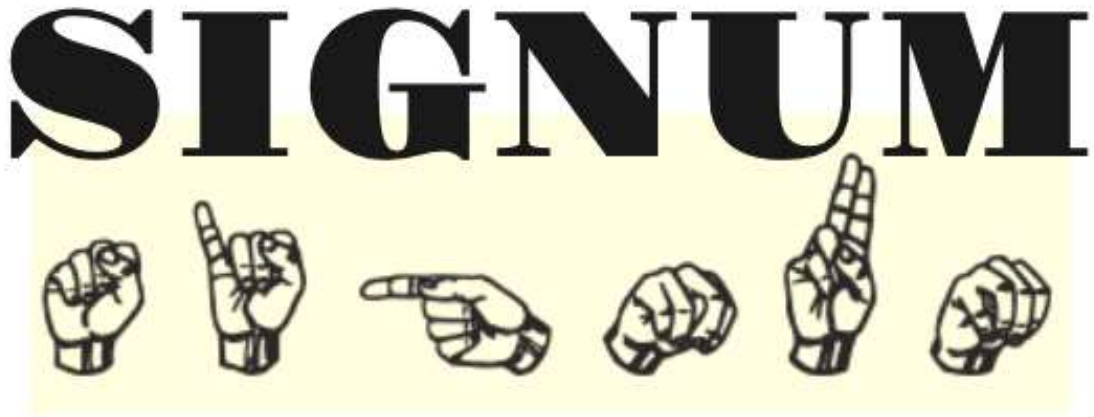
Informatics 464: Value Sensitive Design

Final Report



The Analysis of Sign Language Technology

Written by
Nina Tran (ntkt@uw.edu)
Isabelle Donbach (basillee@uw.edu)
Larry Tian (ganlin@uw.edu)

Abstract

Deaf and hard-of-hearing users may often face issues such as social withdrawal as a result of limited access to services and difficulties communicating with others, and there may be emotional issues caused by a decrease in self-esteem and confidence. We conducted a stakeholder analysis, a value scenario, research into existing sign language technologies, an interview with someone who is Deaf, and designed a solution to assist with ordering food and communicating with others. We found that there needs to be a lot more research and technologies developed in this area, as current options need to improve in accuracy, speed, and accessibility.

Keywords

Deaf, hard-of-hearing, accessibility, voice-recognition, sign-recognition, communication, assistive technology, design, user experience, user interaction

Introduction

According to wfdeaf.org (2013), there are more than 70 million Deaf and hard-of-hearing (HoH) people in the world. Inaccessibility is one of the major issues that many Deaf and HoH users experience in their everyday life. For a Deaf/HoH person, interacting with a hearing person in a public setting can be difficult such as ordering at drive-through restaurants due to communication barriers. Sign language technology can be a communication tool for Deaf and HoH people who prefer sign language. However, there are also some barriers to the use of sign language technology such as lack of facial expressions, inaccuracy, and body language. This study focuses on analyzing existing sign language technologies while looking into how they could be adapted for certain situations Deaf and HoH people encounter such as drive-through ordering. While sign language technology should not be a replacement for human interpretation, every Deaf/HoH person should always have the choice.

Design Process

Conceptual Investigation

Stakeholder Analysis

We have decided to focus on Deaf and HoH users who use American Sign Language (ASL), hearing ASL students, and friends and family members who do not know ASL as well as employees who work at drive-through restaurants. Deaf and HoH users often experience communication barriers in their everyday life. Our research aims to create a specific targeted goal that can help bridge the gaps in communication through the exploration of sign language technologies as well as the experiences of Deaf and HoH users.

Values

The most important values that Deaf and HoH users care about are: effective

communication, interactions or intercommunication, and accessibility. Some of the values are shared by friends, family members, and employees; however, they value simplicity in the aspects of sign language technology such as ease of use and time-saving. For a complete list of our stakeholder values, see appendix B.

Value Tensions

According to research, accessibility challenges what should make communication more effective. Our stakeholders do not always share the same communication preferences. Some may find sign-to-text, speech-to-text, or writing on paper to be tedious and time-consuming, which leads to inconvenience, technical errors, and inaccuracy. Most of the sign language technologies are one-way communication, limiting interactions between Deaf/HoH users and their hearing counterparts compared to two-way communication, which often involves human interpretation.

