Multipurpose Vertical Plotter Machine – MVPM

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***Abstract*—The multipurpose vertical plotter machine is a device which functions as drawing or writing robot which designs images on wall, prints text on panel or board. It can be used for diverse applications like interior design, wall design, notice board writing and Advertisement design.**

***Index Terms*—CNC Machine, Vertical plotting, 3 axis control, embedded system.**

I. Introduction

The present world is developing many technological advancements in order to solve critical problems and issues in an efficient way. It may be of reducing the resources use to solve any kind of problem and making the process easier. In context to this, we are creating a machine which helps to solve complexities in different fields of plotting pictures, texts and designs. Basically we are developing all in one vertical plotter machine which can be used to plot on walls, boards and panels in a flexible way.

In order to establish this machine, we are using the Computer numerical Control technology using which the several motors are actuated to plot the design on the vertical panel. This CNC technology helps in creating required designs on the software and plotting that design on the XY plane with the help of various motors.

Multipurpose vertical plotter machine works on the principle of CNC (Computer Numerical Control) [2]. Multipurpose vertical plotter machine basically works with two stepper motors and a servo motor, the machine plots the design given to it from the software on any vertical panel using Arduino which contains ATMEGA328p microcontroller. The multipurpose vertical plotter machine has control over all 3 axis [4], horizontal and vertical control is done using stepper motors and servo motor is used to control the z axis. Every axis motor is actuated by arduino and a driver connected to it.

A multipurpose vertical plotter machine eliminates many disadvantages which are present in the conventional methods. For designing any vertical panel like board or wall, the conventional methods are highly depending on manual procedure. The man made writing and designs probably have less accuracy, poor quality and more error prone.

This machine is fully automatic and has computer based designs so it comes with high precision, better quality and less chance of error occurrence.

The plotters machines are predominantly horizontal plotters which can only plot the design on horizontal axis, with the help of plotter technology and adding verticality to its process fills the requirement of automatic vertical plotting in an efficient way.

II. PROPOSED METHODOLOGY

To establish this system we require different electronics hardware and software elements

A. Hardware:

1) Arduino UNO
2) GRBL Shield
3) Water Level Sensor
4) Stepper Motors
5) Servo Motor
6) DC 12 volt 5A Rechargeable battery

B. Software:

1) Arduino IDE
2) Universal G-code Sender
3) Inkscape editor

A. Arduino UNO

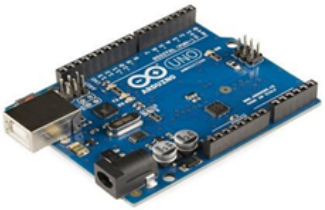

Fig. 1. Arduino UNO board

One of the important device in our system is Arduino Uno. It is a development board [5] which contains the ATmega328P Microcontroller. It has 14 digital GPIO pins, 6 analogue IO pins, a 16 MHz crystal oscillator, a USB port, a power jack, a reset button and an ICSP header. The board has all the supportive hardware for microcontroller; we just need to connect it to a PC with a USB cable and supply the power.

Arduino is a core controller of this system, after creating the design in G-code format, we upload that to Arduino board, we connect GRBL shield to Arduino which acts as a driver to the actuators, the G-code received by the Arduino is sent to GRBL shield which eventually drives the stepper and servo motors.

B. GRBL Shield

GRBL shield is used to make our system compatible with CNC machine. It is an open source firmware which and mainly works in the motion control for CNC machines. In simple words, the GRBL software is uploaded to Arduino in order to control the motors through Arduino. The above shown shield will be fit on off arduino Uno which converts the G-code to motor motion.

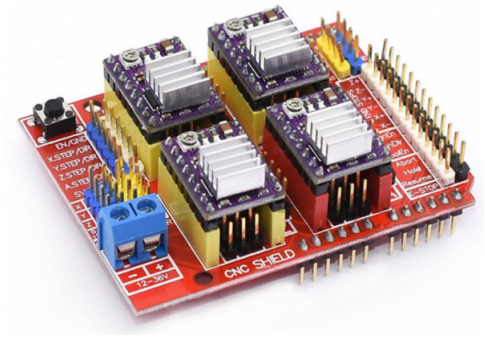

Fig. 2. GRBL Shield

The GRBL is very compatible to work with CNC machines with low-cost small scale microcontrollers. It has its various application with Arduino Uno, some of them are, laser engraving/cutting machines, CNC milling machines, drawing machines.

