



AN-NAJAH NATIONAL UNIVERSITY

FACULTY OF ENGINEERING & INFORMATION TECHNOLOGY

COMPUTER ENGINEERING DEPARTMENT

CNC plotter

*Presented in partial fulfilment of the requirements for Bachelor degree in
Computer Engineering*

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31 August 2022

Acknowledgment

First, we would like to thank our families and friends for their continuous support and assistance Throughout the period of working on this project.

We also want to express our sincere thanks to our supervisor Dr. Raed Qadi, for his insightful comments, helpful information, patience and practical advice that have helped us a lot.

Disclaimer

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Abstract

The principle of CNC machine is worldwide-applied principle in different fields especially industry, but we saw that also graphical tools are growing fast, such as 3D printers and 2D drawing machines, so we tried to work on an idea related to this development. Since everyone these days tries to use anything easier, our project is a CNC machine that takes words by voice recognition module to write it on a paper, or a word to draw a shape on the paper. The main features of our project will be A4988 Driver, servomotor, Stepper motors, Arduino Uno, raspberry pi and voice recognition module. The projects works simply as following, the voice recognition module listens to the word that we say it nearly to the voice recognition microphone, then it sends it to the first Arduino using serial with baud rate (9600), then the Arduino sends it to the raspberry pi using serial with baud rate (115200), after that we have the word that has been said on the raspberry, there is files with Gcode extension that are saved on the raspberry so each word has an file for it, G code is nothing but a language in which people tell computerized machine tools 'How to make something'. The How is defined by instructions on where to move and how fast to move. then Gcode has a commands as a vectors and it sends them to the second Arduino which has GRBL library and connected to the stepper motors so the GRBL send these vectors as a steps to the stepper motors which represents the movement of the project, so all you have to do is to speak.

1 Introduction

CNC stands for Computer Numerical Control and has been around since the early 1970's, before computer, it was called NC, for Numerical Control. The Arduino CNC plotter moves its parts in accordance with the instructions it is provided in order to draw a desired image or text.

1.1 Statement of the problem

Many people facing diseases such as Parkinson's disease and ataxia lead to loss the control of hand, which leads to prevent the patient from writing or drawing.

1.2 Objectives

Most of the creation of the ideas is to solve a problem, our idea is aiming to solve problems that some of ill people are facing. The project aiming to simplify the way of writing or drawing by only pronouncing the shape or the word that wanted to be drawn or written.

1.3 Organization

This report is organized as following:

- Constraints: This chapter includes problems and difficulties that were faced during project development.
- Literature Review: This chapter includes citation of relevant work.
- Methodology: This chapter shows methods, tools and languages that were used in creating the project and how it was created.
- Results and Discussion: To show the contribution of this project and discuss the results.
- Conclusion and Recommendation.
- Future work: Talk about more features and enhancement for this project.

2 Constraints, Standards and Earlier Coursework

2.1 Constraints

As most of the hardware projects, the design of the project is the hardest challenge. One of the challenges that we faced was the design of the Plastic parts used in our project. We tried to find a 3D printer to print it out exactly how we want it.

In addition, we faced a problem that the first try for our project is that we did not want to use raspberry pi, we only wanted to use Arduino uno, but we found that using Arduino we only could use manually softwares and libraries without writing even a single line of code, so we bought an raspberry pi microcontroller which offered for us more options for coding. After that, we found that we are dealing with sensitive hardwares.

Another challenge was the Plastic parts density was low, so it can be broken easily. We tried to print another few parts with high density so it cannot be broken with any simple wrong move.

After collecting everything required for the project, we tried to test it but the Steppers did not work at all , we tried to find out what was the problem, after several tries, we found out that our power supply was not working well, so there is not voltage gain arriving to the motors, so we changed it.

2.2 Codes

For the GRBL, we used library called GRBL, we did not need to alter anything with it, for the communication between the Arduino Uno and Raspberry pi we used compatible code for both sides, we used Python code for the Raspberry side. We used the voice recognition module documentation to write it's code. all of sites which helped us is listed down in the References section.