Value Scenario

Drive-through ordering

If accessibility was improved, it would decrease wait time in line for everyone, including the Deaf/HoH customers who use the drive-through option. The ability to ask questions easily would be enabled when an order goes wrong, resulting in complete and accurate communication of the order status. Social gatherings and asking strangers questions are not included, but more information about them can be seen in appendix C.

Benefits and Harms

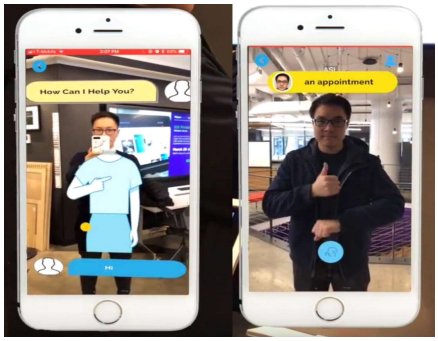
Sign language technologies would greatly improve customer service for the Deaf/HoH users who use the drive-through option. If they prefer to communicate through sign language technology or human interpretation, that is available to them. Another benefit of using sign language technologies is that they can help bridge the gaps in communication, which allows Deaf/HoH users to build a connection with their hearing counterparts. It would encourage accessibility to become an integrated part of the everyday culture. However, sign language technologies should not be a replacement for human interpretation in serious situations such as doctor's appointments and emergencies due to misinterpretation and miscommunication. In addition, emotion is often lost when translated from sign language to spoken language.

Empirical Investigation

Qualitative Approach

Research into Existing Technologies

Hand Talk is a free app that translates from speech to sign to allow people who are Deaf/ HoH to know what others are saying around them. A downfall of this technology is that it only has one way communication, not providing a solution to help Deaf/HoH users respond. This app also lacks representation, only having one white male interpreter to display ASL. MotionSavvy is a two way communication platform that does both speech to text and sign to speech/text translation. For this technology, each communicator has their own device with the app and messages are sent between their devices. The technology behind this app is not fully realized yet, so it does not support a full conversation using ASL. SignAll is a sign to text app that allows people to relay messages faster than typing, but requires the other party to read their messages, and does not allow two way communication. The most promising research we found discusses the possibilities of Augmented Reality (AR) Sign Language, in which people could hold their phone out like a window with sign language or text being shown to translate in real time, while still being able to see someone's face, emotion, and body language. Included here is a picture of what this might look like in the future.



Interview

We did an interview with someone who is Deaf, who I will call Laura for the sake of her privacy. Full notes on this interview can be found in the appendices. Laura shared with us that she mostly uses texting and typing on the notes app to communicate with people who do not speak ASL. The biggest challenge she faces with this technology is speed, as pausing to type our messages takes a long time, even just to have a quick question answered. Another challenge she faces is that a lot of people are unaware of how to communicate with her, not understanding why she is typing and trying to speak back to her rather than typing a response. She thinks a big factor in this ignorance is a lack of education about Deaf culture and history, as well as a lack of exposure or experiences with people who are Deaf/HoH. We asked her to explore Mimix for the first time, an app designed to translate spoken word and text to sign language, and tell us about her experience. She was excited to see this new technology, as it opens the door to many more options for communication, however there were some problems. The app did not use correct ASL grammar, using signs but structured with English grammar. There were also some regional signs that would be hard to understand depending on the geographic location of the user. Lastly, her favorite part about being Deaf is the visual richness of expression and body language while speaking in ASL. This expression was lacking from the Mimix technology, which she found inhibited understanding and communication.

Technical Investigation

Signum: communication has never been easier like this

Since mobile phones are a tool that people often carry around nowadays, our team decided to build a mobile phone software to help people who are Deaf, HoH, or have hearing loss communicate more easily in public places.

