without prior complicated knowledge of VMC milling and investing on costly machines. Away from each other from PCB manufacturing, robust solutions for customized wood and plastic surface engravings can also be provided through this project.

***Keywords:*** VMC Machine

## I. INTRODUCTION

First of all, we have to know what VMC is. VMC is an acronym for vertical milling center where less human interaction with high precision plotting jobs can be done. With the help of CAD (computer aided design) or CAM (computer aided manufacturing) programs, a2-D or 3-D version of any image can be implemented on a plain surface. This image is later translated to extricate the orders required to work a specific machine by means of a postprocessor, and at that point stacked into the VMC machines for creation. Despite the fact that idea of VMC based machines was created in mid-twentieth century and has experience numerous improvements, the cost is an imperative factor that stays unchanged. Because of the high cost of these machines many are not ready to possess one despite the fact that they have to do some valuable machining operations.

Printed Circuit Boards (PCB) appeared for the first time in the 50's. Since then, the world went through many revolutions on the manufacturing processes. It reduced the costs of these boards to a level where it was possible to insert them into nearly all electronic devices. One of these manufacturing processes is milling. After Second World War the first Computer Numerical Controlled (VMC) machines appeared. It didn't take time to familiarize them to the many machining machines existent. This is how the firsts VMC milling were developed and the industry discovered that it was one of the best processes to manufacture PCBs. Even though it's a good choice for bulk production, the PCB milling for domestic users is not a worthy economical option. Based on these arguments this paper presents the development of a low cost VMC milling machine for manufacturing of PCBs by domestic users.

VMC Machine is a generally used in the manufacturing sector that involves the use of computers to control machine tools. Tools which can be controlled in this way include milling, and drilling. The VMC stands for vertical center milling. From this VMC machinery, the biggest change in the world of digital electronics & Microcontroller, we are giving here an idea of VMC bit plotter using ARDUINO UNO. The idea behind this project is to make a small VMC machine which can draw images or pictures on surface which can be a paper or anything. It uses three stepper motors on each axis X, Y & Z. While printing, the proper organization of this entire three axes i.e. stepper motors, is most exciting task.

## II. PROPOSED MODEL

Low cost VMC machines are perfect for offering preparing students especially in the field of Engineering on the grounds that the cost and upkeep of the machine is low. As the use of cell phone is expanding step by step, interfacing the machine with cell phones operating Bluetooth network makes it easier to understand. The slighter size make it compact, portable and the segments can effortlessly be dismantled or collect. The size, space and vitality required for the machine is additionally pointed. It presently requires just less material and parts to make the machine, accordingly cutting down the cost extraordinarily.

The main purpose of doing this project is, this project will enable companies and engineering students to make 2-D model of their project at ease For a VMC machine an end mill attached to the machine as spindle which cuts the material. The machine spindle can be replaced with a laser engraver, plasma cutter, drill machine, water jet cutter drag knife or hot wire for a variety of applications making it more multipurpose. Also the probing feature helps the machine to set the zero for z axis automatically with a touch plate

- What is to be done
  We developing demo model form get idea about big VMC. VMC machine study of X Y Z axis working
- What are the deliverables
  Get chemical free PCB development with small object cutting and designing
- Who is going to do it
  Small scale PCB Design Company can work on project also Privet Company are supporting him.
- How will be it be done

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Practically for original model required the 6 month for developing in Electroarc Company

- How much will it cost
- According there design capacity we made the 5cm X 7cm design capacity model up to 20000

## III. BLOCK DIAGRAM

In this concept of project, Arduino microcontroller platform with ATMEGA 328 core is used. It can be easily interfaced with PC using FTDI module whereas also with the easy drivers and stepper motors to. The basic block diagram is as shown in FIG.1 The explanation is given as follows:

