**Key things to be aware of**

“Be **simple**, be **direct**, nothing **fancy”** – Stilgard, Dune II

5,000 really **isn’t** much, if we write run-on sentences, we will quickly run out of space

We have a word limit, but **no** diagram limit, provide with as many diagrams/charts/tables/CAD/Circuits as possible

In Chinese, there’s a saying that *an image is more than a thousand words （一图胜千言）*

Always **proofread** what each other writes (I was to be blamed for some silly mistakes in presentation)

**Third person regular tense** (except for the reflection and describing the experiments that have been done, where we use the past tense), **passive** is preferred

**Abstract**

Write the abstract at last, focus on the key facts numbers in our result, highlight what advantage our system has. ~150 words are fine.

**Introduction/ Background**

Setting up the context of our project

What issue are we trying to tackle with our product? (This is essentially a product pitch)

List and refer necessary fact to contextualise readers and provide solid scientific grounding, but don’t overplay it

What are some existing products out there in the market (This is essentially a competitor analysis)

A summary in table what are the existing solutions, columns include things like image, brief description of function, indications (target user), price range, life span, cons/shortcomings (in bullet points)

A brief explanation and description of where we place our product amongst those

Use a diagram to illustrate this, think of a spectrum, or 2D scatter graph (usability-price for example)

On the y-axis, we can line all solutions from the most wearable to the least wearable bottom to top. On the x-axis, we take the log scale of the average price range of each solution.

Our device should somewhat sit in the lest bottom side of this graph.

**Requirements definition**

Have **4-7** criteria, each starts with a single word

The subsection does not need to be a copy from our PSD. In fact, it should be more generalized and higher-level compared to the PSD, outlining what we **intend** to do, not how exactly how:

Our intention (Introduction)

General requirements (THIS section)

Specific requirements (In PSD)

Actual outcomes (The body of the report)

Comparison and evaluation (Discussion)

This should be as short as possible, within **one page** is the best.

**Design**

**Design of Mechanical Parts**

Picture of the final CAD (at least three viewing angles)

Picture of the printed prototype

**Electrical Components**

A table summarising all electronics in our design

Use Altium to draw the circuit diagram for the left-half of the glass

Raspberries Pi

Briefly mention where is it used, which type, for what

Include picture illustration

Google Glass

Briefly mention why it is used, the dev env, platform

Include picture illustration

**Software**

Use the directed graph to show the relations amongst different modules

For each module, use additional flow charts to show the program logic:

One for eye-tracking

One for OS

One for interface

For each module diagram, specify the input data type, output data type and the steps of modifications in between (make sure the explanation is clear enough that other people can implement using another language/package)

**Assembly**

Picture of the product with integrated mechanical parts and electronics

A picture of one of our members wearing it on his/her head to add authenticity

Screen shot of the running software

**Experiments (detailed descriptions should be in the Appendix)**

**Experiment 1: ROI Detection**

**Description of the Protocol**

* Select **three distinct ambient light conditions**: *dim*, *moderate*, and *bright*.
* Under each lighting condition:
  + Generate a randomised sequence of **Region of Interest (ROI)** identifiers.
  + For each trial, instruct the wearer to visually fixate on the specified ROI within the interface.
  + Allow a **2-second window** for the system to process the input.
  + Classify the result as follows:
    - **True Positive (TP):** Correctly identifies the user’s intended ROI.
    - **False Positive (FP):** Identifies a different ROI.
    - **False Negative (FN):** Fails to identify any ROI.
  + Include **sham trials** where the user gazes *outside* any defined ROI:
    - If the system outputs no classification → **Correct Rejection**.
    - If it misclassifies to an ROI → **False Positive**.
* Use this data to construct an **accuracy matrix** reflecting detection performance across all lighting conditions.

**Result 1:** *Accuracy Matrix*

**Experiment 2: IMU Motion Detection**

**Description of the Protocol**

* Define a set of gestures encoded into the IMU gesture recognition algorithm (e.g. nod, shake, tilt).
* Recruit **≥3 participants**, each performing **≥ 100 gesture trials**.
* For each trial:
  + Instruct the participant to perform a target gesture.
  + Observe whether the system detects and maps it to the correct command.
* Classify:
  + **Correct Detection:** Command is triggered accurately.
  + **Incorrect Detection:** Misclassification or no response.
* Compute **detection accuracy (%)** for each gesture across all participants.

**Result 2:** *Accuracy Score Table*

**Experiment 3: Steady-State Temperature**

**Description of the Protocol**

* Run a **computationally intensive task** on the Raspberry Pi (more demanding than actual program usage) to simulate worst-case thermal load.
* Measure temperature under two conditions:
  + **With Cooling Fan**
  + **Without Cooling Fan**
* Measure surface temperatures at:
  + **Left temple region** (housing the Pi and electronics)
  + **Directly on Pi chip surface** (via internal probe if accessible)
* Continue until thermal equilibrium is reached (plateau in temperature readings).
* Record coordinates and temperatures to extrapolate a **thermal distribution map** of the housing.