Effective Communication

Signum allows users to communicate in four ways: sign-to-text, 3D gesture scan, text-to-sign, and connecting with a certified interpreter. During our research, we realized that our stakeholders usually care about speed and effectiveness when they are using sign-language technology. To increase the speed of the translation process, Signum allows users to type replies while the speech is being translated synchronously when using speech-to-text and text-to-speech translation. Additionally, our stakeholders are also concerned about interaction and eye contact with others. To address this issue, we designed a feature called 3D gesture scan. Users can pass their phone to the other party during the conversation, and Signum will use the camera on the phone to detect the user's gestures and translate the sign language. When a hearing person is replying, they can type in their response, reply with a simple ASL gesture (instructions will be provided by the app), or translate their language from speech to text. In our research, we also found that users care about the accuracy of the translation. In order to prevent

our system from breaking down and resulting in improper translation during a serious conversation, Signum allows users to find and contact professional online translators within minutes for accurate and effective translations. Finally, if users simply want to communicate with others via text message, they can share a QR code through Signum, and it will generate a temporary chat interface to allow two users to chat.

Clear Indications

Deaf/HoH users often have trouble expressing their emotions in conversation, and they often wonder if the volume is generated when the phone converts text into speech. To solve this issue, a bar will appear on the screen to indicate the volume of the phone's play when Signum is converting the user's text message into speech. The length of the bar will change according to the volume of the output, and the color will change according to the mood selected by the user.

Better Food Ordering Experiences

In our study, we also found that Deaf/HoH users often had trouble ordering food in restaurants (whether through drive through or dine in). To make their ordering experience better, Signum will work with restaurants to create a platform that allows restaurant employees and people who are Deaf/HoH to have a better and effective communication experience. Restaurants can post Signum's QR code on their drive through machine or on their dining table. When users scan that QR code, Signum will either direct users to the restaurant’s website and order online, or users can chat directly with the restaurant staff and place an order via text message.

Discussion

In our research, we learned that hearing impaired users tend to be concerned about the effectiveness and accuracy of conversational translation, so we tried to design a tool to make the translation process as smooth and fast as possible. A lot of times, when users are communicating with a hearing person, the hearing person will often habitually express their thoughts by voice. To solve this problem, we've incorporated some instructions into the app to teach people simple ASL reactions and try to show them the Deaf culture. One interesting insight we've got is that users may find it more difficult to communicate when they don't have a phone. So for our future work, we plan to design a translation attachment that users can use without mobile phones.

Conclusion

This is an area that is under researched, and the technologies are mostly still in Beta testing. Although interpreters are crucial for important appointments, education, etc. it is great to develop more options for other situations, such as ordering food, social gatherings, and asking strangers questions. Sign language technologies open up opportunities for accessibility by increasing speed and accuracy of communication. Sign language technologies should continue to be researched and improved.

References

Kipp, Michael, Nguyen, Quan, Heloir, Alexis, & Matthes, Silke. (2011). Assessing the deaf user perspective on sign language avatars. *The Proceedings of the 13th International ACM SIGACCESS Conference on Computers and Accessibility,*107-114.

World Federation of the Deaf. (2013). Who we are: Our mission, our values, our people. *World Federation of the Deaf*, https://wfdeaf.org/who-we-are/.

Roszkowski, Ernest. (2017). *Audialtext Improving Communication Accessibility for the*

Deaf Through Automatic Voice-Recognition and Wearable Smart-Technology. https://www-proquest-com.offcampus.lib.washington.edu/docview/2014462110?pq-origsite=primo.

McLeod, Regina. (2019). Deaf and Hard of Hearing Accessibility at Drive-Through Restaurants. *Honors Theses. 3115.* https://scholarworks.wmich.edu/honors_theses/3115

Appendix A: Reflections on Design Process

Reflections

Isabelle

We worked really well as a team for this project! We did the stakeholder analysis, value scenario, interview, and ideation as a group, and then split up the writing sections evenly for the presentation and report. It was impressive how deep we were able to dive into this topic, because there are many aspects to consider and many areas in which sign language technologies could improve. It would have been great if we could have found more people to interview who were Deaf, hard of hearing, or hearing and learning ASL. It was challenging to find people and then schedule an interview time that worked for everyone, so we were only able to conduct one interview, when our original intention was to do three.

Nina

The design process went really well for us. There were a few challenges in the empirical investigation because it was difficult to find Deaf/HoH and hearing people who are available for an interview due to the pandemic. We were supposed to have a second interview, but unfortunately, it did not go through. By overcoming those challenges, we used research, including primary and secondary sources, to answer our questions and support our empirical evidence. I appreciated how we maintained our weekly meetings, so we all did great work together!

