Targets and Metrics

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The targets and metrics we have included are derived from our functional decomposition chart, with critical targets being ones that had importance in more than one system. Each target was determined from the functions that were deemed necessary when determining our customer needs and can be seen on Table 1. Functions marked with a “\*” are critical functions.

 Table 1 - Targets and Metrics

|  |  |  |
| --- | --- | --- |
| **Function** | **Target** | **Metric** |
| Alert of Elevation\* | 0.25 to 12 inches | Distance |
| Determine Location\* | Margin of error of at most 16 feet | Distance |
| Alert of Physical Object\* | 65 inches | Distance |
| Identify Possible Threats\* | Up to 60 miles per hour | Velocity |
| Access Emergency Contact | 15 seconds | Time |
| Interpret Sensory Information\* | 7 seconds | Time |
| Store Frequent Tasks | 1 GB | Memory Allocation |
| Interface with Pre-Existing Skills | 70% | User Satisfaction |
| Compete within Market | 20% | Price Range USD ($) |
| Remain Lightweight | <5.1 lb | Weight |
| Remain Discrete | 70% | User Approval |

*\*identifies critical targe\**

Critical Targets and Metrics

One of the few obstacles that someone who is visually impaired might encounter is a change of elevation. The change in elevation we are primarily concerned about is some sort of step such as stairs or a curb on the side of the street. Our goal is to be able to detect changes in elevation as small as one quarter of an inch all the way to elevations as large as one foot. Our quarter inch value comes from the ADA (Americans with Disabilities Act), where they describe a ‘trip hazard’ “as any vertical change of over ¼ inch or more.” The value, twelve inches, is derived by looking at what the vertical curb height is which comes from the Mt. Shasta Municipal Code, Chapter 12.04. This is the largest height value for any obstacle that we assume a visually impaired person may have to step on or over. Our metric for this target will be distance in inches because our larger target is 12 inches, and our smaller target is a quarter of an inch. Determining how far one of these changes in elevations are is covered in our ‘Alert of a Physical Object’ target. We will test our device by using it and validating if it meets the target specifications using a tape measure and from there, we will adjust our product until it meets our target.

For determining location, we would like to be able to have accuracy comparable to a typical GPS (global position) that a smartphone would use. According to GPS.gov, the accuracy of a smartphone GPS has a margin of error of about five meters (16 feet) which is its optimal performance in clear weather and away from large objects such as buildings, bridges, and trees. For determining our accuracy of being able to determine location we will use a metric of distance in feet. Our test for finding the accuracy at which we can determine a location will be to have a test user stand at specific location with our device and compare their true location to what the device says their location is. The accuracy will be measured by a tape measure and be compared to the GPS of a smart phone held by the test user.

To keep our user safe, our device will be able to detect any physical objects in the path of the user. We want to be able to detect these objects early enough so that the user will be able to avoid the objects. Our metric for this will be distance in inches and our target distance of detection will be a minimum distance of sixty-five inches. This target was derived by taking the average height male and determining how long his white cane (visually impaired cane) is likely to be. The white cane is usually four inches shorter in length than the visually impaired person’s height according to The BAWA Cane Team. With the average height male in the United States being 69 inches (5’9”), a white cane for them would be 65 inches. Therefore, to remain competitive with a white cane, our device must be able to detect objects this far from the user. We will be testing whether our product meets the target minimum distance to detect an object by placing objects around a test user and measure at what distances our device will alert the test user of their presence. These results will be measured by a tape measure and objects used to test the device will vary in shape and size.

