CMSC 20370/30370: Inclusive Technology: Design For Underserved and Marginalized Communities GP2

User Research Results and Design Alternatives

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Write an updated one paragraph description of your project. Simply re-introduce the general area of application, the intended tasks your system will support, and the intended user population.

We are focusing on how people who are deaf and hard of hearing navigate life on the University of Chicago campus and in the surrounding neighborhood. In our research, we will consider the task of navigating around on the UChicago campus and Hyde Park, especially when users are on the go, for example walking between buildings, biking to campus, or taking public transit. Our technology will focus on improving the safety of users by increasing situational awareness, especially in emergency situations. Our user population is the full spectrum of individuals who are deaf and hard of hearing in Hyde Park. This includes, students, staff, and other university affiliates as well as non-university affiliated Hyde Park residents.

Briefly state key requirements for your system. Again, the goal here is to re-introduce the requirements developed in Part 1, although it is OK if you introduce new or altered requirements here. Do not exceed one page in this summary.

The task environment is strictly when the user is on the go/in motion, however our final solution may involve introducing a new task environment such as using a smartphone app or wearable. The environment will include ambient sounds as well as more important sounds like sounds from other people talking to or near the user as well as cars and sirens.

A primary goal for our system is accessibility. Our system should be affordable, such that low-income users of all income levels can use it. The system must also be easy to use and add value for users of varying levels of hearing.

Evaluation criteria for the technology includes (a) it improves situational awareness when users are on the go (b) it improves situational awareness in emergency situations (c) it improves safety on campus/in Hyde Park (d) it is easy to use without instruction (e) it adds value beyond existing technology, whether that be through usability, affordability, customization, or the technology's affordances.

Briefly summarize the data that you collected from your users and the key insights gained from the user research

Interview Data:

We collected interviews with students who are hard of hearing at UChicago. We found that students have strategies for coping with limited audio input, but still face challenges navigating around the UChicago campus and Hyde Park.

Key insight 1: Safety is a primary concern, especially at night

Users expressed challenges related to safety navigating in traffic as pedestrians and cyclists in Hyde Park. In Hyde park, an especially treacherous situation which was noted was crossing traffic on the midway. Users also expressed concerns about safety in robbery situations. Overall, we noted a theme that users felt less safe at night. In terms of walking or cycling, users had less visual input and thus significantly decreased situational awareness. Furthermore, robbery was noted as an issue that occurs primarily at night.

Key insight 2: Hearing impairment may be exacerbated by other personal factors

Users noted that challenges related to limited hearing can be exacerbated by obstacles like language barriers and transitions into new environments, social and physical. Since UChicago is a university, many users are students or staff who travel from all around the world and, in the case of undergraduate students especially, experience a lot of difficulty in transition to their new life in Hyde Park.

Key insight 3: Existing technology has limits

While users demonstrated a robust set of strategies intended to help them cope with limited hearing, existing technology was cited as expensive and often uncomfortable. The range of technology used on the go (rather than built into the environment) was also quite limited.

Key insight 4: Design implications

A major insight from our interview data is that users do not want information overload. Rather, they want information that is suited to their needs and, especially in the case of technology that responds to surrounding noise, is only relaying what they consider to be the most important information. Additionally, users want technology that doesn’t distract other people, for example by making loud sounds or transmitting information via speech. Lastly, users wanted a device that is suitable for travel. This includes being lightweight, waterproof, able to connect to one’s phone, and ideally hands-free and eyes-free such that it can be used with their phone in their pocket.

Survey Data:

We sent out a survey to collect data on people who wear headphones when they are on the go. Using (audibly) distracted commuters as a proxy for hearing impaired / deaf people allowed us to gather more information for our research, as our number of interviews with the target demographic was limited. Our data came from undergraduate students at UChicago.

Key insight 1: students who wear headphones have limited external audio input

All of the students in our sample wore headphones while on the go at UChicago. Over half of students in our sample stated that they could only hear very loud noises when they had their headphones in or they could not hear any external sounds.

Key insight 2: Students are concerned about safety on campus

Subjects stated that they felt unsafe when wearing their headphones at night. Some users did not wear headphones at night in order to increase safety. Subjects primarily expressed concerns about robbery, however other students were interested in informations in emergency

Key Insight 3: Subjects were interested in getting information about a variety of audio input

Across the board there was no majority consensus on which sounds users want information about. Subjects were interested in getting information about when their name is being called, honks, and approaching cars, as well as emergency sounds like shouting, sirens, and alerts about emergencies in the area. Two students added “footsteps” in the “other” category for sounds that they are interested in getting information about.

