Project Deliverable Report Instructions

This document is a template for the project deliverable submissions. Your group will edit this document all semester and submit it each time you have an updated section (new deliverable is done). Please keep track changes ON so that the TA can see what has been changed every time it gets submitted. So that it does not become laggy when the document is too large, 2 templates are provided (PD B-D and E-I).

Template conventions:

* Remove all red text, it is only there to guide you
* Remove this page (instructions)
* Replace all instances of <xxx> with the appropriate information for your group, for example you could replace <GROUP NUMBER> by ‘B1.3’

GNG2101

Design Project Progress Update

<GROUP NAME AND GROUP NUMBER>

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<Date Jan. 19th 2024>

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List of Acronyms and Glossary

Provide a list of acronyms and associated literal translations used within the document. List the acronyms in alphabetical order using a tabular format as depicted below.

Table 1. Acronyms

|  |  |
| --- | --- |
| **Acronym** | **Definition** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Provide clear and concise definitions for terms used in this document that may be unfamiliar to readers of the document. Terms are to be listed in alphabetical order.

Table 2. Glossary

|  |  |  |
| --- | --- | --- |
| **Term** | **Acronym** | **Definition** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# Introduction

The project focused on designing a custom camera control system for the person who made videos/vlogger who has accessibility issues such as using wheelchairs. Our clients currently use two types of cameras - Sony ZV1 and Canon SX730HS. The essence of our design is allowing the user to easily, precisely activate, and rotate, adjust the camera 360 degrees, plus includes mechanisms for activating on/off and start/stop functions. This approach not only provides users with greater independence, but also opens new possibilities in the field of the project itself: Accessible Camera. It could enrich the overall quality and variety of vlog content that people with disabilities can make.

In this document, our focus is on interpreting the requirements provided by our clients, comparing them with similar existing products to identify key areas of innovation and prioritize these requirements to shape a clear, specific problem statement. The document is going to guide and record our design process to meet our clients' unique needs effectively.

# Business Model Canvas and DFX

## Business model and sustainability report

## **Value Proposition and Commercializing**

## The suitable value proposition for the project is humanistic care. It may be incompatible with commercialization. Accessible Camera Operation is a customized task object that is strongly related to the client requirement. Different clients have different demands. Based on the client’s demand, we come up with the whole solution and build the entire system and planning. Besides, the product must have a human touch. Clients intuitively measure the value of our products through the use experience. The living convenience that the product can bring to the user directly affects the value of the product. In conclusion, the suitable commercializing and business model for our deliverable is Product-Service System, PSS. This model combines traditional physical product sales with value-added services to deliver a more holistic customer experience and value.

1. **Triple Bottom Line Model Canvas**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Key Partners**  - Wheelchair companies  -Camera companies  -Government Disability Programs  -Logistics and shipping partnersdisability support organizations | **Key Activities**  -Mobility assisting  - outreach programs to raise awareness | **Value Properties**  -Motorized for differently abled users  -Removable  -portable  -Inclusive design  -seamless control | | **Relationships**  **-**Assistance provided with product through Online and in person  -engagement with customers through forums and feedback sessions  - long-term relationships with distribution partners for effective supply chain management | **Customer Segments**  **-**Differently-abled people on wheelchairs  - Photography enthusiasts with disabilities  - Families and caregivers of differently abled individuals |
| **Key Resources**  -Platform  - Training materials and resources for user education  - Research and development team for continuous improvement  -Customer service team for support | **Channels**  -Online Marketplaces  (Amazon)  -Personal Website  -Partnered websites (Nikon website)  - Pop-up events and demo days in partnership with retailers |
| **Cost Structure**  -product Material  -Shipping Material  -Partnerships with online personalities to get the name out in the world  - Compliance with accessibility standards and certifications | | | **Revenue Streams**  -Items sold (unit/bulk)  - Subscription model for added services or features  - Donations and grants from foundations supporting disability initiatives | | |
| **Social/Environmental Cost**  -Environmentally friendly recyclable material  (Hence little to no disposing charge)  -Production process (shipment, manufacturing...etc.)  - Carbon offset initiatives for shipping | | | **Social/Environmental Benefit**  -Gives a sense of independence (social)  -Transforms the standard of Camera usage for differently abled individuals  (social)  Eco-friendly product and production contribute to a greener environment  (environmental) | | |

1. **Model Canvas Core Assumptions and Its Feasibility**

Some core assumptions we have are:

* The customers are going to be either wheelchair users themselves or someone who knows a wheelchair user
* The wheelchair users that will be using this product likely has strong mobility limits, like minimal to no bodily movement
* The user wants the feeling of ease and independence

1. **Sustainability Report**

|  |  |  |
| --- | --- | --- |
|  | Positive | Negative |
| Environmental |  | Production process  Disposal process  Motor powered |
| Social | Gained independence for wheelchair users |  |

## Design for X

The five most important factors in our design relevant to client meet 1:

* Is the accessibility of usage being able to be fully independent starting/stopping the recording
  + The option of the camera’s 360 vision
  + The option of removing the camera for charging
  + The option of adjusting the height of camera angle
  + The option of having the recording capture both the environment and the user

**1.** **Automated mechanism:**

The device must be able to operate without the need of a manual input by the client. The device must be able to start/stop the camera without the need of the user using the Camera’s built-in buttons. The device also must be able to rotate 360 degrees without the need of touching the camera itself. The option of adjusting the height of the camera is recommended.

### **2.** **Power usage/Source**

The client’s wheelchair is new (recently ordered) and is suspected to be under warranty.

Hence the power source needs to be independent as it may void the warranty if tinkered with. Therefore, we must implement our own power source that fits our limited dimensions. Which bring us to compactness.

**3.** **Dimensions/materials**

The device needs to be designed to be compact so that it doesn’t limit the client’s mobility. The device has specific space requirements to ensure that it doesn’t affect user comfort or block doorways due to its size and placement. The materials must be rigid as the vlogs consists of her in many locations (inside/outside) and must be stable and non moving when riding on cracks in sidewalks.

