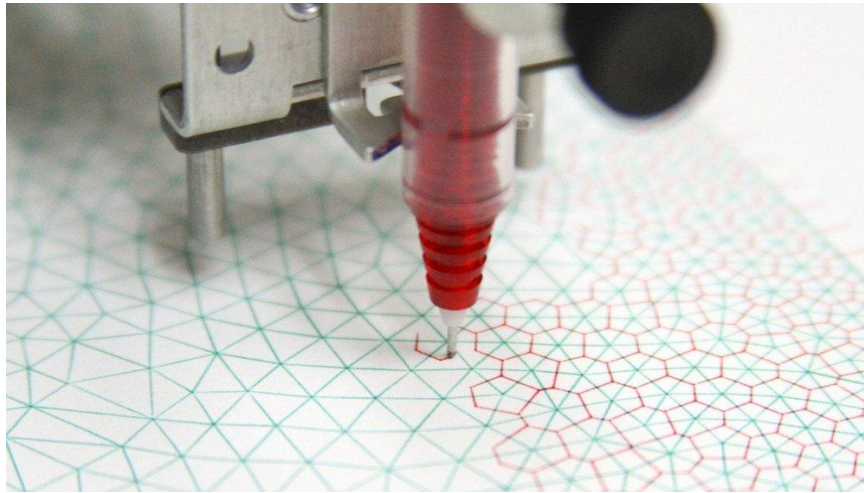# Senior Design 1
Automated Pen Plotter

Department of Electrical Engineering and Computer Science
University of Central Florida
Dr. Lei Wei
Dr. Samuel Richie

Initial Project and Group Identification Document
Divide and Conquer

Group 24

Al Moatasem Al Abri, Electrical Engineering, mn5211@knights.ucf.edu
Patrick Caughey, Computer Engineering, patrick.caughey@knights.ucf.edu
Anthony DeMore, Computer Engineering, anthonyldemore@knights.ucf.edu
Peregrino Quansah, Computer Engineering, pquansah@knights.ucf.edu

Project Narrative

Printing as we know it has been around for quite some time now. The majority of printers we see on the market are inkjet and laser. A somewhat forgotten form of machines outputting images to paper format is known as pen plotting. A major reason for this is the lower cost and speed of inkjet and laser printers cannot be matched by pen plotters. However, the unique output style and artistic expression ability of the pen plotter cannot be matched by modern printers and that is what our group hopes to showcase with our project.

It is evident that pen plotters will by no means ever take over printers. There is however a significant number of enthusiasts who enjoy the art style and story-telling ability that pen plotters can generate. The more analog form of image and shape recreation is unique to pen plotters as they can draw continuous lines and write with the users' chosen writing utensil unlike modern printers.

Our goals for the design of this product are to create an accessible and well-designed pen plotter. Accessibility means that we plan on making an easy-to-use interface which will allow the user to input their drawing without the need for programming knowledge. The interface will be accessible via software which is downloaded to the user's computer. The ability for the user to choose their desired writing instrument is also an important goal in order to allow for artistic expression or to meet a specific criterion of a drawing. A well-designed product would be one that is built sturdy enough to be moved from place to place as needed during the demonstration of our design as well as for any users' purposes. It also needs to be lightweight while remaining rigid.

There are various different pen plotters currently on the market with a fairly wide range of prices. Pen plotters are typically slightly more expensive than printers. We plan on designing a product to be marked towards the low to mid-price range. The differences in low to high priced pen plotters is typically their drawing area as well as additional features such as automated pen color/style switching. There is also a market for legacy pen plotters which

resemble more of a traditional closed printer-like design. We plan on creating an open design to allow for the viewing of the work in progress.

In conclusion, our group plans on developing a well-rounded pen plotter to meet both the hardware and software requirements needed to create a viable and interesting product. It is important for us to create a design that is able to make unique works of art as well as be a tool which can be for entertainment.

Specifications

- 3 NEMA 17 stepper motors for the X, Y and the Z axis motion, and a small servo for the gripper.
- Stepper drivers.
- Working area might be the size of regular A4 paper (8-1/4 x 11-3/4 in).
- Wood base.
- Power supply.
- The project will use a specific pen size which can be 0.6mm.
- Arduino UNO board in combination with a CNC shield.
- Switches.
- Firmware to the Arduino.