Larry

I really enjoyed doing the stakeholder analysis and conducting those stakeholder interviews; I learned a lot about the deaf community, and I was really proud that we were able to create a project like this in just a short amount of time. I was surprised with the prototype we finished creating. It would be better though if we could schedule a few more interviews and do more user testing with our prototype. It was challenging to finish creating this prototype and prepare for our presentation during finals week. However, we were able to overcome this by supporting each other and sharing useful resources. I really appreciate how everyone is always on top of things, and I really appreciate how everyone always replies quickly in group chat. Overall, I think we did an amazing job!

Appendix B: Conceptual Investigation - Values

Direct Stakeholder Values	Indirect Stakeholder Values
Connection	Connection
Speed	Speed
Accuracy	Simplicity
Representation	Representation
Inclusion	Inclusion

Trust and acceptance	The ability to correct the order status
Diversity	
Facial expressions and body language	
Having options	

Appendix C: Conceptual Investigation - Value Scenarios

Social gatherings

If the gaps in communication were eliminated, Deaf and HoH people would not be left out of a group conversation with friends or family members. They would be able to fully participate in social gatherings on an equal basis, which means direct contact with friends and family members.

Asking strangers questions

When a Deaf person is lost and needs help with directions, those around them are hearing and do not know sign language. Sign language technologies can be adapted in this scenario where all the involved parties would be able to communicate effectively without spending too much time and receive accurate information. At the same time, hearing users can learn how to use the technology in order to communicate—even picking up one or two signs.

Appendix D: Empirical Investigation

Informed Consent Form

For Deaf, hard-of-hearing, and hearing participants, we will email them with an informed consent form:

Dear Participant,

Thank you for taking time to participate in this research! The purpose of this interview is to research and analyze sign language technologies that involve speech-to-sign, sign-to-speech, and sign-to-text. In our notes and summaries of this interview you will be anonymous. You are welcome to stop at any point, ask questions, and choose not to answer any questions.

By signing this consent form, I acknowledge that I have read and agree to all of the above information.

Name:
___XXXXXXXX_____
Date: __XX/XX/XXXX____

Semi-structured Interview Questions

Deaf and Hard-of-Hearing Participants

1) What sign language technologies do you use? What did you like the most/least about it?
2) Where and how often do you use sign language technologies for work, school, or general use?
3) What are the things you value when you communicate with others? (efficiency, accuracy, reliability, etc.)? How do the use of sign language technology support or inhibit those values?

4) Can you describe a time when you used sign language technology and tell us the experience? Any difficulties you've faced?
5) What was the experience of ordering at a drive-through store location like for you?
6) What are some of the barriers you face when you communicate with others? What are some of the tools you use to help address communication barriers?

Hearing Participants

1) How important is it to communicate with a Deaf person to you? What are the values you care about?
2) Tell us about your experience interacting with a Deaf or hard-of-hearing person.
3) What are some of the communication barriers you have experienced with a Deaf person? What are some of the tools you use to help address communication barriers?
4) What is your experience with the use of speech-to-sign or sign-to-speech technologies? Do you feel that you can understand sign language through the app?
5) What are the technologies you use that are not Deaf-friendly?

Notes on Interview with Laura

There are many sign language technologies, including speech-to-sign, sign-to-speech, sign-to-text, and type-to-text.

Mainly uses text on phone, uses a notes app to have people type what they are saying and respond

What sign language technologies do you use? What did you like the most/least about that technology

Mostly texting, the grammar is difficult and there is a lot of pausing in between to type out messages

Where and how often do you use sign language technologies for work, school, or general use?

Mostly at a business to order, use it every day to communicate with hearing people

What are the things you value when you communicate with others? (efficiency, accuracy. etc.) How do sign language technologies support or inhibit those values?

I value time, for example if I was ordering and there was a long line and the texting takes a long time, I don't want others to feel like they are waiting for you

Both a barrier and a benefit because there is communication and understanding, but it is a barrier because it is slower than desired

Can you describe a time when you were using sign language technology and tell us the experience? Were there any difficulties you faced?