**Result 3:** *Heat Map (Coordinate Extrapolation)*

**Experiment 4: Battery Discharge**

**Description of the Protocol**

* **Step 1: Estimation Phase**
  + List and sum the typical **power consumption** of all connected components (Pi, camera, sensors, etc.).
  + Estimate expected operational time based on **battery capacity (mAh)**.
* **Step 2: Experimental Simulation**
  + Set up an **analog circuit** simulating the device’s power load (equivalent resistance or current draw).
  + Provide with a SPICE equivalent circuit diagram to illustrate the setup.
  + Connect the battery and measure:
    - **Voltage-drop** over time
    - **Current draw**
  + Determine:
    - Whether the battery sustains the expected operation time.
    - Where the system's operation point lies on the **battery's discharge curve**.
* Conclude if the selected battery meets design requirements.

**Result 4:** *Load Line, Current–Time Graph*

**Further Testing**

|  |  |  |
| --- | --- | --- |
| Test Type | Description | Pass Criteria |
| Humidity Test | - Create a sealed moist chamber using a humidifier and measure relative humidity with a meter.  - Leave device inside for **10 minutes at 80–90% RH**.  - Observe any condensation or malfunction. | No malfunction or damage |
| Drop Test | - As defined in PSD: drop device from **1 m** onto hard surface, simulating handling error.  - Repeat on multiple surfaces (wood, concrete). | Fully functional post-drop |
| Edge/Sharpness Test | - Apply **PTFE tape** to edges suspected of causing cuts.  - Press gently against forearm/skin substitute with normal wearable force.  - Evaluate visually, include the tape image. | No visible cuts on the tape |
| Volume Test | - Output pre-defined sentence through TTS.  - Measure SPL (Sound Pressure Level, dB) at distances of 0.5 m, 1 m, 2 m.  - Repeat in quiet and noisy environments. | Must be ≥ 60 dB at 1 m |

**Qualitative feedback**

Before asking them to fill the survey, we will ask them to -

1: Have a read of our one-page pamphlet used to pitch our idea (can be taken from our poster), including main design ideas of our product.

2: Let users to try out our webcam version of the interface program to spelt out some words. We can create a website version of the interface and share via the link in the survey.

Things to be included in the survey (See below for a draft questionnaire)

Survey results presented in charts

2~3 pull quotation to highlight key finding from the filled survey

**Discussion**

**Tick-box Table**

A table listing everything we’ve written in our PSD that we should have done, and evaluating one by one whether we have done it or not, provided with a brief justification

This is an **objective** evaluation of what’s missing and what’s done

**Requirements Table**

Connect to section two, evaluate criteria by criteria whether our design fully meets, partially meets, or not meeting the respective criteria, and mention measures we could take to meet the criteria further

This is a **subjective** evaluation of whether our design is good/good enough/not

Refer to the results obtained in experiments to justify our own marking

**Improved Version**

Here, propose two major improvements. They must be something we cannot do due to our limitations, otherwise we should have incorporated that already in our current design

This is an **optimistic** outlook on the future steps. In publications, that’s usually where the researchers invite more people to go

**Option 1**: A much **cheaper** alternative suitable for **mass production**

Replace Google Glass with a cheaper display

Improved case design suitable for ejection moulding

Customised circuit board to integrate our electronics

**Option 2**: A more **high-tech** alternative for **enhanced functionality**

AI-driven model for CV, input classification and prediction

Other modalities, such as the sMEG (aha, we sneak that in)