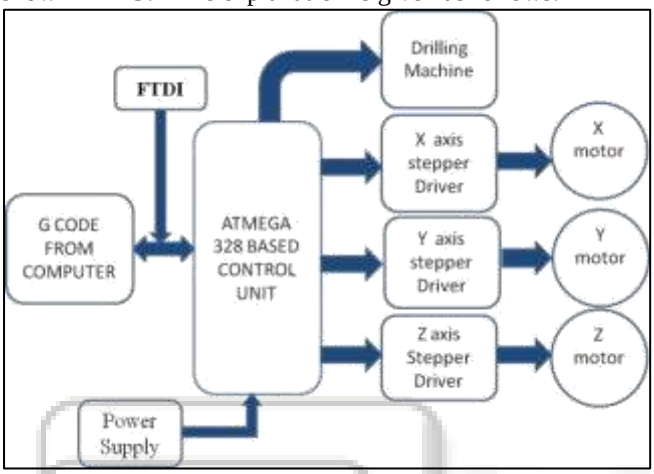


Fig. 1: Block diagram

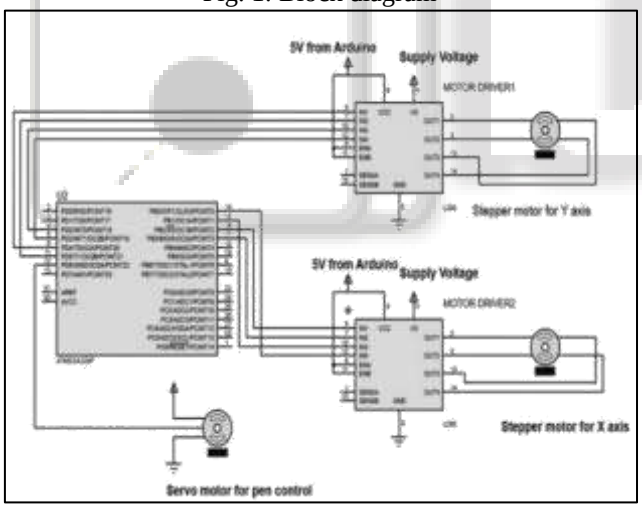


Fig. 2: Circuit diagram

Arduino Uno microcontroller core platform is used in this project. It can be easily interfaced with computers, drivers and stepper motors as well. The Arduino Uno microcontroller needs 12V power supply. Program will be dumped to the Arduino IDE software and then converted to the compiler of Arduino. The driving circuit is designed to control the mechanical setup and to communicate through software with the computer. This project will explore a VMC machine's ability to create its own components. VMC PCB machine is a drawing machine where a computer controls the individual axes of the machine through a motor.

## IV. METHODOLOGY

The G code is interfaced through ATMEGA 328 VMC based controller by FTDI module which is used to convert the code in suitable controller code i.e serial to USB converter. Hence it actions like interfacing module between PC to Controller. This code is additional passed to stepper motor by easy drivers which converts the code and as per instructions the stepper motor moves. We want three arises X,Y,Z which operates as follows X stepper motor move left and right Y stepper motor moves front and back and Z stepper motor up and down as per given measurements these axis's will move on.

## V. WORKING

The two stepper motors are driven and controlled by two drivers. These two stepper motors are connected to the X axis, Y-axis and one Z-axis to servo motor line. • G code from PC G- code is a programming language for Computer Numerical Control (VMC) in computer aided- design and manufacturing (CAD/CAM). The g-code used in the computer tells the VMC machine how far to move and at what speed. • Conversion from G- Code to C-Code To make the G-code interface with the microcontroller, each piece of the G- code line will be treated as a different character, composing a reasonable C-code to display the G code after a few executable C-code instructions are executed. The G-code is interfaced with the Arduino microcontroller used to convert the code to a USB converter, i.e. serial.

We need three axis X, Y, Z which operates as follows: -- X motor move left and right, -- Y motor moves front and back, and -- Z motor moves up and down.

## VI. ORGANIZATION OF DISSERTATION

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 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.
Design At this phase the 3D model, the CAE analysis and the analytical dimensioning are made. Also, all materials to be used on each part are selected, as well as the specifications for the commercial components are defined. Since one of the main design premises was the low manufacturing cost of the machine, the material selection focused on common materials. The main material used on

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the milling machine is aluminum, because of its great weight cost ratio.

The device will be able to move on three axes and will be talented of drawing with multiple instruments, i.e. pencil, laser, etc. in an addition the machine will also be capable to cut and plot on flat surface. The machine should meet the goals of balancing high precision and speed, use- limited resources and as many recycled parts as possible. Stepper motors otherwise servo motors are used for defined motion. The working requirement of a router is larger which means condition of longer ball screws. A good alternative can be to use belt for X and Y axes as they are cheap and requires less maintenance. A microcontroller reads the program file, interprets it and later sends it to the machine. Arduino UNO is best suited to be used as a microcontroller since it is open source, cheap and readily available in the market. A Shield is inserted to the Arduino UNO to connect the stepper drivers, limit switches and Emergency stop. Limit switches control the machine movement beyond the safe limit and an emergency stop is used to stop the machine in case of emergency.