Key insight 4: Design Implications

Respondents suggested a variety of design ideas for use while they are wearing headphones, but the most common overall affordance was getting information about surrounding sounds that that users can’t hear due to headphones being in and which would improve user safety. Some design ideas included cameras, microphones, or motion detectors that would allow users to be notified when they are being approached from behind.

Design Implications From both Interview and Survey Data:

Comfort is key: users want something that isn’t heavy, uncomfortable, or burdensome. They also wanted the device to be waterproof when walking / biking in the rain.

Non-visual interfaces: users were interested in something that they don’t have to look at in order to get information. Some users were concerned about looking at a device while on the go (crossing the road, on a bike) and some were concerned about taking out their phone or another obvious piece of technology in a potential robbery situation.

Customization is valuable: users had different needs for technology; some were more concerned about hearing honks or sirens, some were concerned about fast motion, and others wanted to know if there were people approaching from behind. Also, user needs fluctuated throughout the day, with different needs cropping up in the daytime vs the nighttime.

Integrating new designs with their existing technology: Across the board subjects wanted to integrate new technology with existing devices. Some subjects cited wanting to adjust current technology with a phone (for example, customizing hearing aids through an app) and others wanted audio input to connect to their headphones. Subjects mentioned that they were concerned about having multiple devices that could get lost or stolen.

Discuss your methods for designing your prototypes. Talk about how you incorporated methods or techniques discussed in class (e.g., participatory design, action research, contextual inquiry) in your design process.

We started by understanding user needs, activities, concerns, and goals when navigating campus. This was in the form of interviews and surveys. We organized key insights by grouping data by themes (as written in the data source write-up). Once we understood our user, we brainstormed as a group ways in which to address these needs with a holistic view. Additionally, we implemented partial participatory design by asking for design ideas in the interview and survey. After this, we discussed different artifacts and interfaces that could implement these solutions. We grouped different features/artifacts/interfaces into categories and eliminated some features that were far removed from our goals or felt unachievable. We then used these revised groupings to build three designs.

We also looked at current systems that work (i.e. hearing aids) and considered how our designs could incorporate, incorporate on successes of, or improve on failures of these existing technologies. Finally, we also listed different scenarios that the target user may face when navigating campus, and considered how we could add or remove affordances from our initial groupings to better fit certain situations. Ultimately, we felt like 2 of our designs were helpful in a range of situations that our subjects were concerned about, whereas the second design (transportation planning) was suited specifically for transiting in less safe conditions, including poor weather conditions and nighttime conditions.

Describe the design space of the potential interfaces for your system. In particular, answer the following questions (you may use each of these questions as section sub-headings if you wish, but that is not required).

What requirements may be difficult to realize?

It might be difficult to maintain a light and cheap piece of tech given that we need to include enough microphones and sensors to take input from the environment. A lot of existing tech suffers from being heavy and expensive, which is the result of the technical difficulty of the tasks required.

What are some tradeoffs that you should or did explore?

Some tradeoffs that we explored were those of information vs safety and convenience. We found that users wanted a system that could be used hands-free and eyes-free (i.e. if it is a phone app, can be used while the phone is in their pocket). This would increase safety as they don't have to walk home, cross a street, or ride a bike while constantly looking at their phone. However, this limits the amount of information that we can give without overloading the user. For example, giving a visual radar of people around you can be much easier to understand than a wearable that vibrates a specific number of times for the direction and number of people around you. Thus, our biggest tradeoff that we are exploring is what type of interface and feedback to give (whether a visual app, a speaking audio aid, or tactile alert wearable).

Which tasks will be easiest to support? Which are the hardest to support? Say why.

Supporting walkers and cyclists in planning routes by transmitting information about safest paths to walk or cycle is straightforward. This functionality can be found in various forms in existing apps like Waze and UChicago safe. The hardest task to support is transmitting information while the user is not looking at their phone. Since our users can experience limited audio input, often they will rely on visual engagement to get information. However, since our users are on the go, looking at screens/visual engagement with a device in the situations we are considering (unsafe situations, while crossing a road, while cycling) does not align with our primary goal of safety. This applies to emergency situations, too, when a user might not have time to look at a device and get information and might need to just react really quickly (like in the car example for design 1).