C. Stepper Motors

Fig. 3. Stepper Motors

The stepper consist of rotor and coils, the rotor rotates when the pulse input is given to the coils. The direction of the rotation can be controlled by supplying the Pulse Width Modulated signals which are controlled by the arduino board. Because of its precise motion and high torque production in low power supplies, it is very much suitable for our system. It has various uses in low-cost and position control applications.

D. Servo Motor

Fig. 4. Servo Motor

The servo motor is DC motor uses very less power and generates high precise degree rotations. When the electric signal is provided to servo motor, it changes its mechanical motion with accurate speed and direction control. In our system we are using servo motor to control the z-axis. The end effectors like pen or brush is connected to this motor, it holds the pen up or down according to designing.

E. Arduino IDE

Fig. 5. Arduino IDE

The Arduino IDE (Integrated Development Environment) is an environment used to write logic code according to our system controlling requirements. It consists of an editor window, text console and toolbar for different functions. The environment is written in C and C++ functions. Initially we write our code here, then connect the board to the computer and upload all code to arduino board.

F. Inkscape editor

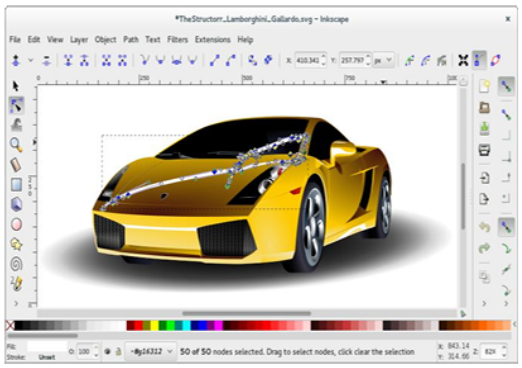

Fig. 6. Inkscape editor

The CNC machine works on G-code input. Hence any kind of design we want to draw need to be converted to G-code. Inkscape software[7] provides the facility to construct the design as per our requirement and convert it to G-code format. In Inkscape we can create or edit graphics such as diagrams, illustrations, line arts, charts, logos and complex paintings etc.

G. Universal G-code Sender

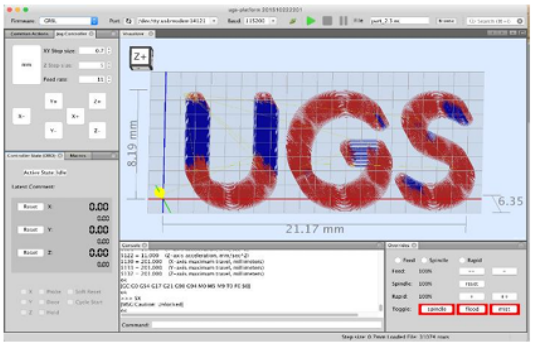

Fig. 7. Universal G-code Sender

As name explains Universal G-code Sender is a platform used to upload the G-code to the GRBL through arduino board. It is a java application compatible with Windows, Mac OSX or Linux.

The below block diagram and circuit diagram explains the structure and working principle of the system.

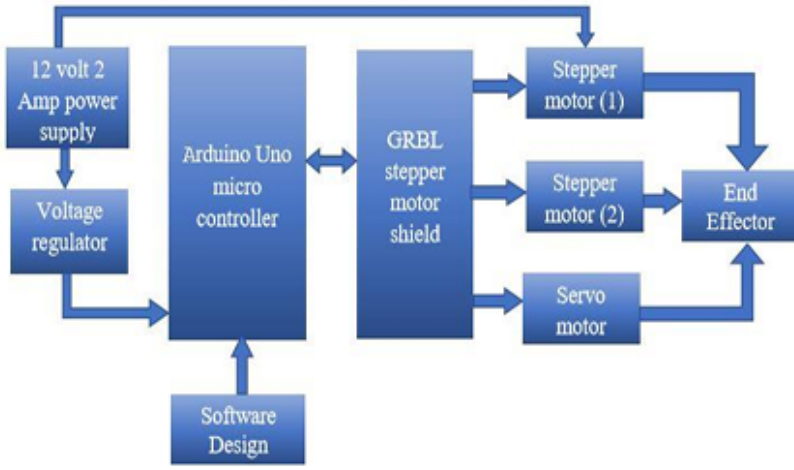

Fig. 8. Block diagram

The above figure shows the different blocks of the multi-purpose vertical plotter machine.

It has Arduino Uno as a core controller board which receives the input commands from software and drives the motors. The GRBL stepper motor shield will be connected on the top of the Arduino board to which the stepper motor drivers are connected.

It has two stepper motors and one servo motor. The stepper motors are used to actuate the end effector in x and y axis and servo motor to control in z- axis.