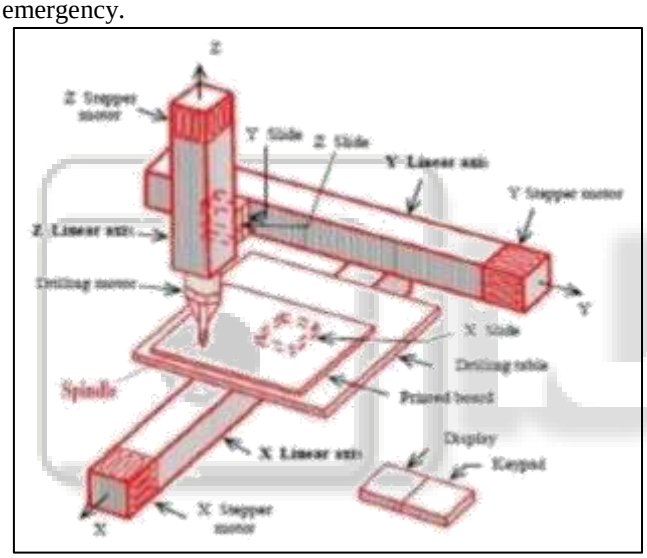


Fig. 3: General Structure

## VII. SOFTWARE SVG

Scalable Vector Graphics (SVG) is a World Wide Web Consortium (W3C) normal for portraying two-dimensional vector picture registers. Vector pictures comprise of shapes, line vectors and style data rather than the varieties of pixels accessible in raster pictures like JPEG or PNG. SVG records are ASCII content reports in XML arrange, and can be controlled with a design project, (for example, the open source editorial manager inkscape) or with a content administrator as plain content. The open standard and XML arrange permits the documents to be scanned in as content and afterward parsed into a usable information structure by our image conversion software.

### *A. G-code*

G-code is an industry standard for a machine control guideline set, specified in a few international standards including RS274D and ISO 6983. G-code documents are ASCII content records, comprising of an arrangement of charge codes. Each order code is, as a rule, a solitary in sequential order character took after by numeric parameters.

All G-Code programs files save with a extension ".nc".

- Steps to run the program:
- Stocking a marker into the spindle (while it is off). Markers work superior than pens because the tip is softer and is more forgiving. Then, setup a piece of paper or other material on which to draw near the center of the machine's work envelop.
- Power on the machine.
- Connecting to the machine with Universal G Code Sender
- Setting the Zero Position
- Jogging (move) the spindle to the midpoint of the device table Under the "Machine Control" Tab enter ".1" into the "Step Size" box & press enter. Selecting - "inches".
- To move the machine close to the center of the work table The X+,X-,Y+ and Y buttons are used.
- Marker tip gets close to the paper. To tell the machine to remember this location as the X zero location, Press the "Reset X Axis" button.
- To tell the machine to recall this position as the Y zero location, Press the "Reset Y Axis" button.
- Now we want to slowly use the "Z-" button to lower the marker tip. Then, stop when the marker tip gets close to the paper.
- Adjusting the "Step Size" to .01. After entering the value, Press enter.
- Until it touches the paper by tapping the "Z-" button, let's continue lowering the marker.
- To tell the machine to reminisce this position as the Z zero location, Press the "Reset Z Axis" button.
- Withdrawing the marker from the paper using the "Z+" button. Let's go at least .1" above the paper. This is the same to 10 clicks of the "Z+" button when the step size is set to .01

### *B. Loading the VMC Program*

- Going to the "File Mode" tab.
- Selecting "Browse" and search for the "circle.nc" file.
- Clicking "Open".
- The subsequent button press will refer the "circle.nc" G- code program to the machine and it will start to move
- This is for all the marbles. Let's click the "Send" button.
- The device will start moving First, it will move the Z axis to .25"
- Next, the device will move to X = -0.5 and Y =
- Important to remember that the marker should not be touching the paper yet.
- Now the machine will lower to Z = 0.0. Also, marker should touch the paper.
- The machine will slowly draw a clockwise circle.
- As soon as the circle is complete, the device will move the Z axis up to .1"

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- Now that machine will return to the X & Y zero location.
- Lastly, the z axis will move back up to the original. 25" starting position. Figure 5 below shows universal G-code simulation.