**4.** **Removable**

The client wants the device to be removable for the caretaker to edit and post the videos on to YouTube, not for daily use but as an option. This means we can't use screws to attach it to the wheelchair in the usual way, so we need to find an alternative solution.

**5.** **Functions**

The product's purpose is to allow the differently abled user to be independent in setting up/ taking vlogs hence the functions are clear. These include 360 rotations, adjusting the height of the camera, and starting/ stopping the recording all through the independence of the user.

# Problem Definition, Concept Development, and Project Plan

## Problem definition

|  |  |
| --- | --- |
| **Need** | **Importance (1-10)**  **(10 being of foremost importance)** |
| Base will allow camera to rotate 360 degrees | 9 |
| Will be able to start/stop/turn on/turn off camera/recording | 9 |
| Will be able to transfer device to another wheelchair | 2 |
| Does not affect client's or associates' comfort/ mobility | 10 |
| Stability of camera when wheelchair moving | 9 |
| Base's height can be adjusted | 4 |
|  |  |

**Problem statement:**

Invent a compact, removable, sturdy base/mount that will allow the user to be independent before, during and after vlogging. The system includes accessibility features that will allow the user to use camera functions and more without physically touching the camera itself. The system mounts on the right armrest and does not hinder comfort/ mobility.

|  |  |  |
| --- | --- | --- |
| Need  (value) | Metric | Units |
|  | Occupying space | Cm^3 |
|  | Strength of materials | Brinell hardness scale |
| 150 | cost | CAD |
| 0-360degs | Adjustability range | CM^2 |
|  | Weight of chassis | Newtons |
|  | Force of motor |  |
|  |  |  |

Target specifications:

Operating range (angle adjustment):

Ideal value: 0° to 360°

marginally acceptable values: 0° to 180°

Ease of use (adjustment time):

Ideal value: less than 10 seconds

Marginally acceptable values: less than 30 seconds

Reason: Quick adjustment is user-friendly, but the adjustment time of 30 seconds is also an acceptable value without affecting the need for emergency adjustment.

Stability (vibration amplitude):

Ideal value: vibration less than 2 mm

Marginally acceptable values: vibration less than 5 mm

Reason: Video quality depends on the stability of shooting, the ideal value ensures high-quality output, and the minimum value prevents obvious video shake.

Cost effectiveness (total cost):

Ideal value: no more than $150

Marginally acceptable values: no more than $200

Reason: Try to keep costs within budget but try not to compromise on quality and functionality to keep costs down.

## Concept development

Through consensus and most importantly sketches were used to determine what the best design would be. We categorized three main elements who are 1: The mount for the camera 2: The mount to the wheelchair 3. protective chassis

The mount for the camera: These is the tripod sockets of 2 types of cameras that the client is using currently. They are using ¼ UNC Screw for camera mounting.

We will 3D print the base assembly (and most of mechanical components) to mount the camera into the system.



(On the left is Canon SX730HS, on the right is Sony ZV1)



**The mount to the wheelchair:**

We decided to use a simple robotic arms system to hold the camera. To power up the system, using stepper motors is our first choice.

 (robotic arms)

(NEMA stepper motor)

**Protective chassis:**

Made by 3D printing to protect the motor. Simultaneously linked to the robotic arm

**Analyze and evaluate:**

Using a simple robotic arm and stepper motors (NEMA stepper motors) may provide the necessary stability and accuracy. Stepper motors are very useful for precise angle control and are often used for precise position control, which is crucial for the client.

Using 3D printing to create the base assembly and most of the mechanical components, this approach potentially reduces production costs and provides design flexibility. 3D printing also allows for rapid prototyping and custom parts, making it ideal for low-volume production and custom designs.

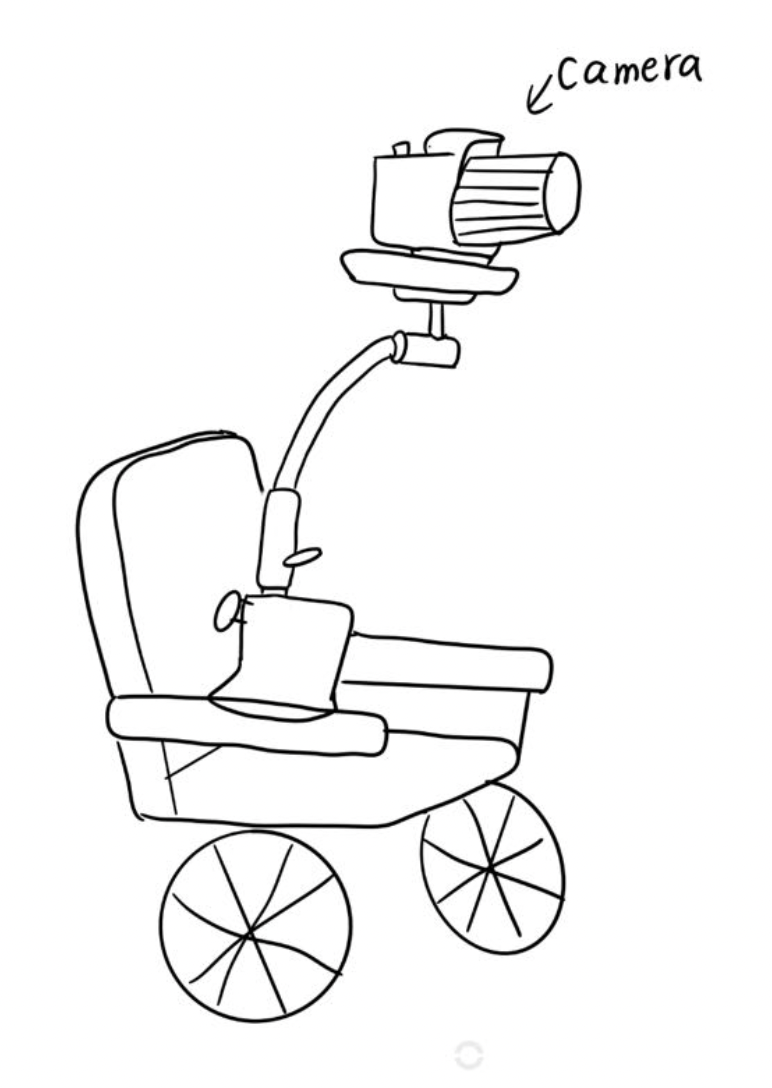
The tests we will do next:

1. Use CAD software for design simulation and structural analysis to ensure that the robotic arm and stepper motor can bear the weight of the camera and remain stable.

