1 Team, Problem Statement, Requirements, and Engineering Standards

1.1 TEAM MEMBERS

- Sami Bensallam
- Alexander Black
- Jacob Burns
- Yogesh Chander
- Jacob Lyons
- Sergio Perez-Valentin

1.2 REQUIRED SKILL SETS FOR YOUR PROJECT

1. **Leadership** - Project management to ensure staying on task and completing project to specifications.
2. **Hardware Design** - Compact design to ensure practicality of device, skill with haptic sensors and Raspberry Pi will also be necessary.
3. **Software Design** - Python will both be used to control the hardware devices.
4. **Testing** - Efficient and wide-ranging testing to ensure reliability.

1.3 SKILL SETS COVERED BY THE TEAM

1. **Leadership** - Sami, Sergio, Alexander
2. **Hardware Design** - Alexander, Jacob L, Sami, Yogi
3. **Software Design** - Sergio, Jacob B, Sami, Yogi
4. **Testing** - Jacob L, Jacob B, Sergio

1.4 PROJECT MANAGEMENT STYLE ADOPTED BY THE TEAM

Agile management style - open to changes in plans and quick to act on feedback from our client.

To support agile execution, the team will have daily standups, two-week sprints with defined user stories, demos at end of each sprint, and a kanban board to visualize workflow. With the hardware/software components, some waterfall project planning is still beneficial for sequencing dependencies. But overall an agile approach will provide the speed, flexibility, and collaboration needed for success.

1.5 INITIAL PROJECT MANAGEMENT ROLES

- **Sami Bensallam** - Project lead, will be supervising both teams and assisting both teams, along with communication with advisor.
- **Alexander Black** - Hardware lead, component assembly, minute taking.
- **Jacob Burns** - General software development, git repository manager, website maintainer.
- **Yogesh Chander** - Software/Hardware integration, making sure both these elements work together smoothly and quickly.
- **Jacob Lyons** - Component and system design, ensuring each piece of hardware works well on its own and as part of the greater system.
- **Sergio Perez-Valentin** - Software lead, component testing, project management and revisioning.

1.6 PROBLEM STATEMENT

Visually impaired individuals, ranging from partial blindness to complete blindness, find it difficult to perceive objects and surroundings daily. This interference gets amplified when they are put into scenarios they have not encountered before or get disoriented. To mitigate these issues, we are attempting to create a product that can scan an environment and relay vital information to its users. We are attempting to do so in a manner that is intuitive and is representative to that of someone with normal eyesight.

1.7 REQUIREMENTS AND CONSTRAINTS

1. Functional Requirements
   (a) True modeling of surroundings.
      i. Track objects up to 7 meters. **(constraint)**
      ii. Vibration displacement of 16 zones. **(constraint)**
      iii. Distinct frequencies per zone relative to detected distance in mm spans.
   (b) The frequency of data input and output is sufficient for users to stay orientated.
      i. The scanner refresh rate must have a minimum of 15 Hz, preferably over 30 hz. **(constraint)**
      ii. The response time for the user from the time of measurements must be below 200 ms. **(constraint)**
   (c) Device power limitations must stay reasonable for user usage.
      i. Power draws must not exceed 12 watts. **(constraint)**
      ii. Device runtime must extend past 2 hours. **(constraint)**
   (d) Data transfer must be within the bounds of use.
      i. Spatial metrics to the breadboards shall be transmitted via USB.
      ii. Image data must remain for intended use cases and discarded.

iii. There needs to be a user agreement that the system is not 100% reliable and must be used at the user's own risk.

2. Usability Requirements
   (a) Comfortable and intuitive design language.
      i. Easy to assemble and put on.
      ii. Can be worn for extended periods of time.
      iii. Has a sleek, low-profile design that does not stick out.
   (b) Climate, weather, and solid resistance.
      i. Functional in a temperature range of 0 to 100 degrees Fahrenheit. **(constraint)**
      ii. Be IP24 rated - constant handling and splashing from all angles. **(constraint)**
   (c) Consistent and reliable modeling of surroundings.
      i. Rescans of an object must have repeatable measurements with a mean deviation of less than 10 mm. **(constraint)**
      ii. Low visibility (fog, low light, etc.) must not impair accuracy.
      iii. System logging for fast and easy diagnosis and repair.
   (d) Reasonable cost of production.
      i. The first Prototype must not exceed $1000 **(constraint)**
3. Resource Requirements: See 1b
4. Qualitative Aesthetics Requirements: See 2aii
5. Economic/Market requirements: See 2di
6. Environmental Requirements: See 2b
7. UI requirements: See 2ai
8. Performance Requirements: See 1b
   (a) Must output to the user at least 15 times each second. **(constraint)**
9. Legal Requirements: See 2diii
10. Maintainability Requirements: Not needed
11. Testing Requirements: See 2ciii

1.8 ENGINEERING STANDARDS

Below are the identified engineering standards required for our project:

1. **IEEE 2671-2022** - This is the IEEE Standard for General Requirements of Online Detection Based on Machine Vision in Intelligent Manufacturing and is needed to standardize transmission processes, data formats, and quality standards for applications of machine-to-human vision.

2. Connection Standards:

   (a) **GMSL2 FAKRA** - Used for the transmission of video out of the camera.

   (b) **USB 3.1 Type C** - Used on the outside of the device for charging and other data transmission.

1.9 INTENDED USERS AND USES

The main beneficiary of our project is targeted toward total blindness users, with a partial utilitarian use for partial blindness and other spatially impaired users. Such users will use the product to create mental images of objects and surroundings that will allow them to navigate within said environment. Expected use cases are:

1. **Navigating Hallways** - Guide the user through hallways, corridors, and tight spaces to prevent collisions with walls or furniture.

2. **Sidewalk Obstacle Avoidance** - Detect objects on sidewalks, such as parked cars, street signs, or pedestrians.

3. **Park Exploration** - Enhance outdoor experiences by identifying rocks, trees, and other features for the user.

4. **Office Navigation** - Assists in locating restrooms, break areas, and other sections of an office.

5. **University Navigation** - Guide the user by helping to identify buildings and entrances.