2.3 Earlier Coursework

Multiple courses that were presented to us by the computer engineering department Were helpful in building this project, these are:

- Critical Thinking and Scientific Research Course

This course helped us to enhance our critical thinking and research skills though discussions and assignments. In addition, it is the bedrock of writing this paper. Methodology: This chapter shows methods, tools and languages that were used in creating the project and how it was created.

- Microcontrollers Course

The course taught us how to deal with microcontrollers, so the concept was known for us even if we did not use the same microcontroller.

- Microcontrollers Lab

This course brought the previous one's theoretical knowledge into Practice in dealing with I/O, serial communication, motors, and had a last part

In which Arduino programming was introduced for the first time.

- Programming Course

It is the first software course, which helped us to use the Arduino Uno IDE using C language. Also helped us with using functions and logic.

- Operating System Course

This course learned us how to use Linux operating system, how to use terminal on it and how to write commands which helped us with the raspberry pi operating system.

3 Literature Review

CNC plotter as explained before is a machine to simplify the process of drawing or writing. It aims to help people who have issues with controlling their hands, such as Parkinson's disease.

The CNC plotter machine can be done by using simple microcontroller such as Arduino Uno, you do not have to do software or write a code, you only need softwares such as Universal Gcode sender, Inkscape using computer, Inkscape software takes the photo you want to draw, then it creates a file with Gcode extension, then the Universal Gcode sender takes the file that Inkscape created, after that it will communicate with the GRBL library that is downloaded earlier on the Arduino Uno, so the steppers moves after that and the photo will be drawn. That is what [1] referred.

By studying the above papers, it was obvious that Arduino alone is not a fully functional board. Therefore, we used Raspberry Pi in addition to Arduino as a modification. As the Pi uses python programming language it is easy to use to develop an operating system. It is as good as a mini computer. In addition, we have used voice recognition module as the primary input. Raspberry Pi is not having a short pulse, and hence it cannot rotate a stepper motor on a high speed. In addition, it cannot take the load of multiple motors rotating simultaneously and thus use of Arduino is required.

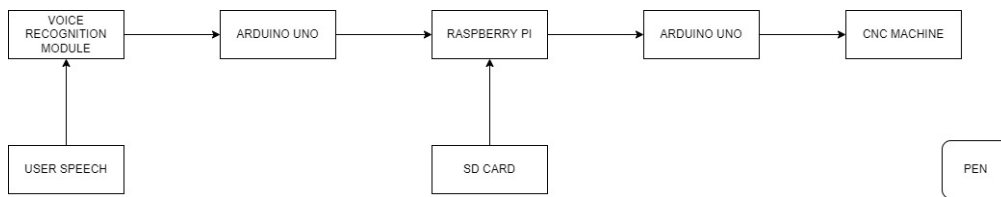


Figure 1: Flowchart

4 Methodology

Here we are going to explain my experimental section as much as possible. Explain briefly what are the components of our project, and what software did we use in each component.

4.1 Hardware Tools

Microcontroller:

After looking at all the options, we found that the Arduino Uno microcontroller [Figure 4.1] fits all our needs for the voice recognition module, we can easily train commands to the voice recognition, then get it whenever we want. In addition, we used Arduino Uno for the Stepper motors and it was enough but we had to use drivers with the motors.

Serial communication wire/cable is used for serial communication between Arduino and Raspberry pi.

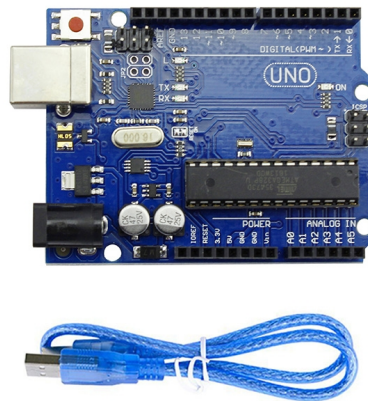


Figure 2: Arduino UNO

Microprocessor:

Raspberry pi 3 B+ was a good microprocessor choice for running Universal Gcode sender and control it with Linux commands, since we can use scripts on Linux, we wrote a code on a script file, which it opens a serial communication between the Arduino Uno that is connected to the voice recognition and the Raspberry pi on 115200 baud rate, it receives a word from the serial then it takes the word and send a Gcode file as parameter to the second Arduino that is connected with the stepper motors. Then the GRBL library controls the steppers.