2. Conduct a cost analysis to compare the cost-effectiveness of different types of motors and manufacturing methods.

3. Conduct ergonomic assessment based on user needs to ensure the accessibility of the design.

**Global concept:**



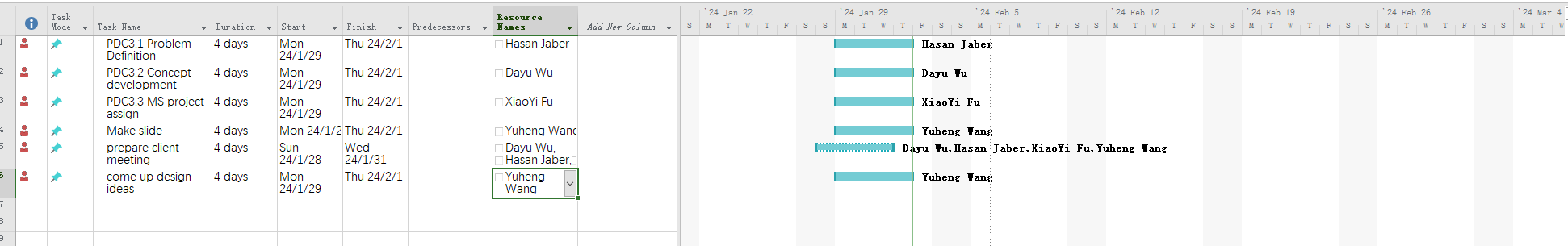
(sketch of our concept)

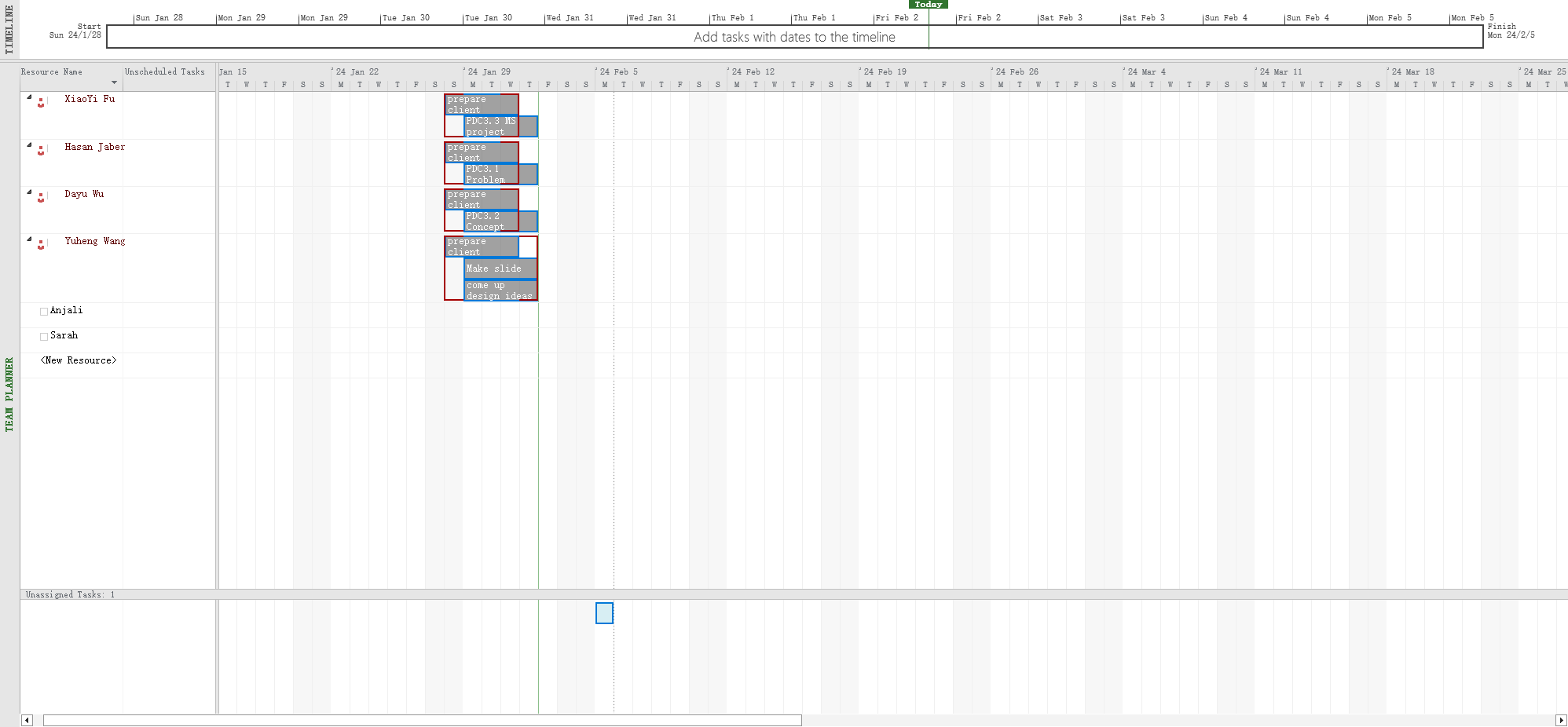
We will use 3D printing to make the base of the camera, use a robotic arm to fix the camera and achieve 360-degree rotation of the camera, use stepper motors to power the device, and use bearings to connect our device to the wheelchair.