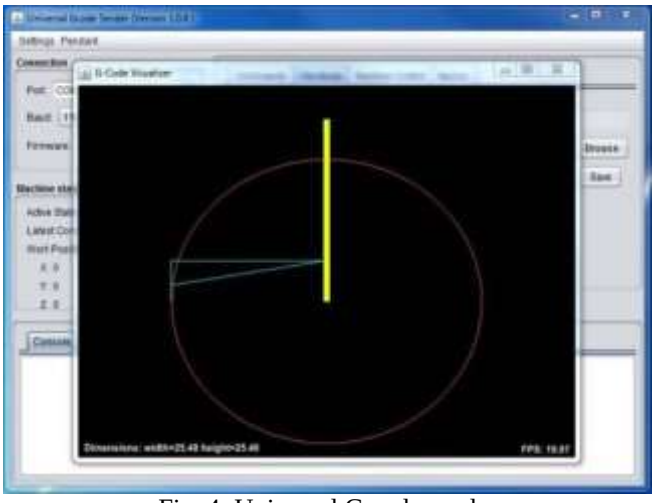

Fig. 4: Universal G code sender

## VIII. DESIGN CALCULATION

*1) Stepper Motor Calculations*

There are several different equations that you should know in order to setup your machine properly. If you don't want to go through the work of figuring out the numbers you must use, here is a quick reference table with information on what our machines come setup as standard. (These settings assume you are not using the Microstepping feature of our electronics).

| Axis | Motor Steps Per Revolution | Leadscrew Revolutions Per Inch | Steps Per Inch | Clock Speed |
|---|---|---|---|---|
| X | 200 | 5 | 1000 | 3.3 KHz (at 200 IPM) |
| Y | 200 | 5 | 1000 | 3.3 KHz (at 200 IPM) |
| Z | 200 | 12 | 2400 | 2 KHz (at 50 IPM) |

*2) Steps per Inch*

The standard calculation used by Mach3 and other CNC control software is the number of steps per inch. That is the number of steps your motor must turn in order for your machine to move 1 inch on any particular axis. This equation is dependent not only on the stepper motor your choose, but the type and size of leadscrew. This equation also takes into account microstepping, which allows your motors to move a fraction of a step (usually with less power).

$$Leadscrew\left(\frac{Revolution}{Inch}\right) * \frac{1}{Microstep} * Motor\left(\frac{Step}{Revolution}\right) = \frac{Step}{Inch}$$

*3) Steps per Revolution*

The stepper motor will play a factor in the above equation. This will depend on the type of stepper motor you select. Some motors can be odd, and move in different amounts for each step. This equation is helpful in determining how many steps your stepper motor requires to move one full revolution. Typical stepper motors are 1.8 degrees per step, which is 200 steps per revolution.

$$\frac{\frac{360\ Degree}{1\ Revolution}}{\frac{Degree}{Step}} = \frac{Step}{Revolution}$$

## IX. COST OF PROJECT

| Sr no. | Component | Pics | Price | Total |
|---|---|---|---|---|
| | Stepper | 3 | 650 | 1950 |
| | Motor driver | 3 | 250 | 850 |
| | Cnc shield | 1 | 500 | 500 |
| | Arduino | 1 | 500 | 500 |
| | Screw axis 300mm | 3 | 750 | 2250 |
| | Drill 12v | 1 | 650 | 650 |
| | Power adapter 12v | 1 | 500 | 500 |
| | plywood | 1 | 350 | 350 |
| | Bearing | 3 | 100 | 300 |
| | Wire | | 1000 | 1000 |
| | Supporting pipe | | 150 | 150 |
| | Programming code | | 11500 | 11500 |
| | Total | | | 20500 |

## X. CONCLUSION

We can conclude from this project is we able to study the meaning of VMC which stands for Virtual Milling Control The advantages of using this VMC machine is the machine is very accurate measuring so it will not have any error in measuring the object unless the user enters the wrong measurement. The code that use in VMC machine is G-code. Milling is the machining process of using rotating cutters to remove material from a work piece by advancing in a path at angle with the axis of tool. VMC is acronym for computer numeric control where less human interface with high precision plotting jobs can be done. Now a day the VMC available have cost and large in size by this project we try to make VMC which is small in size and compact also the cost of this VMC is less than the existing machine

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