FINAL YEAR PROJECT PROPOSAL

Project Title	Vertical Plotter (Vincent van Bot)		
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Supervisor Name	Dr. Saeed R Taghizadeh	**Approval Date**	27/09/2023

1 Introduction

With an increasing number of people having access to creative tools, such as photoshop, midjourney and GIMP (GNU image manipulation program), creating art has never been easier. A gap in the market is obvious upon close inspection, Many physical art mediums are not as accessible, ones like painting and drawing. My proposition is a vehicle between both forms of art in the form of a autonomous drawing bot. The project will use user generated images to draw a physical image on a wall or canvas.

2 Objectives

- Incorporating Hardware and software solutions for tasks required
- Learn PCB (printed circuit board) creation and implementation
- Familiarise myself with G-code file format
- Research how to impose a Cartesian coordinate system on an arbitrary workspace
- Create a working prototype capable of moving to specified points on a flat vertical surface
- Create final Product capable of drawing an image on a flat vertical surface

3 Relevant Experience

Many skills will be utilized in this pursuit, programming, arithmetic, geometry, electronics *etc...* I have undertaken some such projects in the past although not at this degree of complexity. This grants me familiarity with languages like C, python and Java. The level of mathematics involved in this project are within my abilities with my background in physics. Coupled with consultation from Dr. Taghizadeh and his wealth of practical experience any gaps in my capabilities should be resolvable and further improve my own skills.

4 Deliverables

A hardware unit with appropriate firmware capable of taking an image, either from a camera or saved image. It should then be able to draw the image on a predefined flat vertical plane. Initially the image will be black and white but extendable to RGB if time allows.

5 Planning

Firstly, we need to identify potential challenges that we may encounter in the creation process. The product will have to fulfil some basic functions which will require a motor for movement, a normal dc brushless motor will have inherent imprecision due to its continuous nature, however using a stepper motor will allow exact and discreet motion. This will enable increased accuracy for movement as we can equate each motion to a number of steps. The second main challenge will the transformation of image data into a set of motor rotations. Research indicates G-code and a microcontroller are the best methods to accomplish this.

To allow the project to be completed in an efficient, focused and timely manner, planning is essential. I resolved my plans into two distinct categories. Time management and the design overview will grant the project some solid direction as well as implement restraints on features to prevent feature creep. The project itself will have to be completed within a 24 academic week period and the plans must reflect this. Other factors such as material costs and availability will also be major factors to take into consideration.

5.1 Time management

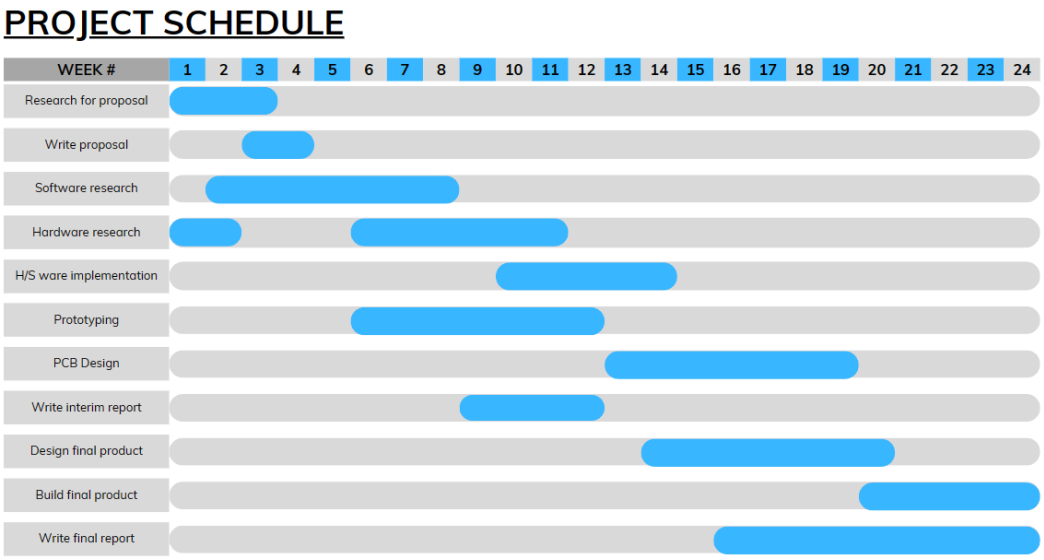

Figure 1: Tasks allocated to a schedule via gnatt chart

It is important to compartmentalise all the required tasks and their estimated duration using a gantt chart. This will ensure that challenges and features are within the scope of what is possible in the allocated time frame. It is imperative that the project is completed. In industry delays and distraction can lead to massive loss of money and great opportunity cost.