You more than likely modified, added to, or removed elements of your requirements and usability criteria as a result of conducting the design process. Discuss these in this section, what were the changes you made and why did you make them?

Most of our initial evaluation criteria still holds after learning more about our user. This includes the device's usefulness, intuitiveness, and the overall user experience while using the device. However, we found that the users did want the technology to have specific requirements such as the ability to be used with their phone in their pocket (non-visual interface option). They also wanted the device to be lightweight, inexpensive, comfortable, waterproof, customizable, and able to integrate with existing technology (see Key Insights section of paper).

Briefly describe the design alternatives that you considered exploring, including alternatives that you did not ultimately pursue. Do not cover every idea that you discarded, but rather group them and discuss as a whole. Make sure to justify your choices (Why did

you not pursue certain avenues? Why did you decide to pursue the designs that you actually produced?). Justifications need not be lengthy; a few sentences for each should suffice.

We were able to combine and include all of our design alternatives into our final three designs. Many of them used the same type of technology (i.e. taking audio from surroundings) but had different interfaces (visual vs wearable), thus we combined them into three final groups. Each group is customizable to include the different alternatives / interfaces. We chose to do this to give users (with varying abilities and needs) different options when using the technology. Thus a hard of hearing person could benefit from an audio interface while a deaf person could benefit from a tactile interface, both using the same technology / main design.

We chose not to create a device which is integrated into the environment because our users are on the go and will be interacting with a variety of environments within Hyde Park. We also chose not to incorporate the technology into specific tools like the bike or sneaker so that it could be used by bikers, runners, pedestrians, etc.

We also chose not to do more complicated wearable tech (like a belt or a more dispersed wearable system) because our users felt like they already carried a lot of tech with them on the day to day. Also, our users are on the go, and thus cannot be burdened by heavy or complex devices while they move about.

We chose the wearable or audio amplifying device because it gives users valuable information to support their safety without further distracting users. A lot of our users stated that they wanted something that they could use without taking their phone out of their pocket, whether that be because they are crossing the street or feel unsafe at night (e.g. think someone might rob them).

We chose to do the commute planning app because it is intended to specifically support a space in which deaf and hard of hearing individuals are particularly vulnerable, but can also be used by a broader user base. This design is also easy to use as it expands on the functionality of a lot of existing map/safety apps, and it is accessible to all ranges of hearing. The app is also more specific to the college campus context, although it could also be used in the non-campus setting as well.

We chose to do the motion/heat/radar design to probe how users might benefit from different kinds of input--motion rather than audio. Especially for users who have never had audio as a part of their experience navigating the world, using visual based alerts might be more usable and thus more smoothly/consistently motivate self-preserving reactions in unsafe situations.

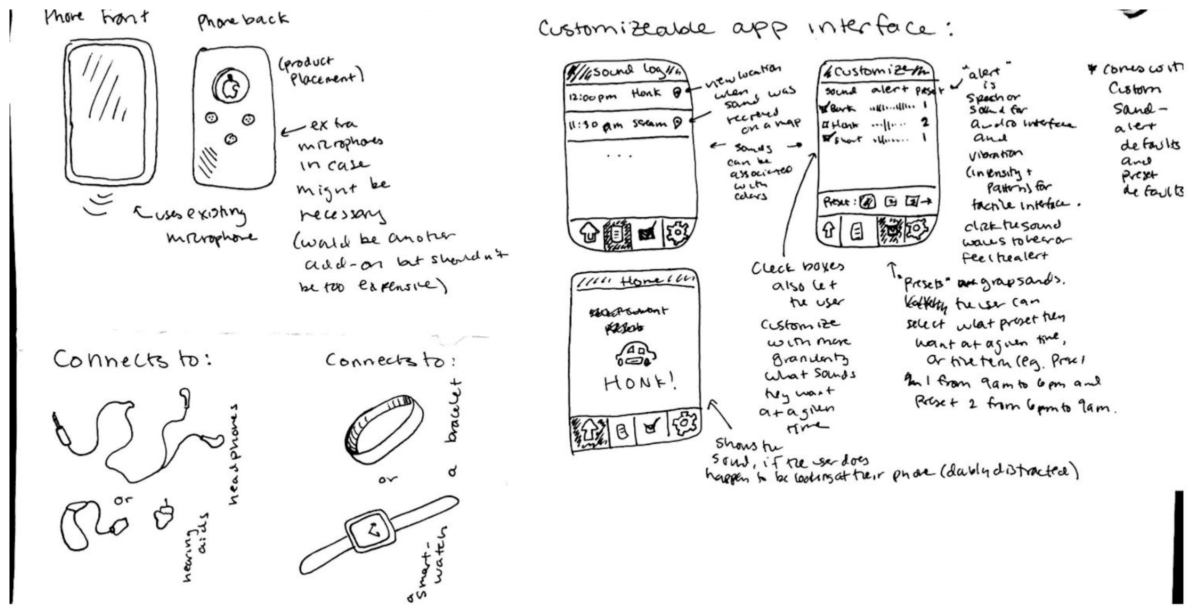
The Designs: Present each design that you created. Remember that you should present at least three designs. Cover each design in its own section by presenting the following information.