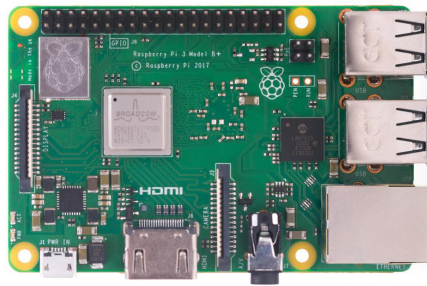


Figure 3: Raspberry bi 3B+



Figure 4: SD card

Voice recognition module:

We used the voice recognition module [Figure] as the input of the voice. Firstly we have to train the voice recognition on the words that we want to speak and then it will be stored in the module database. When we want to load the word, we first need to write a code to load the records in the database to the module recognizer, so when we say the word and it's stored on the module and has been loaded to the recognizer, the module will return to us the number of the record.

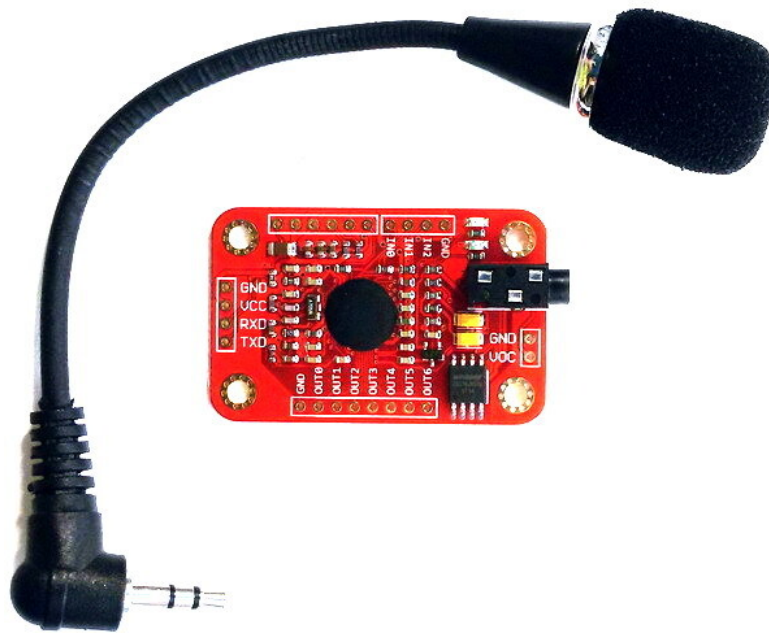


Figure 5: Voice recognition module

Drivers:

We used the A4988 driver [Figure]; the A4988 stepper motor driver has an output drive capacity of up to 35V and $\pm 2A$. Which let us control a bipolar stepper motor such as the NEMA 17 at up to 2A output current per coil. The driver has a built-in translator for easy operation.

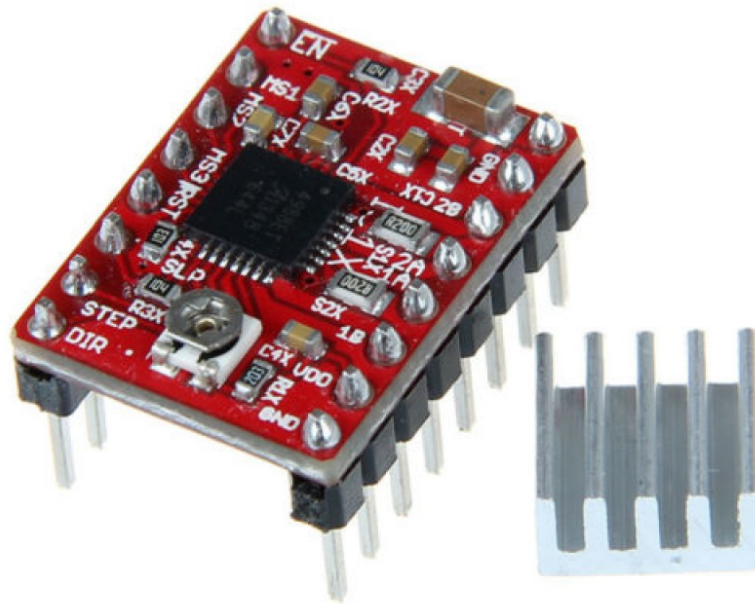


Figure 6: A4988 driver

Motors:

The movement process for our project mainly depends on two types of motors, Stepper motor (STP-42D2131) which makes the project move in the x-axis and y-axis, the other motor is SG90 micro servo motor, which takes the responsibility of raising the pen up and down.