5.2 Design draft

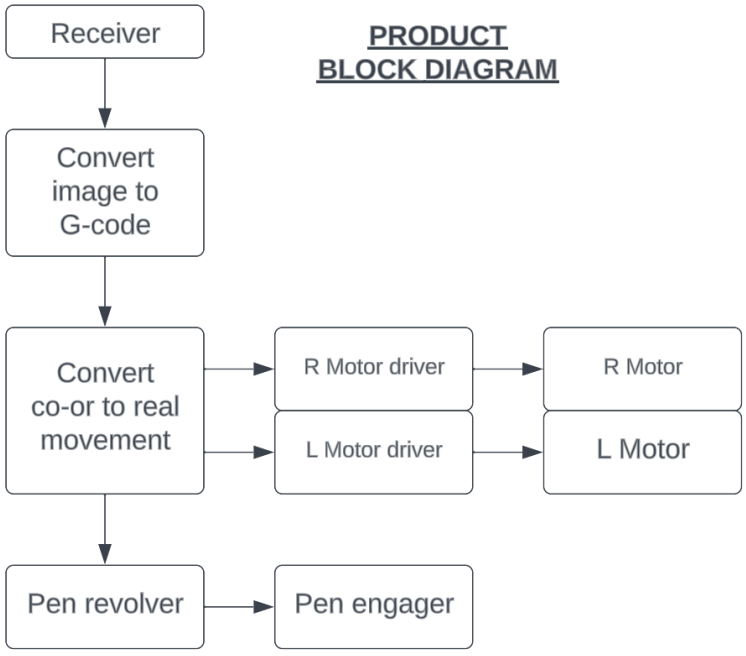

Figure 2: A proposed methodology for turning a image signal into mechanical drawing

The desired end function of the project is known, however there are almost always multiple approaches to any problem. The use of a block diagram can focus development into relevant pursuits by dictating the desired operation structure of the final design.

6 Estimated costs & material requirements

Ultimately for the final design price is a factor we will attempt to minimize. Below are the predicted parts required for the project not including the image receiver (as that is yet to be decided).

Part	Potential Models	Price	Quantity
Fishing line	N/a	£2.50	2
Stepper Motor	28BYJ-48 - 5V	£3.20	2
Motor Driver	ULN2003A	£1.22	2
Microcontroller	atmega32u4	£4.47	1
530 Ω Resistor	N/a	£0.20	8
PCB	N/a	£50.00	1
3D printed Case	N/a	£2.50	1

note these prices are approximate and vary significantly depending on source and quantity. Many of these costs can be further reduced via wholesale purchase if mass production is an end goal. Other parts can be avoided completely with access to specialist machinery such as a 3D or PCB printer.

References

[1] Faisal Ahmed et al. "Assembly of Robotic Arm Based on Inverse Kinematics Using Stepper Motor". In: *2012 Sixth UKSim/AMSS European Symposium on Computer Modeling and Simulation*. 2012, pp. 285–290. DOI: 10.1109/EMS.2012.36.

[2] Prodan Prodanov and Dobroslav Dankov. "Reliability of low-power stepper motor drivers". In: *2022 XXXI International Scientific Conference Electronics (ET)*. 2022, pp. 1–5. DOI: 10.1109/ET55967.2022.9920214.

[3] Vinod Kumar S et al. "Study of Stepper Motor Control using Programmable Logic Controller (PLC) based on Industry 4.0". In: *2022 International Conference on Smart Generation Computing, Communication and Networking (SMART GENCON)*. 2022, pp. 1–4. DOI: 10.1109/SMARTGENCON56628.2022.10083617.

[4] J.N.V.R. Swarup Kumar et al. "Wireless Control System for Custom-Designed Application using IoT-Enabled Stepper Motor". In: *2023 International Conference on Sustainable Computing and Smart Systems (ICSCSS)*. 2023, pp. 1032–1035. DOI: 10.1109/ICSCSS57650.2023.10169841.