**Benefits and drawbacks:**

We designed it to allow users to easily and precisely activate and rotate the camera, adjust it 360 degrees, and include mechanisms for activating on/off and start/stop functions. We chose Voice Control from three control methods (Voice Control, Bioelectric Control, Eye Tracking). In this way, we can allow users to control the camera through simple pronunciation. Compared with the other two methods, users can use the camera independently.

## Project plan





# Detailed Design and BOM

## Detailed design

**Feedback and improve:**

In the second client meeting, we discussed the rotation structure, Camera Mounted and control methods with the client. The client agreed with our idea of using a motor to rotate the camera and using 1/4UNC screws to install the camera. However, the client still has many concerns about the control methods we provide. We have proposed three control methods: voice control, bioelectric control, and eye tracking. After our discussions and understanding of our client’s unique physical situation, we decided that none of these three options was the most reasonable solution. We re-discussed the control method after the meeting and tried to come up with some simpler and more client-friendly methods.

## BOM

BOM Table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Serial number | Item name | function | imputed price | remark |
| 1 | 3D printed system shell | The system body | 45$ |  |
| 2 | NEMA Stepper Motors | Use to drive the system and do the rotation actions | 25$ | NEMA 17, NEMA 14, NEMA 11 |
| 3 | MCU | Control the whole system | 5$ | microcontroller |
| 4 | Screw Rod | Height adjustment | 5$ | If needed |
| 5 | Power source | Provide electricity energy | 10$ | 18650 3.7v |
| 6 | Other Expense | - | 10$ |  |
| Total Cost |  |  | 100$ |  |

Detailed BOM for the system mother board:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Quantity | Comment | Designator | Footprint | Value | Manufacturer Part | Manufacturer | Supplier Part | Supplier | LCSC Price |
| 1 | 8 | 100nF | C1,C3,C6,C8,C10,C14,C17,C18 | C1206\_ | 100nF |  |  |  |  |  |
| 2 | 2 | 100uF | C2,C7 | CASE-D\_7343 | 100uF | TAJD337K010RNJ | Kyocera AVX |  | LCSC |  |
| 3 | 2 | 100nF | C4,C5 | C1206\_ | 100nF | CL05B104KO5NNNC | SAMSUNG(三星) | C1525 | LCSC | 0.007355 |
| 4 | 2 | 220nF | C9,C13 | C1206\_ | 220nF |  |  |  |  |  |
| 5 | 8 | 47uF | C11,C12,C15,C16,C19,C20,C21,C22 | CAP-TH\_BD6.3-P2.50-D1.0-FD | 47uF | KM476M050E11RR0VH2FP0 | CX(承兴) | C45101 | LCSC | 0.093931 |
| 6 | 2 | 1N5819WS | D1,D2 | SOD-323\_L1.8-W1.3-LS2.5-RD |  | 1N5819WS | Hottech(合科泰) | C191023 | LCSC | 0.077033 |
| 7 | 2 | 1N4007WS | D3,D4 | SOD-323\_L1.6-W1.3-LS2.7-RD |  | 1N4007WS | JSMSEMI(杰盛微) | C2687395 | LCSC | 0.095552 |
| 8 | 6 | SZYY1206R | LED1,LED2,LED3,LED4,LED5,LED6 | LED1206-RD-R\_RED |  | SZYY1206R | yongyu(永裕光电) | C434438 | LCSC | 0.086348 |
| 9 | 3 | 10K | R1,R2,R3 | R1206-1 | 10K |  |  |  |  |  |
| 10 | 3 | 220 | R4,R5,R6 | R1206-1 | 220 |  |  |  |  |  |
| 11 | 2 | 120Ω | R7,R8 | R1206-1 | 120Ω | 0603WAF1200T5E | UNI-ROYAL(厚声) | C22787 | LCSC | 0.006769 |
| 12 | 2 | 499 | R9,R10 | R1206-1 | 499 |  |  |  |  |  |
| 13 | 4 | 4.7K | R11,R12,R13,R14 | R1206-1 | 4.7K |  |  |  |  |  |
| 14 | 4 | 1K | R15,R16,R17,R18 | R1206-1 | 1K |  |  |  |  |  |
| 15 | 1 | DSIC03TSGER | SW1 | SW-SMD\_3P-L7.6-W6.0-P2.54-LS9.3-BL |  | DSIC03TSGER | 康深 | C5123695 | LCSC | 3.23 |
| 16 | 2 | KH-6X6X5H-STM | SW2,SW3 | SW-SMD\_4P-L6.0-W6.0-P4.50-LS9.0-2 |  | KH-6X6X5H-STM | kinghelm(金航标) | C2837531 | LCSC | 0.12092 |
| 17 | 2 | AMS1117-5.0 | U1,U4 | SOT-223-3\_L6.4-W3.5-P2.30-LS7.0-BR |  | AMS1117-5.0 | 国芯佳品 | C2992571 | LCSC | 0.20956 |
| 18 | 2 | CH340N | U2,U3 | SOP-8\_L4.9-W3.9-P1.27-LS6.0-BL |  | CH340N | WCH(南京沁恒) | C2977777 | LCSC | 3.08 |
| 19 | 9 | 2.54 - 4P | U5,U6,U10,U11,U15,U16,U20,U21,U22 | 2.54 - 4P |  |  |  |  |  |  |
| 20 | 2 | L7805CD2T-HXY | U7,U17 | TO-263-2\_L10.2-W8.5-P2.54-LS15.2-TL |  | L7805CD2T-HXY | HXY MOSFET(华轩阳电子) | C7469133 | LCSC | 1.3947 |
| 21 | 1 | stm3f411ceu6 | U8 | stm32f411ceu6 |  |  |  |  |  |  |
| 22 | 1 | 2.8inch TFT LCD | U9 | 2.8inch TFT LCD |  |  |  |  |  |  |
| 23 | 8 | a4988 | U12,U13,U18,U19,U23,U24,U26,U27 | a4988 module |  |  |  |  |  |  |
| 24 | 1 | ffc143d8276c44578a3cfb16aa13db7b | U14 | esp32c3-mini |  |  |  |  |  |  |
| 25 | 1 | 1.3 inch OLED | U25 | 1.3inch OLED module |  |  |  |  |  |  |
| 26 | 2 | DB301V-5.0-2P-BU-S / | U28,U29 | CONN-TH\_2P-P5.00\_L7.6-W10.0 |  | DB301V-5.0-2P-BU-S | DIBO(地博电气) | C395882 | LCSC | 0.59142 |
| 27 | 2 | TYPE-C 16P QTWT | USB1,USB2 | USB-TYPE-C-SMD\_TYPE-C-16P-QTWT |  | TYPE-C 16P QTWT | SHOU HAN(首韩) | C5187472 | LCSC | 0.434529 |