Figure 7: stepper motor



Figure 8: Servo motor

Capacitor:

We used Capacitor [Figure] with 25 Voltage and 100 micro-farad capacity because the capacitor with large filter can be used to absorb and store energy when the AC power is higher than what is needed by the DC load and to supply energy to the load when the AC power is lower than what is needed.



Figure 9: capacitor

Breadboard:

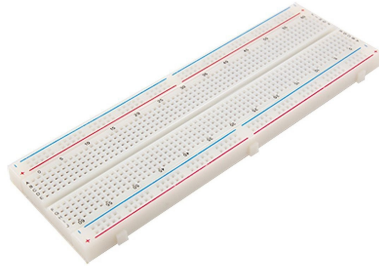


Figure 10: breadboard

wires:



Figure 11: Wires

4.2 Building Tools

Our building tools were made of plastic. We printed out these parts on a 3D printer.



(a) Pen Holder



(b) Stepper base

Figure 12: some of 3d printed pieces

4.3 Mechanism of Movement

There are some proprieties should be found in each axis movement:

- Smooth
- Easy
- Low error rate

How can we achieve these properties?

As most of the mechanical systems that require smooth movement, we thought that we should use bearings.

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts.



Figure 13: Bearings

In addition we used other mechanical parts to assemble the machine and make it ready to move.



(a) 8mm steel bar



(b) Belt



(c) 3mm screw



(d) 3mm nut

Figure 14: Others



(a) 4mm screw



(b) 4mm nut



(c) Threaded bar



(d) 10mm nut

Figure 15: Others contd.

5 Results and Analysis

5.1 Testing

The voice recognition module was connected with Arduino Uno, we tried to train the module with a few commands so we can test if it works properly, then the testing was by trying to load words from the module database, we used baud rate 9600.

The Stepper motors were firstly connected with the driver on a CNC shield connected with Arduino for testing purposes. The testing process for Steppers was not difficult, we used software called Universal Gcode sender, we gave it Gcode file, downloaded the GRBL library on the Arduino and connected the software on the Arduino port, the Universal Gcode sender sends commands to the GRBL from the Gcode file and the GRBL library controls the motors easily.

After we saw that everything was okay, we removed the CNC shield and connected the motors with breadboard and Arduino Uno.

For testing the micro servo motor, we only connected the servo with Arduino Uno and downloaded an example from Arduino Uno IDE to the Arduino.

The most important testing was the communication between the Arduino and the Raspberry pi. We used wire/cable to connect between them and then opened a serial communication on baud rate 115200.

6 Conclusion

Finally after going through all the troubleshooting of hardware and software. We have presented the use of CNC machine for small-scale application purposes due to the rapid growth of technology and the usage and utilization of CNC machine; we connected our idea with the idea that there are people blind or have a disease that makes them lose control of their hands.

This project is about drawing a shape, word or a draw by only pronounce the name of the word or the shape or the draw, the voice recognition identify the word and sends it to the Arduino, the Arduino communicate with the Raspberry pi by serial, the Raspberry pi takes the word and finds the Gcode file specified for it, then sends the file to the second Arduino as a parameter. The GRBL library on the second Arduino controls the motors easily from the Gcode file.

This is a low cost project compared to other CNC machines. It is designed for a small-scale purpose. It is also small and can be carried anywhere without much effort. The pen can be replaced with something else such as a laser.

This machine can run for hours without interruptions. The error rate of it is very low.

7 References

https://www.elechouse.com/elechouse/images/product/VR3/VR3_manual.pdf

<https://www.arduino.cc/en/software>

https://winder.github.io/ugs_website