A way of informing the user of a potential threat is a critical target in our project since our project is intended for use in high traffic areas where danger may be more prominent. Often there will be an unexpected disturbance. This target falls within the systems of mobility and utility. The method of validation for this target could be to have a blindfolded person not in our senior design group walk through the FAMU-FSU College of Engineering hallway while using our device. This would help test if threats, such as people, chairs, tables, etc., are notifying the user. This metric could be interpreted for distance in terms of velocity (feet per second), and acceleration (feet per second squared). The average person walks three to four miles per hour, allowing for a relative velocity of six to eight miles per hour (Cronkleton, 2019). Standard speed limits in Florida where walking on a sidewalk would be common range from 20 miles per hour in school zones, 30 miles per hour in business or residential areas, and up to 55 miles per hour on other roads and highways (Speed Limit Laws). Therefore, our target would be a device that is able to detect velocities up to 60 miles per hour to ensure that all possible threats are accounted for.

Interpreting sensory information is critical to ensure that the user is obtaining all the information they do not know they are missing. This target is one of the key features of our product, it will allow the user to understand all the other targets mentioned. Being able to interpret sensory information related to the product itself, as well as the user. Current products on the market use audio, haptic feedback, and braille to relay the sensory information obtained back to the user. There are many studies that have occurred about whether sensory compensation occurs in people who are visually impaired. For people who are visually impaired, their sense of touch, hearing, and smell is proven to be heightened (Miller, 2017). This heightened sense will likely receive a quicker response time than somebody who is not visually impaired. This metric can be measured by how long it takes the user to be notified of sensory information and how quick the user is to interpret the supplied information; this may vary per person. The metric will be measured in seconds with a standard timer and have a desired time of seven seconds. The timer will begin once the device is able to interpret the sensory information and once the user reacts to the supplied information the timer will stop.

 The device itself also needs to be able to evaluate the information it needs to relay. This involves interpreting the distance of how far disturbances are located, processing the information, and relaying the information to the user properly. This metric can also be determined with a timer. Ideally, we would want the response time to as small as possible but aim for it be less than five seconds in resemblance of real-time sensory information. The device should be able to detect object 20-30 feet away from the user, this can be tested and measured with an open reel measuring tape. A possibility for implementation is using LIDAR.

Targets and Metrics

Access to an emergency contact can be a valuable target to add for safety reasons. This could be notifying friends and family when changing locations or when arriving to a desired location. This allows independence, while still maintaining an aspect of safety. This can be done with the user's personal phone if our product has interfacing capabilities. There are many apps already existing on the market that have a sole purpose of personal safety (Speed Limit Laws). The number of times the emergency contact(s) are notified each day could be derived from an integrated counter. Another metric of measuring this target is how many seconds it takes to notify the selected contacts of the information. This can be determined with a simple stopwatch. Our target to notify an emergency contact is less than fifteen seconds, however this will be based off the interfaced devices alert time. The time it takes for the notification to be acted upon or assistance to arrive would not be included in our target metrics.

The metric for the storing of frequent tasks is based upon memory storage on a mobile device. As such, one would need to store a buffer containing a set number of tasks. If one were to store the entire map of Tallahassee, Google Maps would require a maximum of 15 megabytes. Since the nature of the device has not been determined yet, this approximation seemed appropriate for possible offline pathing storage. If one were to consider a two-gigabyte memory card, one could theoretically fit 133 of these offline maps inside it. This assumes no extra storage would be used, which is incorrect. Therefore, we assume that around half of this value would be sufficient, fifty tasks. If one is to assume phone compatibility, average app size is 38 megabytes (Boshell, 2017) so there is even less storage. The amount of storage available in a smartphone fluctuates, but assuming at least one gigabyte is available seemed safe. This would be tested through running software needed for the design and ensuring the amount of memory allocated does not decrease performance speed on design. If design were to slow or freeze at a set number of tasks, the user may be in danger which goes against our objective. The testing consists of obtaining and recording a set of data and duplicating it until they occupy around two gigabytes of storage and analyzing its performance.

