ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

Android Based 2-D CNC machine with IoT Enabled Capabilities

Omkar Tulaskar[1], Varad Tole[2], Abhigya Upadhyay[3], Harish Yadav[4], Abhay Kshirsagar[5]

Abhishek Choudhary[6]

UG Student [ETRX], Dept. of ETRX, Vivekanand Education Society's Institute of Technology, Mumbai, India[1]

UG Student [ETRX], Dept. of ETRX, Vivekanand Education Society's Institute of Technology, Mumbai, India [2]

UG Student [ETRX], Dept. of ETRX, Vivekanand Education Society's Institute of Technology, Mumbai, India [3]

UG Student [ETRX], Dept. of ETRX, Vivekanand Education Society's Institute of Technology, Mumbai, India [4]

Associate professor, Dept. of ETRX, Vivekanand Education Society's Institute of Technology, Mumbai, India [5]

Assistant professor, Dept. of ETRX, Vivekanand Education Society's Institute of Technology, Mumbai, India[6]

ABSTRACT: 2D plotters use the coordinate system to implement movements in the horizontal and vertical direction to transfer the data onto a page. The paper deals with the implementation of software algorithms and the whole functionality for providing a user-friendly interface to the traditional plotters. The developed system uses the Internet of Things to make the job of the user much easier. The paper then introduces the use of an Android application at the user end for sending the data to be plotted. Once the data is sent, the plotter then extracts the information of plotting such as the x-axis offset, y-axis offset and the angle with respect to the x and y-axis. At the end of the entire processing, the data is plotted on the page. The system employs AVR based micro-controller for controlling the movement of axes. The system provides flexibility to the user in terms of modularity of the structure and software environment.

KEYWORDS: Internet of Things, MySQL Database, 2D plotter, Client-Sever architecture.

I. INTRODUCTION

A CNC based plotter machine is a 3D controlled 2D plotting machine which uses a pen to draw text or image on any given solid surface[4]. Any plotting system uses G-codes generated from an image to move the header to the respective location**.** In general plotting systems, the user needs to develop the G-codes on his own using an open-source software tool available and then send them to the plotter where another interpreter would handle rest of the procedure of extraction and plotting. This paper proposes an efficient and easy way of establishing communication between the user and the plotter. The data that is to be displayed is sent to a local server running a PHP script which extracts the contents of the payload and updates the databases accordingly. A python script keeps checking the database for any new data available for plotting. Another python script then sends that particular data which is not yet plotted to the plotter via serial communication from the local server. The plotter, on the other hand, has a controller who receives the data and plots the image/structure on the page.

The system works on G-codes and M-codes. These are languages used by machine tools on how to move the header in x,y or z-axis. Here the G-codes and M-codes used are restricted to only 2 axes. The plotter is designed in the most economical way and to provide high accuracy during plotter[1]. The plotter side incorporates the AVR based micro-controller, stepper motor driver and the stepper motors. Stepper motors with the maximum current capacity of 3A were used so as to provide the desired slow and fast movements according to the coordinates that were provided. Zero manpower is needed during the whole process. Eliminations of human intervention and providing flexibility for the user to not be present near the machine all the time are the two main advantages of this whole system.

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II.PROPOSED METHODOLOGY

The developed system employs a Client-Server architecture wherein the Android application is working as the client and makes the necessary requests to the server. The client here is deployed in the form of Android application which will make the standard HTTP GET requests which will contain the data to be plotted as a payload. The User-Interface(UI) provided gives the user flexibility to either send letters, words or predefined images as per his needs to the server. The server end consists of a PHP script to accept the payload. This script is responsible for pushing the data into the MYSQL database. Each data is given a status attribute which represents whether the plotter has completed plotting that particular structure or not. The server is connected to the plotter through serial communication using a PYTHON script. An algorithm is developed which uses a polling scheme to continuously check the database for any new data. This algorithm is responsible for checking the status attribute of the new data available and further send the signal to the plotter regarding what to plot.