Design 1: Transmitting External Audio Input

A brief overview of the design.

We will present two designs concurrently in this section. Both transmit information about notable sounds in the user's environment. They rely on a phone based interface to collect information about sounds in the environment and relay that information to a second device. One uses a wearable, a wrist based bracelet, or connects to a smart watch if the user already has one, which vibrates when appropriate sounds are detected. The other transmits information about surrounding noise through speech or other constructed audio input (for example, a honk might be played when a car is heard approaching), which is transmitted through headphones or connects to a user's hearing aids. The sounds that the devices pick up on and transmit information are generally related to safety, often in situations where the user will want to quickly react. They are highly customizable, however, using an app interface to allow the user to easily customize what sounds they want information on and at what times (for example, users might only want information about whether someone is approaching them from behind at night). Furthermore, customizations like the intensity of the transmitted information (e.g. how intensely the tactile design vibrates or how loudly the audio design outputs sound) and the form of the transmitted information (e.g. the pattern of the vibrations or the speech/sounds relayed by the audio device) allow the user to make these pieces of tech work for their needs within the environment.

Illustrations of the design (sketches, storyboards, etc.)



Describe at least one scenario of use written from a user's perspective.

I am a student who is hard of hearing crossing the midway on my way from Cathey Dining Commons to Cobb for my afternooon class. One other student on the other side of the street starts to move along the crosswalk. As I begin to step into the street I [hear a honk in my ear] [vibration on my wrist] and instinctively jump back onto the sidewalk. A car speeds by right in front of me. I look up and see that my light had been red. I knew to jump back because [I heard the honk in my ear from the left, coming from my phone-based tech, which made me realize that a car was approaching from the left] [the vibration on my wrist was intense, so I knew that something loud was happening, and since I was in a dangerous place in the street, my instinct was to jump back onto the sidewalk]. I had been following the other student, who was carefully timing their walk in accordance with that car, so I didn't check if the light was red. Without the [audio tech] [tactile tech] I would not have realized the car was coming down the midway.

Present an assessment of this design (advantages, disadvantages, and the degree to which your requirements can be met by the design). Include feedback from potential users in the assessment. Make sure to express how you gathered this feedback.

Shared Design (customization app interface):

The app is highly customizable, meaning that users will be able to adjust to safety needs of their own particular environment or needs within the UChicago context. The customization features also help prevent information overload, something that was stressed in our interview data.

Furthermore, the app alerts users with a visual cue if they are on their phone, so if users are distracted by their phone and their limited audio input, they will be fully brought into reality by a full screen alert.

Audio (headphones/hearing aids):

In line with the preferences expressed in interview data, this design connects to existing devices. It allows users to keep wearing headphones and stay alert, and gives detailed information about sounds, particularly where they are coming from and what they are. In alignment with interview and survey data, the device does not require visual engagement. Users who are on the go--walking, running, or cycling--can continue unencumbered by visual distractions, and users who are feeling unsafe don't need to put themselves at risk by pulling out their phone.

One of the major drawbacks of the advice is that it is not as accessible as we want. This device only works for users who have some hearing capacity, excluding d/Deaf users. Also, the flaws associated with the tech this device works through transfers to this design. For example, some survey users noted that they don't like wearing headphones at night because they feel like it makes them a target for robbery, and others noted that hearing aids are unusable at times and can become uncomfortable overtime.