**4.3 List of skills and resources:**

**Skills:**

* 1. Mechanical Engineering: Skills in designing mechanical parts and systems, especially for compact and sturdy camera mounts.
  2. Electrical Engineering: Expertise in designing and implementing control systems using microcontrollers and stepper motors.
  3. Software Development: Abilities in programming microcontrollers, creating user interfaces, and possibly developing motion control algorithms.
  4. 3D Design and Printing: Experience in creating and printing custom parts for prototypes and final products.
  5. Project Management: Skills in planning, executing, and monitoring project timelines and resource allocation.
  6. 3D Printers: For creating prototypes and parts.
  7. Microcontrollers and Stepper Motors: Key components for the control system.
  8. Design and Development Software: CAD for mechanical design, and development environments for programming.

**Missing Skills/Resources and Acquisition Plan:**

* 1. Ergonomics and accessibility expertise: Although not a strong point yet, learning can help fill this gap as much as possible.
  2. Advanced prototyping tools: Current 3D printing capabilities are limited and can only produce rough parts.
  3. Materials Science: Knowledge of materials that are lightweight, durable, and suitable for use in medical or accessibility-related devices.
  4. Regulatory Compliance: Understand the legal and safety standards associated with devices designed for accessibility to ensure the product meets all necessary guidelines.

**4.4 Realistic assessment of time:**

Our next process is: Prototype Development, Integration and Testing, Refinement and Final Testing, Documentation and Preparation for Design Day. Each job takes about ten days. We currently do not have a specific division of member because we do not know the next time schedule of each member, but we have divided the work and will divide the work according to the professional knowledge and time schedule of the team members.

**Prototype Development:**

1. Start assembling the prototype based on the 3D model. This involves 3D printing the parts and preparing the electronic components for integration.

2. Write code for the product. This part was given to Yuheng because his timing was suitable and he was good at writing code.

3. Conduct preliminary testing of components and software to identify any immediate issues or required adjustments.

4. Record work progress and write deliverables.

**Integration and Testing**

1&2: Work together on integrating the electronic components with the physical prototype, ensuring everything fits and functions as designed.

3: Continue refining the code, focusing on reliability and user accessibility features.

4: Design and execute a detailed testing plan for the integrated prototype to identify any functional or usability issues.

**Refinement and Final Testing**

1: Focus on resolving any material or hardware-related issues found during testing, sourcing alternatives if necessary.

2&3: Collaborate on adjusting the physical design and software based on feedback from testing, ensuring both are optimized for final use.

4: Lead the final round of comprehensive testing, including user experience aspects, to ensure the product meets the project's goals.

**Documentation and Preparation for Design Day:**

All Members: Contribute to preparing detailed documentation of the design process, technical specifications, and user manual for the product. Also, prepare a presentation that outlines the project's objectives, design process, challenges encountered, and the solutions developed.

**4.5 Critical product assumptions:**

Key product assumptions that may impact the ability to implement a design include:

1. Material availability: Assume that specific materials and components (such as specialized stepper motors or microcontrollers) can function as we envision.

2. Power consumption: It is assumed that the power consumption of the device is compatible with the wheelchair power system without affecting its functionality.

3. User interface adaptability: It is assumed that the control interface can perfectly adapt to our users.

4. Durability and reliability: Products must be able to withstand daily use in a variety of environments without the need for frequent maintenance or parts replacement.

5. Regulatory Compliance: It is assumed that the design complies with all relevant safety and accessibility regulations for medical or assistive devices.

6. Cost-Effectiveness: Assume that the amount to achieve the final product is within our budget.

7. Technical Specifications: Key features such as the camera's range of motion and control accuracy are assumed to effectively meet the end-user's needs.