On a college campus without an interpreter, took so much time and they didn't know what to do to make sure I got my paperwork and there were things I had to know that were not being communicated so i missed out on information, there were concerns I had that I was not able to address

How did you like the experience of ordering at a drive-thru? Was it hard?

Typically i will have my whole order listed out and that is fine for some people, but usually something is missed, people often speak in response because I can't understand what they are saying if they don't figure out that i am deaf

I go straight to the person and show a sign that says I am deaf

What are the barriers you face when you communicate with others? What are some of the tools you use to help address communication barriers?

Some people will text back and forth, some people don't understand and will just talk back, people are awkward and don't know how to use technology so their

responses vary and are not sure how to communicate
Gesture is really great if it is simple, but text is good for
I will have to gesture through and have a lot of patience, if I am lucky i will be able to get a piece of paper to write back and forth
Usually use a piece of paper

We would love to watch you use an app called mimix for the first time. Tell us about your experience using it?

I am very impressed by the speed and accuracy
Knew that I needed fingerspelling and it knew what I needed to say
It does match the signs but there are some regional signs that would be hard to know based on location - whether it is geographically dependent or not
It is a mix between english ordered language, not completely ASL, follows grammatical structure of english not ASL, what matters though is that I can understand it well
It would be a great recommendation for people who are learning ASL
No facial expression which is fine for people who know ASL but it wouldn't be perfect for learning because it doesn't show actual deaf culture

What do you wish people did differently?

I wish more people would understand us and have exposure to deaf people and deaf culture, so it makes people be awkward and try to avoid interacting with us, so I wish people would not do this and just talk to us

What is the best way to communicate with people who are deaf if you don't know ASL?

Texting is great or a paper and pen, just write it out

What is the difference between using an interpreter or notes like mimix?

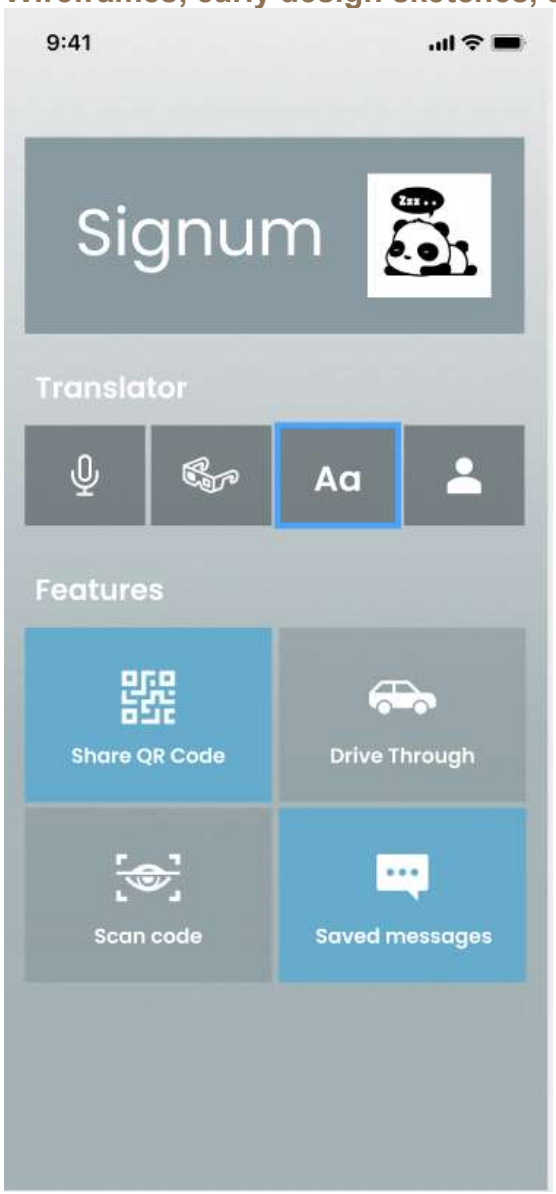
With an interpreter there is a third party, nice to have interpreter but can't look at person speaking, while texting is great for looking in the eyes there is a disconnect because of texting

What is the best thing about being deaf?

I love how expressive we are, very visual. It is very rich how the hands and face move. It feels like you're on stage, beautifully visual and rich, like seeing color for the first time.