Miniaturise and optimize for wearability and seamless camouflage

**Appendix**

**Team Management – Lina you got this**

**Risk Management**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Assembly** | **Failure & Effect** | S1 | O1 | D1 | **RPN before** | **Preventing measures** | S2 | O2 | D2 | **RPN after** |
| **Device edges** | The edges of the device could cause small cuts and damage skin | 4 | 5 | 6 | 120 | Use PTFE tape for testing and apply chamfer and smoothening edges where the test result shows potentially damaging corners | 2 | 2 | 3 | 12 |
| **Device temperature** | Device could locally cause temperature rise exceeding 41 , leading to skin discomfort or damage | 4 | 4 | 5 | 80 | Combine with the heat map result and apply ventilation outlets and heat-resistant casing to reduce local heat accumulation | 3 | 2 | 4 | 24 |
| **Cable connections** | Loose or exposed cables may cause short circuits or user discomfort | 4 | 5 | 6 | 120 | Secure connections with insulated sleeves and strain relief clips; visually inspect prior to use | 2 | 2 | 3 | 12 |
| **Electronic circuits** | Malfunction or exposed circuits may result in minor shock or device failure | 5 | 4 | 5 | 100 | Encapsulate all components in insulating resin or plastic housing, check against BS EN 60601 | 3 | 2 | 3 | 18 |
| **Batteries and charging** | Battery overheating, swelling, or leakage causing burns or hardware failure | 6 | 4 | 6 | 144 | Use certified battery with thermal protection and follow BS EN 62133 test standards | 3 | 2 | 3 | 18 |
| **Excess light stimulation** | Device screen may overstimulate sensitive users, potentially causing discomfort or triggering conditions | 3 | 4 | 4 | 48 | Consult AAC experts, adopt low-saturation and adjustable brightness interface design | 2 | 2 | 3 | 12 |
| **Visual hinderance** | AR glass and camera module may block peripheral vision, impacting navigation or daily activity | 4 | 3 | 5 | 60 | Minimise hardware footprint, validate through wearability and field-of-view testing | 2 | 2 | 3 | 12 |
| **Unintended communication and hacking** | Output may be hijacked or misinterpreted, compromising user privacy and trust | 6 | 2 | 6 | 72 | Limit external access, encrypt data, and ensure TTS and UI confirm intent before output | 3 | 2 | 3 | 18 |

**Ethics**

**Data Protection and Confidentiality**

The system strictly adheres to the General Data Protection Regulation (GDPR) and the UK Data Protection Act 2018. No identifiable user data is collected, processed, or stored. Real-time input is handled without non-volatile memory to ensure patient confidentiality. Additionally, any survey feedback or user testing data was anonymised to protect participant identities and ensure ethical compliance.

**Psychological and Social Impact**

Given that the device is intended for users with speech impairments, often due to conditions associated with social vulnerability, careful attention was given to minimising psychological and social barriers. The form factor of the wearable was designed to resemble conventional headwear, reducing the risk of stigma and promoting dignified usage in public. Respect for user autonomy and dignity guided interface simplicity and discretion of output.

**Accessibility and Equity**

Affordability and accessibility were prioritised throughout the design process. By prioritising components readily available in the UK and optimising the design for manufacturability, the projected cost was significantly reduced compared to commercial AAC systems. This aligns with principles of fairness and social responsibility in engineering, aiming to expand access to assistive technology for marginalised user groups.

**Autonomy and Consent**

The interface was specifically designed to grant the user full control over all outputs. The device only vocalises user-initiated selections, avoiding unintended output or misrepresentation.

**Legal Compliance and Intellectual Property**

A thorough IP review was conducted to ensure the device does not infringe existing patents. Where third-party technologies were incorporated, they are clearly acknowledged in the documentation. This reflects respect for intellectual property and complies with UK legal standards.

**Transparency and Open Communication**

All testing procedures were documented and reported with transparency, including both positive outcomes and system limitations. Future user-facing documentation, such as manuals and instructions, will prioritise clarity and completeness to support informed use. This approach ensures honesty and openness as outlined in standard engineering codes of conduct.

**Nomenclature – Everyone**

AAC – Augmentative and Alternative Communication

wAAC – Wearable Augmentative and Alternative Communication

LED – Light-emitting Diode

CP – Cerebral Palsy

IMU – Inertial Measurement Unit

AR – Augmented Reality

SDK – Software Development Kit

CV – Computer Vision

SPL – Sound Pressure Level

TTS – Test to Speech

**Bill of Materials**

1) Price of our current option

2) Estimated price of the option outlined in improved version 1, if being mass produced in the UK (average price for 1000 units)

**Experiment Protocols**

**Survey questions**

**A. Participant Background**

1. What is your academic/professional background?  
   ☐ Engineering ☐ Medicine ☐ Design ☐ Other: \_\_\_\_\_\_
2. Have you used an AAC device or eye-tracking technology before?  
   ☐ Yes ☐ No
   1. If yes, could you elaborate on your experience with these devices

**B. Usability of the Interface (Likert scale: 1 = Strongly Disagree, 5 = Strongly Agree)**

1. I found the interface intuitive to use.
2. The circular keyboard layout was easy to understand.
3. I was able to make selections accurately using gaze.
4. Visual feedback (e.g., ring filling, color change) helped me track my selection.
5. The timing (1.5 seconds hover) felt appropriate.
6. I would be confident using this interface regularly.
7. I did not feel frustrated while using the system.
8. I felt in control while interacting with the interface.

**C. Cognitive Load & Accessibility**

1. How mentally demanding was the interface? (NASA-TLX scale: 1 = Very Low, 10 = Very High)
2. How physically demanding was it to maintain your gaze for selection?
3. Did the interface cause any discomfort (e.g. eye strain, confusion)? If yes, please describe.

**D. General Product Feedback**

1. What feature did you like most?
2. What feature did you find least helpful or confusing?
3. How do you think the system could be improved?
4. Would you recommend this product to someone with speech and/or motor disabilities? Why or why not?
5. Any other comments or suggestions?

**Collected Survey Response**