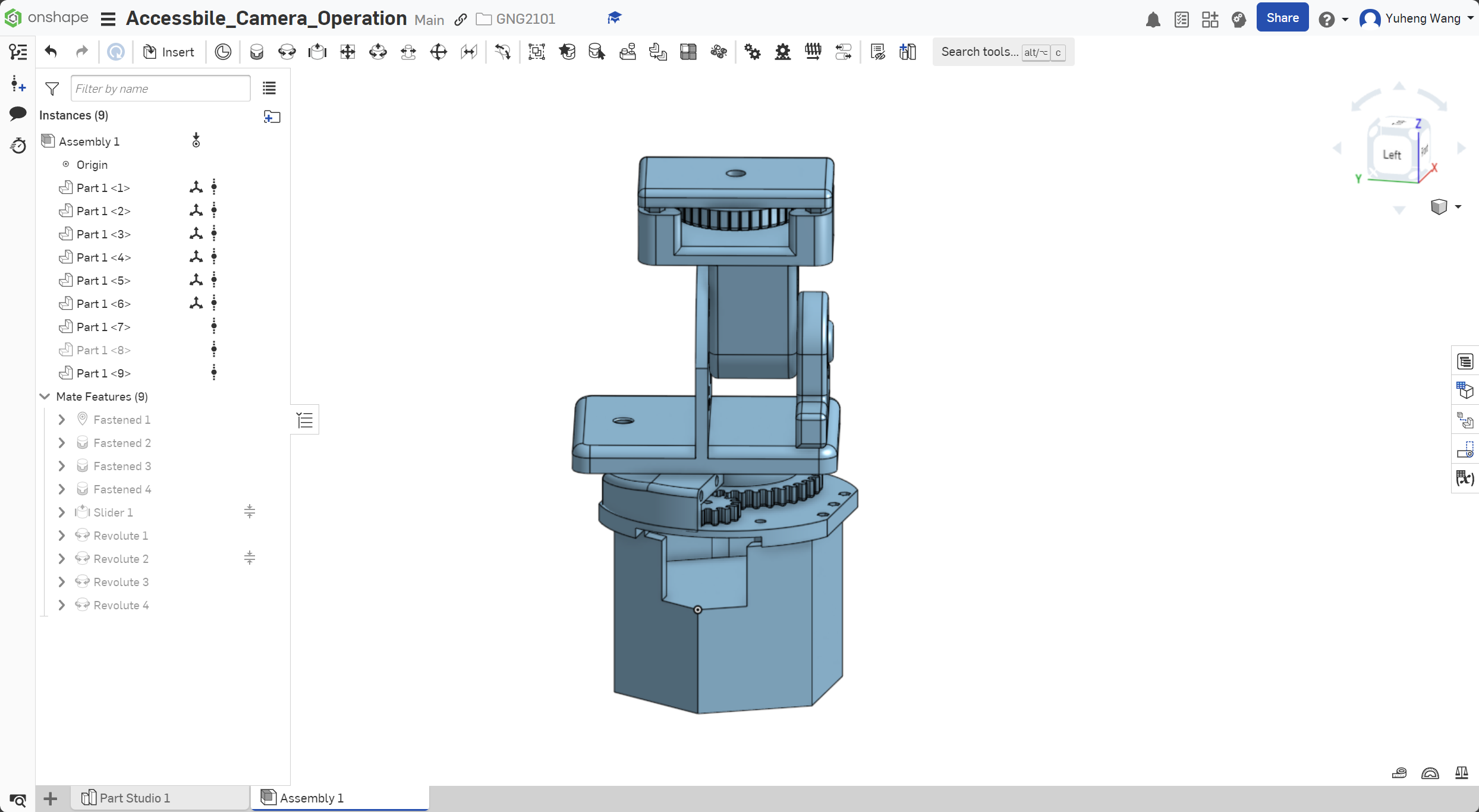
These assumptions are critical to the success of the project and need to be verified during the design and testing phases to reduce risk.

**4.6 Detailed design:**

After multiple versions of CAD updates, we proposed the first 3D prototype of the whole Camera Control System. The system is driven by NEMA stepper motors to make the rotation and other actions. It will be powered by a power source that is able to support 12V/2A. The central processing unit of the system is STM32F411CEU6, a 32-bit ULP microcontroller.

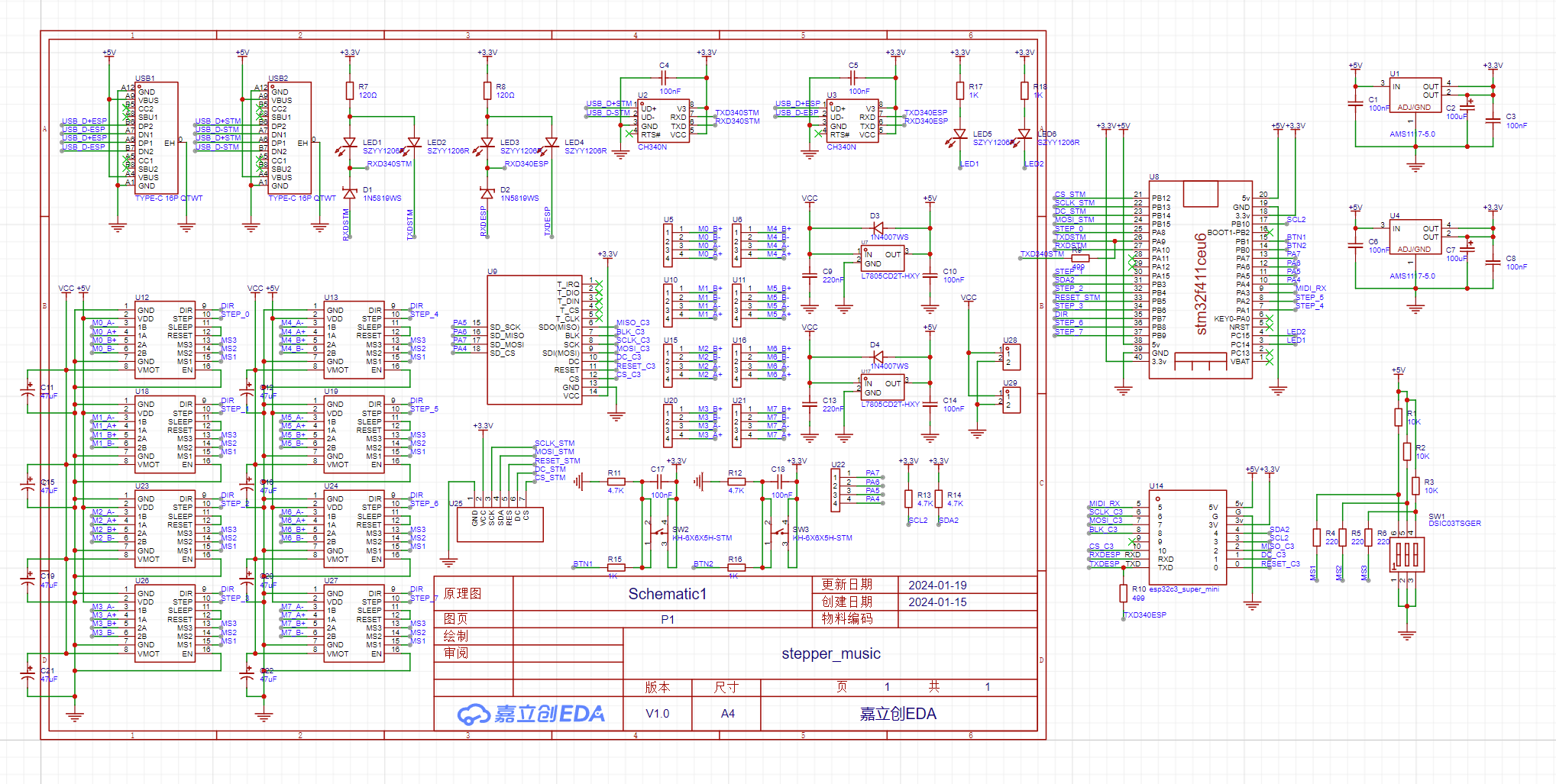
The final suitable control method for the client to control the System would be motion control. In consideration of the client’s physical condition, motion controlling would be the best way to describe the command that comes from the client. The system reads the relative motion of different that generate from the client’s body such as head. After that, the system will control the stepper motors to react the same way as the client did. This is an efficient way.