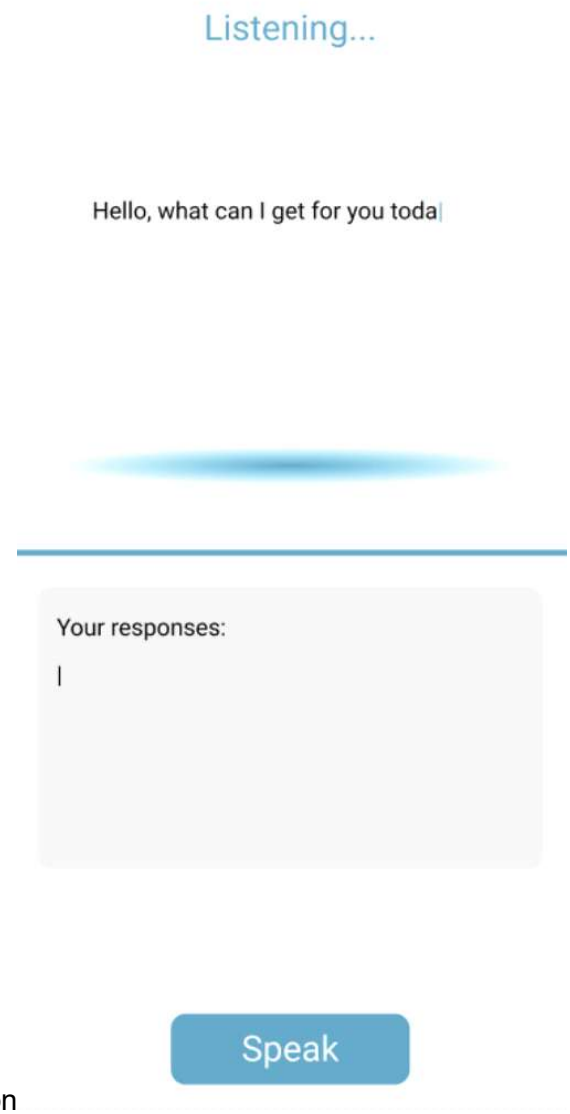
Appendix E: Technical Investigation

Wireframes, early design sketches, and prototypes

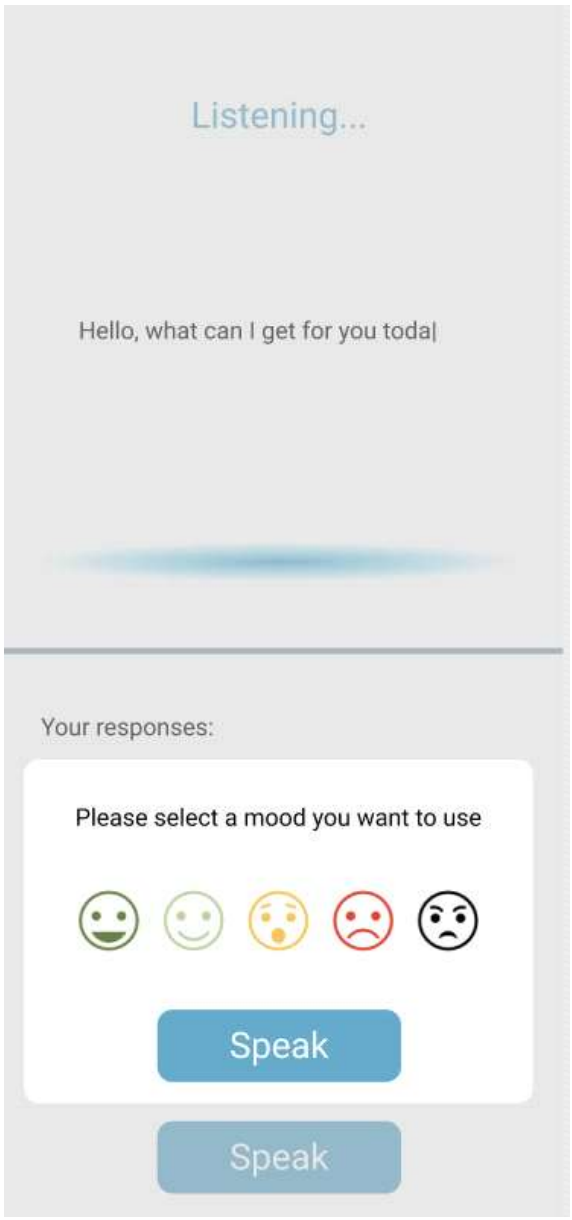



9:41
Signum
3D gesture scan
Use the camera to translate
people's sign language gesture
Start