The 12 volt 2 amp supply is used to power up the stepper motors. The voltage regulator provides constant 5V power supply for Arduino Uno.

The following steps Explains the methodology and flow of execution of the work.

1. Initially we create the required design on Inscape software and generate the equivalent G-code of the design file. (.G code).

2. Then we upload the working program to Arduino Uno through Arduino IDE.

3. After generating the G-code in Incscape software we upload this G-code to Arduino Uno using Universal G-code Sender (UGC) software.

4. When Arduino Uno receives the code commands, with the help of GRBL shield, it actuates the stepper and Servo motors.

5: Because of movement of these motors, the end effector (e.g.: marker, brush) writes the same design on any kind of vertical panels like walls, boards etc.

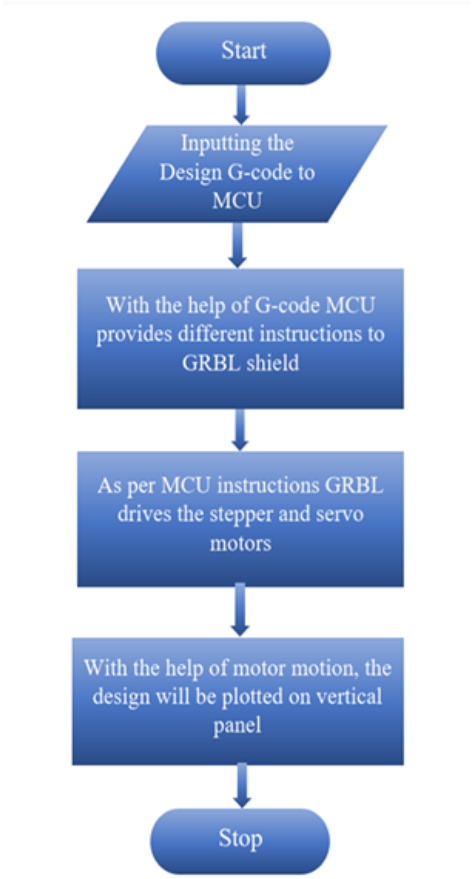

Fig. 9. Work flow

The virtual circuit connection is shown below:

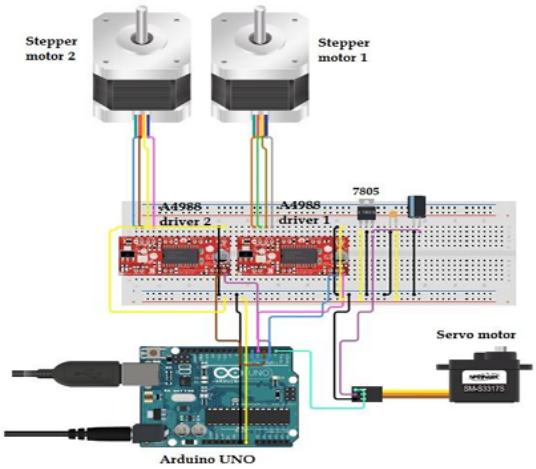

Fig. 10. circuit diagram

III. RESULT AND DISCUSSION

The main purpose of proposing this paper here is to bring up the discussion that, using CNC technology, we can build a machine which will be capable of designing anything on vertical panel with slight modification in end effectors. We have built the prototype of this machine which is shown below, as a first stage we have designed it as a predominant writer as we are connecting pen as end effector. But as we mentioned by developing the design, we can use it for multi-purpose applications like interior designing, designing of wall advertisements etc.

Fig. 11. Prototype of proposed machine

By studying the performance of the system, we can find maximum advantages and few drawbacks.

Advantages

The CNC machine offers several advantages:

- The CNC machine works with high accuracy and acts as a robot, providing very high throughput.
- Manual work is almost eliminated, reducing the chances of human error.
- The machine has a high performance rate and requires less maintenance compared to manual processes.
- Automatic handling of materials makes the manufacturing process more efficient and less labor-intensive.
- The operation of the CNC machine is very reliable, ensuring consistent and precise results.

Initially to develop the machine it may require costly components as application requirements and technically skilled operators are required for handling of the machine. But these can be considered as essential requirements rather than drawbacks.

IV. CONCLUSION

By observing the total system construction and working, we can say the many problems regarding designs and writing can be solved using this machine, as it is automatic, issues related to human errors are eliminated, as it is a multipurpose device we can include ma applications of designing. The conventional plotter which plots only in horizontal axis is here used as vertical plotter so as to fulfil our design requirements. Hence, we can say that this multipurpose vertical plotter machine can bring a change in vertical designing world

V. REFERENCES

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