Tactile (watch/bracelet):

Unlike the mobile device, the tactile device is accessible to a wide range of users across the d/Deaf and hard of hearing spectrum.This allows users to rely on existing strategies for gaining situational awareness but just adding on the alert functionality. The device is light and comfortable, and when connected to a smart watch, it is also integrated with existing tech.

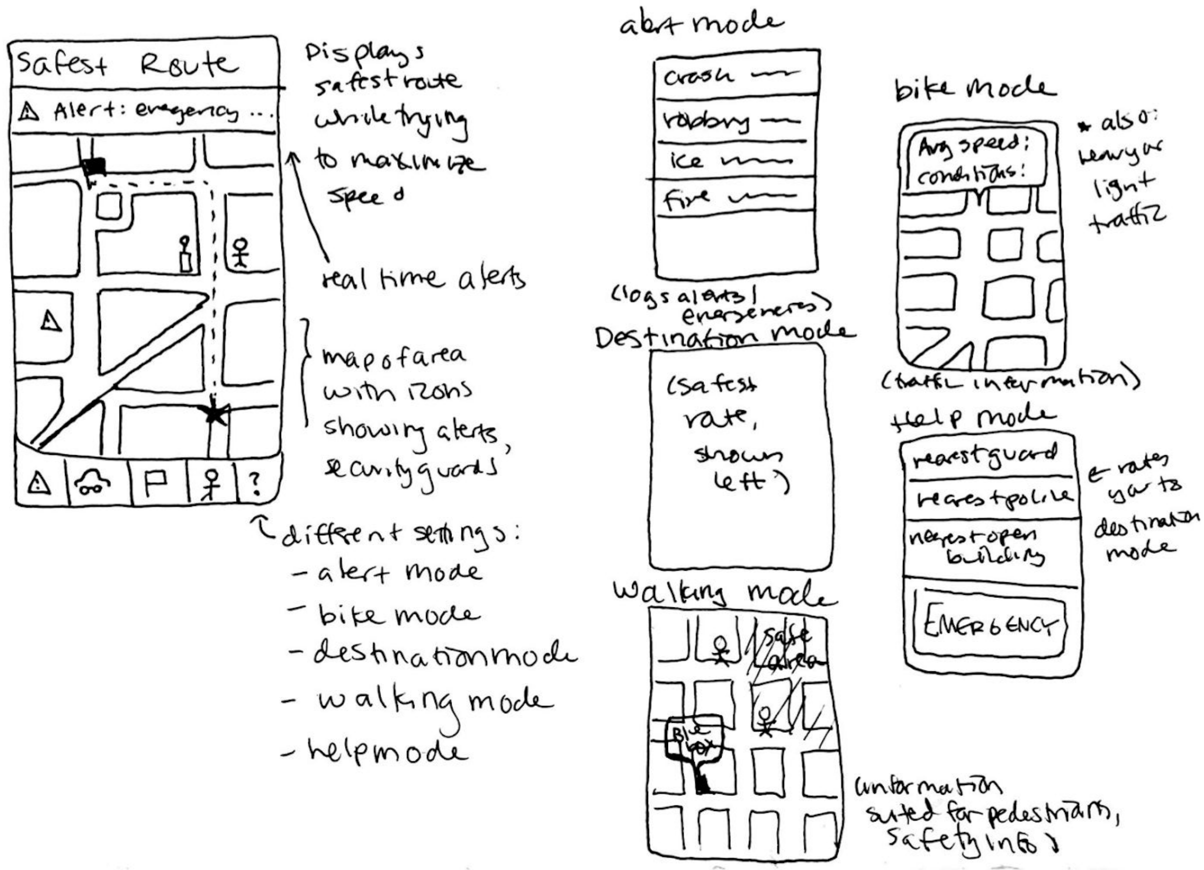
Unfortunately, for users who buy just the vibration bracelet to go along with the in-phone tech, this design presents yet another device to keep track of, which was cited as a negative in our interview data. Furthermore, it is difficult to transmit information about the location of a sound just using a small wrist device. In its simplicity, however, the device allows for a visceral reaction from users (e.g. turning to the left to see where a sound might be coming from), rather than a delay while information that might be relayed through speech in the other design is transmitted. This could be positive in terms of increasing safety.