At the receiving end, the system uses the AVR microcontroller based Arduino development board shown in Fig. 1. This controller is further connected to a stepper motor driver which drives the stepper motor. The board runs a program which uses suitable algorithms to successfully extract the necessary parameters received from the server. The data received from the server contains G-codes and M-codes. Some M-codes used were user-defined so as to make the software implementation easy. The G-code and M-code that are supported in this system are as follows:

Gcode	Category	Function
G00	Motion	Move in a straight line at rapids speed
G01	Motion	Move in a straight line at last speed
G02	Motion	Clockwise circular arc
G03	Motion	Anti-clockwise circular arc

Mcode	Category	Function
M300	Displacement	Push the pen up or down

Table No. 1 G-code and M-code Description

After extracting the relevant data which is usually the x and y coordinate of the location where the header needs to move, necessary pulses will be generated which will be given to the stepper motor drivers. These pulses implement the speed of the stepper motors as well as their direction of motion. Once done, the program running on the controller keeps this location stored as "Last visited location" parameter so as to calculate the next offset on receiving new coordinates.

III.MECHANICAL / HARDWARE MODEL

The proposed methodology relies mainly on the rigidness and sturdy nature of the system. This mainly depends on the mechanical model being deployed. There are various structures to implement a general XY plotter. However, different designs have different parametric constraints. The main objective of the structure was to implement a system with faster throughput which solely depended on the stepper motors used as well the motor drivers used and their capacity of handling the current.
The stepper motor drivers used are 3A max TB6560 motor drivers. The controller used is the Arduino UNO development board.

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Fig. 1 TB6560 MOTOR DRIVER & ARDUINO UNO DEVELOPMENT BOARD

IV.SOFTWARE MODELLING

The software part includes the modeling of the polling script which forms the entry point for execution of the data to be plotted wherein the data which is not plotted is sent to the plotter. Fig. 3 represents the flow of data from the client until it gets plotted. The software tools used are divided into 3 parts:

1. Client: Android application is developed on the Android studio using JAVA and XML. It is mainly responsible for making HTTP requests and also put the user payload which contains the data to be plotted.

2. Server: The server side uses an algorithm implemented using PHP and Python scripts. These scripts are mainly responsible for handling the client requests and maintaining communication with the plotter.

3. Plotter: It uses an algorithm for extracting the required data from the G-Codes developed using C program for the controller. This extracted data contains the new x and y coordinate.

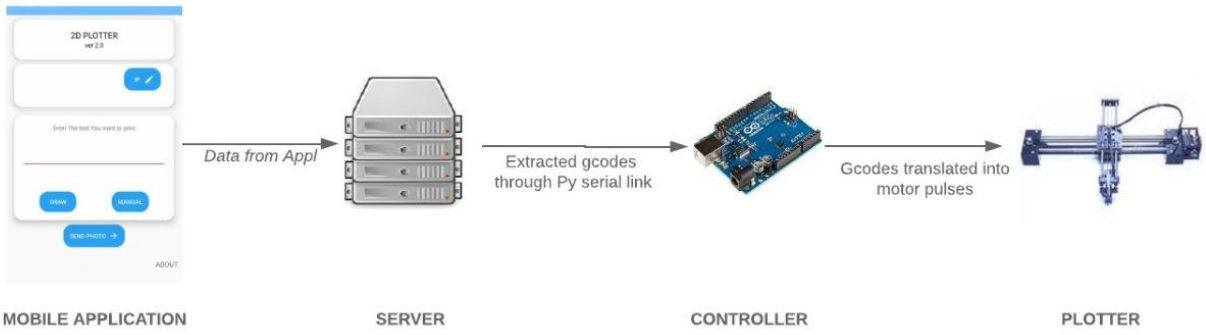

Fig. 2 Working of the system

In Fig. 2, the mobile application represents the client which makes requests to the database residing on the server. The server is further connected to the controller which then drives the plotter .