Here’s the [3D CAD module](https://cad.onshape.com/documents/fc6b3659ee376c0b5e9f863d/w/ac86f86a2acf88c1a9c1d776/e/c536582932526b03cc2d9012?renderMode=0&uiState=65cde3583a62837281d62529):

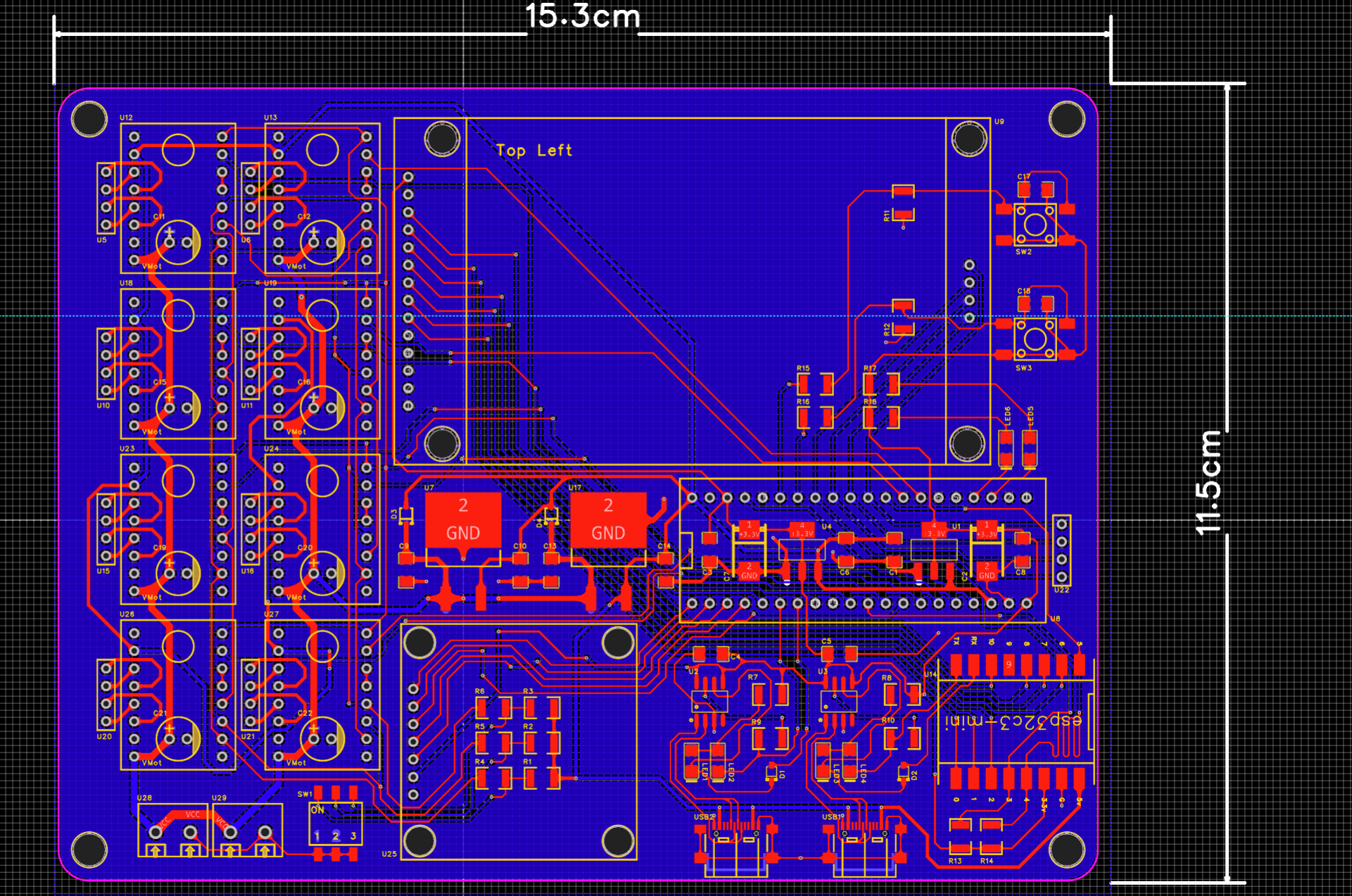


Here’s the system mother board:

