

1. List two to four **Desired Needs** of your project that led to your final design objectives.

Existing navigational aids for the visually impaired lack functionality and are often expensive, inaccessible, and/or inconvenient, to the point that many visually impaired individuals instead have to rely on family or friends for guidance.

2. List the major **Constraints** on your design/project

**Safety/Regulatory Affairs:** As a wearable device, almost every failure mode is also a safety concern. The device must be able to operate fast enough to capture fast-moving objects, have a low enough latency to notify the user such that they can still react, and fail in such a way that the user is not at risk of harm.

**Risks:** The device must be protected from moisture, temperature fluctuations, and normal physical wear and tear associated with use as a wearable.

**Global Impact:** The device must be made affordable enough that it can be used in less developed regions of the world, a demographic that already struggles to obtain navigational aids.

**Manufacturability:** The device must be modular and use off-the-shelf parts wherever possible to reduce manufacturing costs and increase repairability.

**Quality Control/Marketability:** The device must be comfortable enough for long periods of use.

3. List the major **Engineering Standards** on your design/project

Aside from the standards we used in our project, IEC 60601: Safety and essential performance of medical electrical equipment, IEC 62304: Life cycle process for developing and maintaining medical device software, ISO 9241-920:2024: Ergonomics of human-system interaction, and ISO 14971:2019:

Comprehensive process for risk management of medical devices, I would also like to see more standards developed for wearable systems, medical or otherwise. For example, in our project we discovered a comfortable threshold for haptic vibrational intensity for short (<1s), medium (<10s), and long durations.

4. Explain **Ethical, Environmental, or Societal concerns** for practical applications of your project.

The main ethical concern for this project was the scenario where a user trusts the device and it fails, potentially with fatal consequences. There is an element of responsibility that is passed onto the device and its creators once it becomes sophisticated enough to do things without explicit operation. Failure is inevitable so the device must be able to fail gracefully and do so in any (even unforeseen) use cases. There were also societal concerns regarding potential stigma in the appearance of the device and preexisting navigational aids' role in signaling to others the person's visually impaired status.

5. Describe **Active Teamwork and Leadership** in your design group

The project naturally divided itself into two sub-teams, one for software and one for hardware. However, we often had decisions that affected the whole device structure, such as mounting on the head vs. torso, or which responsibilities the Arduino would handle and which would be handled by the app. These were discussed as a group and consensus reached, often through members realizing that certain were outside the scope of the project. Project management was done on an initiative basis, where someone would elect themselves to organize a particular task. Freedom was usually given on when tasks were completed as every member could be trusted to hold to deadlines.

6. What were the most significant motivating factors that led you to...

The most significant motivating factor for me was that I came up with this project idea and genuinely believe in it. Going through forums for the visually impaired really helped me realize not to make the same mistakes of other people who seek to develop assistive devices but get caught up in their own ego and chase ultimate functionality rather than making a device that has the potential to make it to market, and from there into people's hands. When I had to figure out how to actually implement haptic feedback, or iterate through hardware designs, it was easy because it was *exciting*.

7. What are your most **innovative and/or entrepreneurial ideas** for this project

I would love to develop a complete package sans iPhone that could be sold to users at affordable prices. I would also love to extend this technology to not just the visually impaired but everyone. What if the sensors could be shifted from the users to the buildings themselves. Wearable haptics could link with the building and guide you to whatever room you need to go to without looking at a map. Such a system could handle congestion and foot traffic at busy events, clearing people out of the way for emergency services, for example.