Design 2: Commute Planner and Emergency Notifier

A brief overview of the design.

This design is focused on safety when planning commutes. It displays information about obstructions and resources on the way to your destination, as well as emergency alerts (car accidents, robberies, fires, etc). It is a phone based interface that shows the safest path for navigation. For people that ride a bicycle or are navigating to campus, it will display information such as the number of cars on a given street, the speed at which they are traveling, different traffic levels and emergencies, hazards on the street such as ice, and the best time of day to travel. For people walking or navigating on campus, the interface will show busy areas, the safest and well-lit areas to stop, shuttle and transportation information, and the nearest security resources such as guards, blue boxes, buildings with enforcement, etc. Additionally, it has a live feed of emergency alerts that are happening nearby such as a robbery or car crash.

Illustrations of the design (sketches, storyboards, etc.)



Describe at least one scenario of use written from a user's perspective.

I have just finished a late night group project and am looking for a way to get home safely. I use the app to find that traveling North and then East takes me through the safer, least hazardous areas of Hyde Park with the most nearby security resources. On the contrary, Google Maps recommended I travel East and then North even though it is only 30 seconds faster.

Present an assessment of this design (advantages, disadvantages, and the degree to which your requirements can be met by the design). Include feedback from potential users in the assessment. Make sure to express how you gathered this feedback.

While the other designs focus on giving feedback while navigating, this design allows the user to plan their trip accordingly before navigating to maximize safety. During our interviews and surveys, we found that potential users were worried about how to safely navigate campus and Hyde Park, especially at night. They wanted a system that shows nearby resources as well as the best places to go/be during unsafe situations / times of the day. This design addresses that issue. It doesn't require the user to be actively looking at their phone while navigating, though they still can in order to get alerts or find nearby safety resources. It could also integrate with other technologies (i.e. speech in headphones: "turn right" / "robbery one block west of you, continue east", or vibrate when an important alert happens). Thus it meets the user requirements that it is lightweight, easy to use, and implements with current technology (because it is a phone app).

One downside to this design is that it does not specifically address our target users. This device can benefit all residents of Hyde Park, not just deaf and hard of hearing students and faculty. However, those who without full hearing ability are at increased risk of being unaware of their surroundings. They have limited (audio) feedback from their environment, especially in unsafe situations such as walking home at night. Thus it is important that they have the safest path to travel in order to reduce their risk of being put in an unsafe circumstance and decrease the need for audio-based situational awareness.