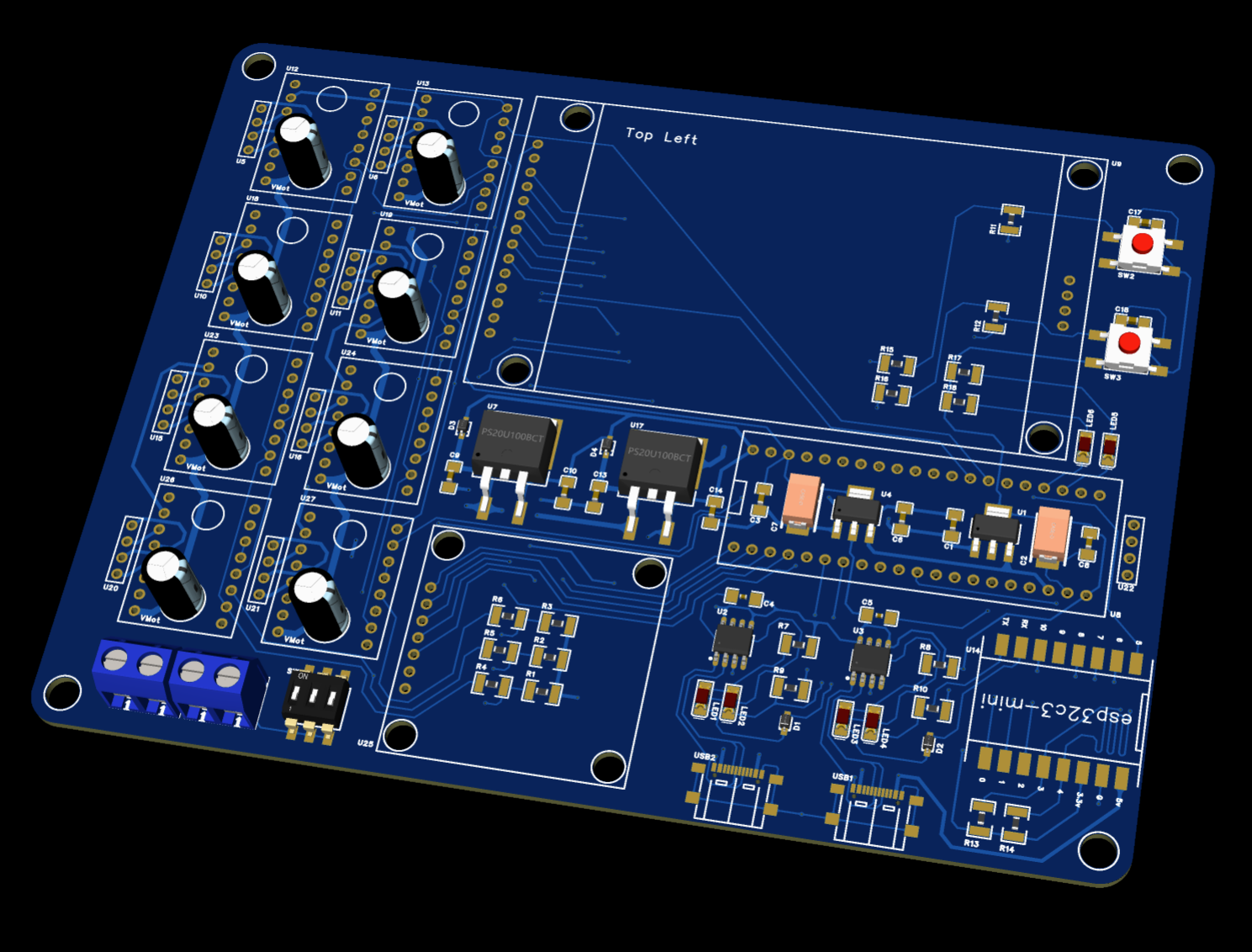
Schematic diagram:



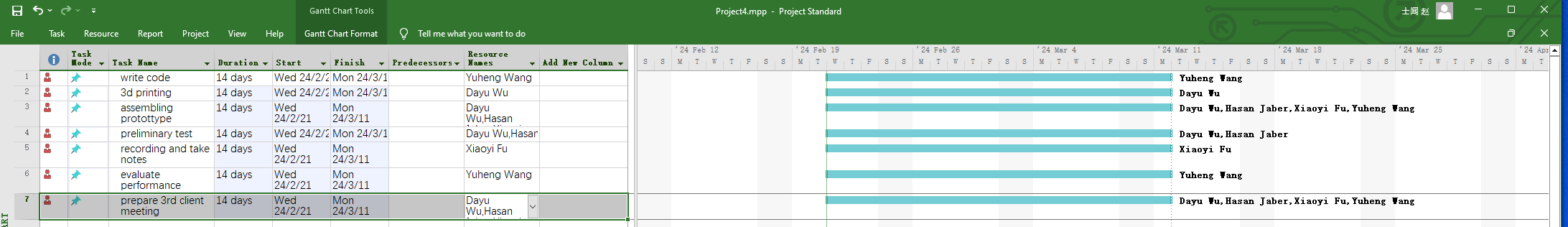
Circuit board diagram:

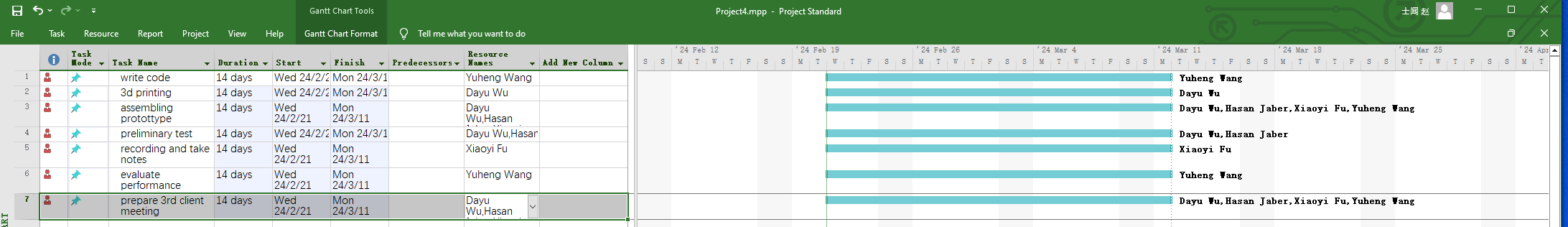


3D model diagram:



## Project plan update





# Conclusions

Summarize your lessons learned and your work related to your project. Discuss any outstanding issues or implications for the project.

# Bibliography

Insert your list of references here.