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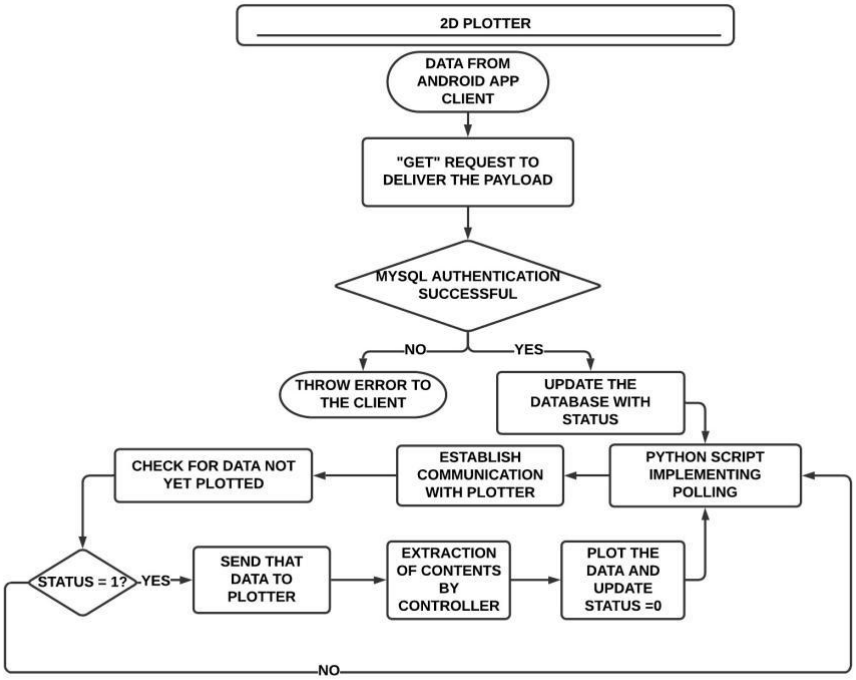

Fig. 3 Flowchart for the process

V.RESULT AND DISCUSSION

The assembly of the structure includes the mechanical fixing of stepper motors to the base. The header which contains the ink is attached to the x-axis. Both the axes use linear bearing mechanism for sliding in a particular direction. The system was able to plot small and big images with accuracy. Also, the entire system working duration limit was found out to be of 5 hours after which the stepper motors started heating. During the fine movements which involved smooth curves, the stepper motor requires more current in amperes because at the slow speed they consume more current than the amount consumed at high speed.

Fig. 4 Mechanical Structure and header module of the system

In Fig. 4, it shows the construction of the plotter with the header attached so as to transfer the images/structures sent by the user on the page. The header used servo motor programmed to move in two directions- up and down.

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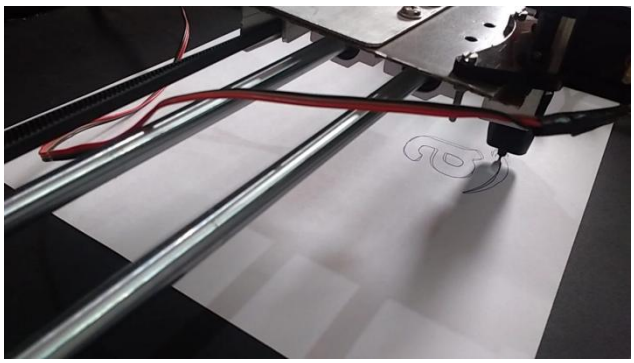

Fig. 5 Outlined images plotted on the page

In Fig. 5, image is being plotted by using the G-Codes sent by the user at the client-side. The header moves up using the servo motor action when nothing is to be drawn and moves down when the pattern is to be drawn on the page.

VI.CONCLUSION

Traditional plotter systems mainly rely on human intervention as well as manual handling of the system. The software environment proposed in the paper provides an alternate provision for sending the data to the plotter. An entire load of processing is at the server end which reduces the burden on the client-side. This improves the user-friendly behavior and avoids the unnecessary use of user's hardware. The modularity of the structure provides flexibility to change the header to extend the application to laser cutting as well as multi-color plotting.

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