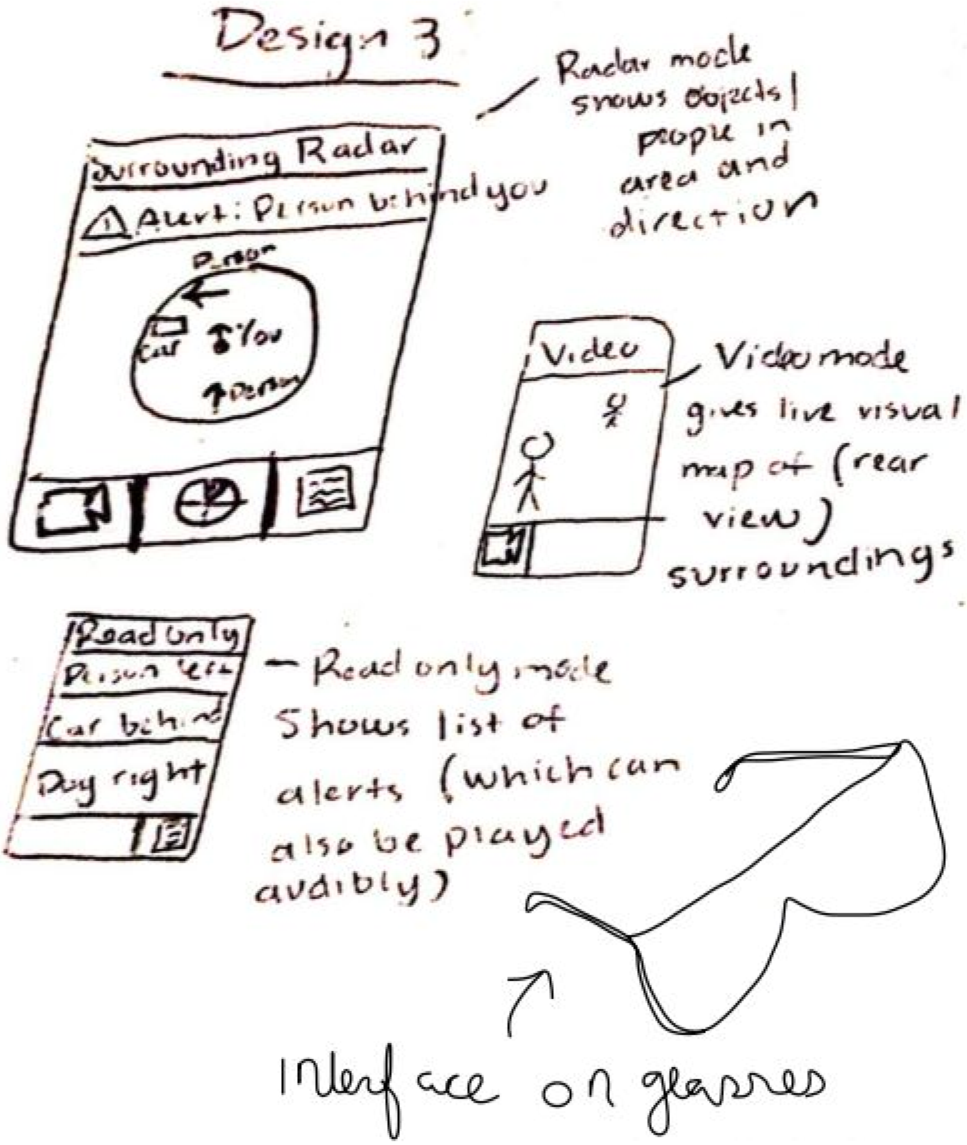
Another disadvantage with this system is that

Design 3: Surrounding Radar

A brief overview of the design.

This interface is similar to Design 1 in that it is focused on giving real-time updates on surroundings. However, this design doesn't solely rely on sound. Using heat, sonar, and/or video, it displays information about who/what is around the user. It is a phone based interface that gives the user a visual drawing of their surroundings based on a variety of possible factors. For example, one idea is to have a camera attached to a backpack or coat which could then give the user a rear view of their surroundings. This view could be shown in the app, or on a wearable such as a watch or Google glass type apparatus. The same can be done for the other types of detection systems such as a sonar-type map or a heat detection lens. For an eyes-free, hands-free interface, the app can alert you when someone or something is approaching. This can be in the form of an audio alert (i.e. "car on your left") or in the form of tactile alert (i.e. a wearable that vibrates when someone is walking towards you from behind).

Illustrations of the design (sketches, storyboards, etc.)



Describe at least one scenario of use written from a user's perspective.

I am walking home at night and can’t hear if there is someone following me. I use the app as a radar to see if someone is following or approaching me and thus change directions to avoid them. Additionally, I can’t hear if a car is behind me but with the app, I can see visually all of the cars, people, and objects of importance within my vicinity, increasing my environmental awareness.

Present an assessment of this design (advantages, disadvantages, and the degree to which your requirements can be met by the design). Include feedback from potential users in the assessment. Make sure to express how you gathered this feedback.

During our surveys, we asked potential users to describe a technology that they would find useful for navigating. One person stated "An attacker radar so it would alert me if someone nearby was trying to attack, rob or harm me in some way." Another person stated the want for a "camcorder attached to each hearing device that allows you to film people behind you because of a [body] heat sensor, and then alerts you[r phone] when someone is within a certain distance and the pace they're moving at." Thus we saw the importance of people not just having auditory or situational awareness, but also visual awareness of what was happening around them. Thus we implemented this design.

This design is useful as it gives information about one's immediate surroundings as well as it gives the users a visual mapping of the area around them (whether through radar or camera feed). It uses existing technology and doesn't rely on sound. However because of this, it lacks information related to certain sounds such as sirens or car honks that could be important. Additionally, it requires a phone and an external device depending on the detection system, which is a disadvantage as some users were already worried about having too many electronics and devices that they have to carry around. Lastly, the use of a camera and other devices to track people (around you) could be a breach of privacy and an ethical challenge.

Remember to link the report and a picture of the poster on your project website.