The interfacing with pre-existing skills is a crucial aspect in terms of the product learning curve for the design, as it corresponds with the primary mobility skills the visually impaired use. The only real way to measure this is through direct data gathering on a group of our intended audience, possibly done by giving them a prototype of the design and later surveying their response in terms of usability and comfort. This would typically result in biased data; however, a survey specifying their demographic can be highly successful for data gathering (Ponto, 2015). They should be given a path to walk through after becoming comfortable with the device and be asked to traverse through it. Since their orientation and mobility depends deeply on their O&M training, this should be the most direct way to measure how they interface. Naturally, if the design were to use smartphone integration it would have to also relate to the skills, they developed to use them.

The largest complication of creating a product that is competitive is the price. To ensure that our product will gain headway in our market, we need to competitively price our product regardless of the added benefits to our device. The three products that we found which represent most of the market are priced extremely differently. The first being the widely used white cane low-tech device which is priced between $15-$30. The second being the Sunu Band which is a wearable device priced at $299. Finally, the OrCam which is the most high-tech device, priced between $2,000 and $5,000. Our target market is somewhere between the Sunu Band and the OrCam. We want to construct a high-tech device that can be easily operated by individuals with vision impairment. We will be measuring this price in the currency of the Unites Stated Dollar. Each of these metrics were gathered by researching the individual products and comparing their prices to each other. To be able to compete with the other products in our market, we are seeking our device to be within a 20% price range of the other relatively high-tech products.

Our desired product is targeted to be a lightweight and portable device. We will be measuring the weight of our device in terms of pounds (lbs). Our current competitors have designed products in the same way. The typical white cane weighs around 7 ounces (Winter, B.), the Sunu Band weighs 40 grams (Sunu) and the OrCam weighs 22.5 grams (OrCam). The Department of Defense recommends that hand-held equipment should not weigh more than 5.1 pounds and should be capable of being held and operated with the same hand (Ahlstrom, 2005). We will be using a digital scale to weigh our final product/ components of the product. Considering these are all light products, our product does not need to fall within these boundaries.

Our targeted device is one that is discreet and does not draw attention when being used. The areas that need to incorporate this feature is the size, ergonomics as well as the intended use to translate information. One of the major targets is that the users must be able to hold, transport or wear this device According to the FAA ergonomic design standards, these devices should be smaller than 4 inches (100 mm) high, x 10 inches (255 mm) long, by 5 inches (125 mm) wide. A product built around these requirements also allow for easy storage in things like pockets, purses, and backpacks (Ahlstrom, 2005).

Another important aspect for having a discrete product is making sure the transfer of information is comfortable. If our product uses sounds as a feedback mechanism, we will need to ensure that the product can be used in noisy or quite conditions. Likewise, we would want the volume output of this device to be manually operated by either a physical dial on the device or the possibility of linking it with a smartphone. Another option can be to create a product with a self-looping algorithm which will automate the output volume based on the ambient surroundings. To measure this, it is proposed that a calm pace of sound is less than or equal to 15 decibels (Kumar, 2020). This can be validated by using a microphone on a smartphone device to measure the input and output volume on the product, as well as create a code for the device that loops the input of ambient noise and automatically compensates for it. Because the level of discreetness is subjective, to validate that our product is in fact discrete, we are seeking 70% approval by our users.

Summary

Of all the functions the team deemed important from the cross-reference table, five of them were designated to be critical including: alert of elevation, determine location, alert of a physical object, identify possible threats and interpret sensory information. The remaining functions are important to the device as they also indicate the physical and technical specifications that we expect our product to encompass. Each function was paired with one or multiple targets in which we assume will carry it out that specific function. Similarly, these targets each correspond with a metric to carry out how it is measured. The team will validate each of these targets and metrics, accordingly, following the procedures established in this section.

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Appendix A

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Appendix B

Target Catalog

1. Access Emergency Contact\*
2. Alert of Elevation\*
3. Alert of Physical Object\*
4. Compete within Market
5. Determine Location\*
6. Identify Possible Threats
7. Interface with Pre-Existing Skills
8. Interpret Sensory Information\*
9. Remain Discrete
10. Remain Lightweight
11. Store Frequent Tasks

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