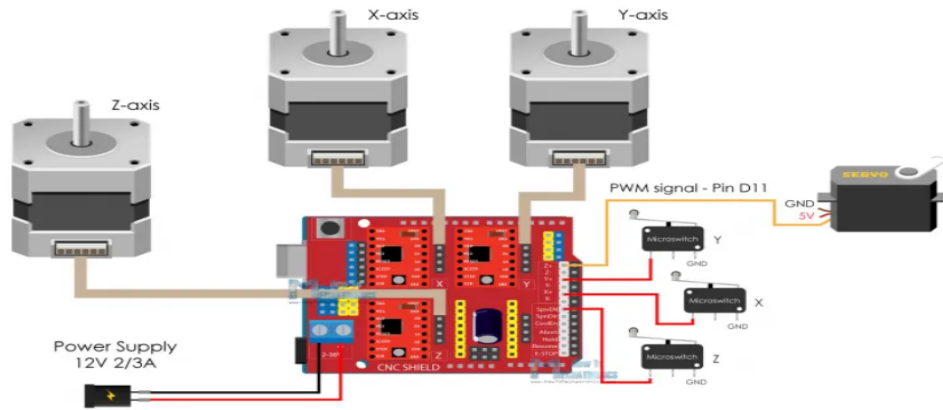# House of Quality

Engineering Requirements

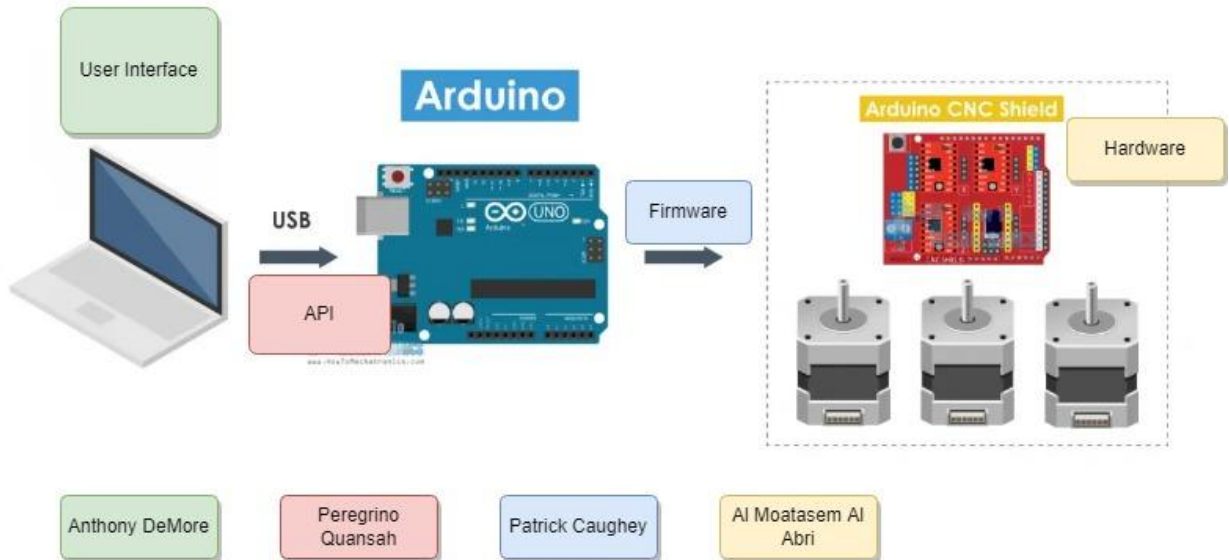| User Requirements		Draw time	Pen Output	Install time	Dimensions	Cost
		-	+	-	-	-
Quality of lines	+	↓	↑↑		↓↓	↓
Writing quality	+	↓	↑↑			
Install Ease	+			↑↑	↑	↑
Cost	-		↓	↑	↑↑	↑↑

Legend

↑↑	- strong positive
↑	- positive
↓	- negetive
↓↓	- strong negetive

Block Diagram

Circuit Diagram

Firmware and Control Software

Budget

       This is an estimated list of the parts that the project will need, this list might change in the future and there will be some added parts and there might be some deleted parts. These are most of parts that will be needed in order to build the machine:

Part name	Seller	Estimated price
MGN15H Linear Rail	Amazon / AliExpress	$43.99
Linear Rod 6mm	Amazon / AliExpress	$9.99
Linear Bearing 6mm	Amazon / AliExpress	$9.49
Stepper Motor – NEMA 17	Amazon / AliExpress	$12.99
GT2 Belt + Tooth Pulley	Amazon / AliExpress	$15.99
GT2 Idler Pulley	Amazon / AliExpress	$8.59
Spacer Nuts	Amazon / AliExpress	$9.99
Bolts and Nuts set	Amazon / AliExpress	$26.99

The second table is for the electronic parts:

Part name	Seller	Estimated price
Stepper Motor – NEMA 17	Amazon / AliExpress	$12.99
Stepper Motor – NEMA 17 23mm	Amazon / AliExpress	$9.99
A4988 Stepper Driver	Amazon / AliExpress	$10.99
Servo Motor	Amazon / AliExpress	$10.69
Arduino CNC Shield	Amazon / AliExpress	$7.39
Arduino Uno	Amazon / AliExpress	$23
Limit Switch	Amazon / AliExpress	$6.99
DC Power Supply	Amazon / AliExpress	$12.99

Initial Project Milestones

Milestone	Planned Completion Date
Research programming language and development platform	2/20
Decide on software specs and development platform	2/28
Research moving parts	3/1
Research chassis	3/7
High level plan of hardware design	3/14
High level plan of software design	3/28
Design chassis and moving parts	4/6
Research protocols and electrical parts needed for the chosen moving parts	4/20
Order hardware, development platform, and electrical parts	4/28
Prototype code	5/20
Get parts moving with prototype code	5/30
Drawing code	6/5
Tool Switching code	6/15
Refine hardware	6/18
Refine software	6/18
Finish code	6/21
Order PCB	6/22
Implement PCB	7/22
Finish development	7/30

Conclusion

Our goal for this project is to create a user-friendly pen plotter that is controlled by computer software which will be easily accessible by anyone. The software will allow for the user to input their design and they will be able to watch their artwork be created in front of their eyes. We will use parts like mentioned in the budget to create the robotic arm needed to draw on paper. The design of this pen plotter is similar to many dual axis robotic machines making for many readily available parts such as motors and metal rails making for lower costs.

References

Information on pen plotters:
- https://all3dp.com/2/pen-plotters-best-xy-plotters/
- https://medium.com/nightingale/pen-plotters-are-the-perfect-tool-for-data-storytelling-b05c71ceadd5

Title image:
- https://www.axidraw.com/