Figure 1 - Home screen
Figure 2 - Translation selection
Figure 3 - Speech-to-Text
Figure 4 - Speech mood


Listening...
Hello, what can I get for you toda
Your responses:
Speak

selection


Listening...
Hello, what can I get for you toda|
Your responses:
Please select a mood you want to use
Speak
Speak

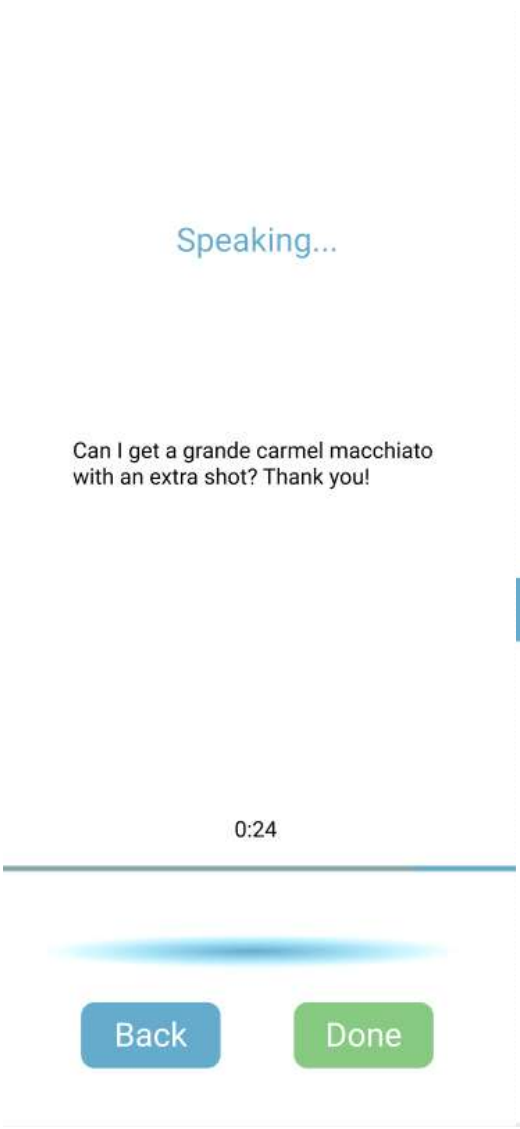


Figure 5 - Signum speaking

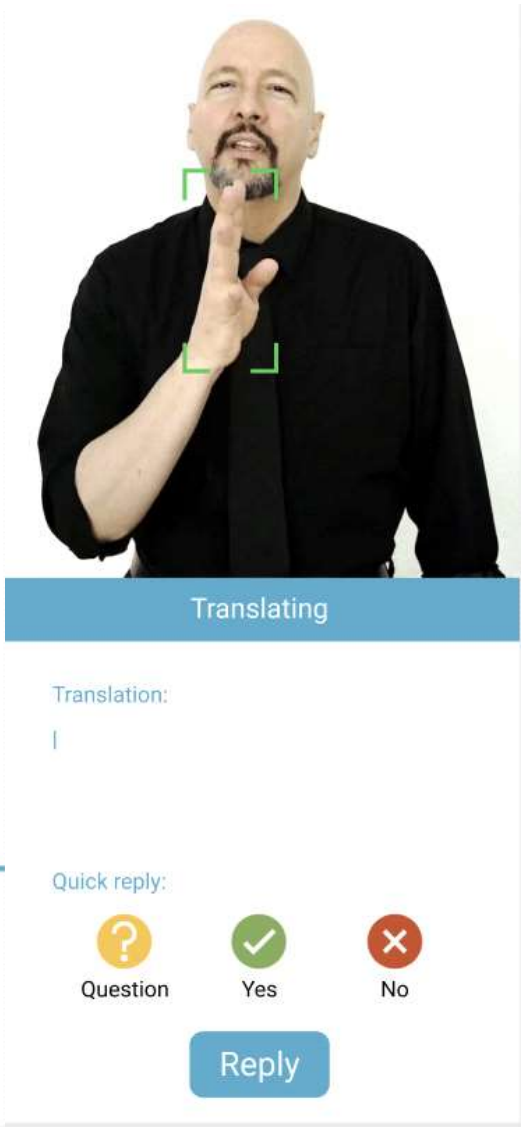
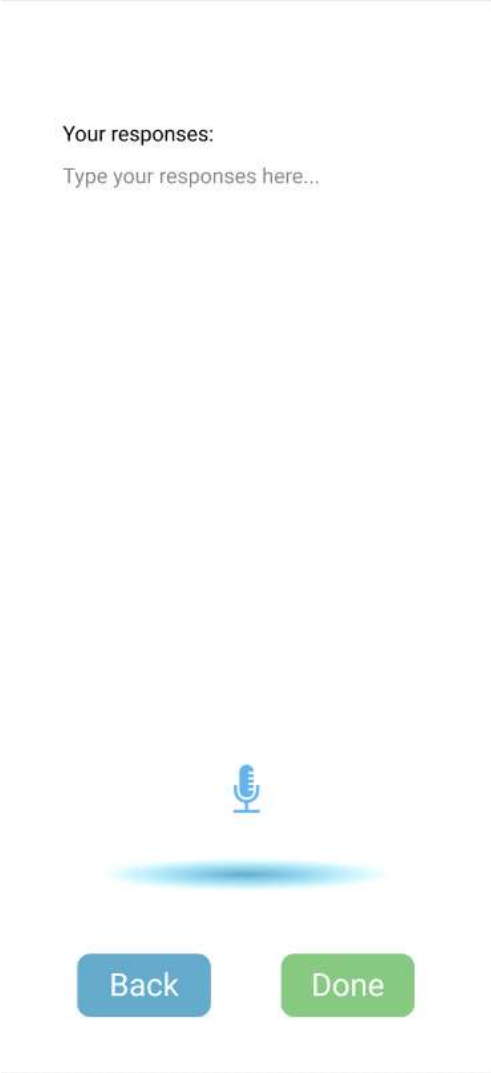


Figure 6 - 3D gesture scan

Figure 7 - Easy ASL instruction

Figure 8 - Speech-to-Text replies



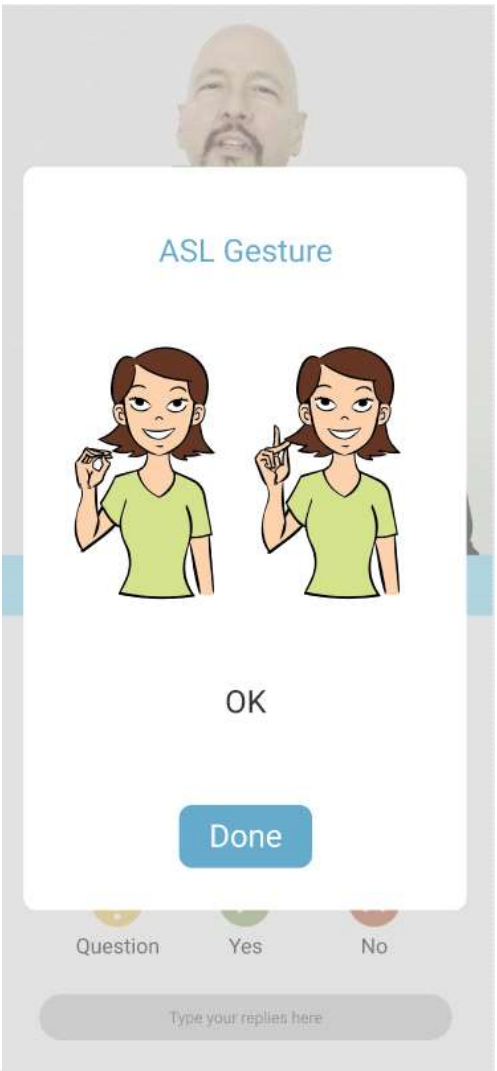
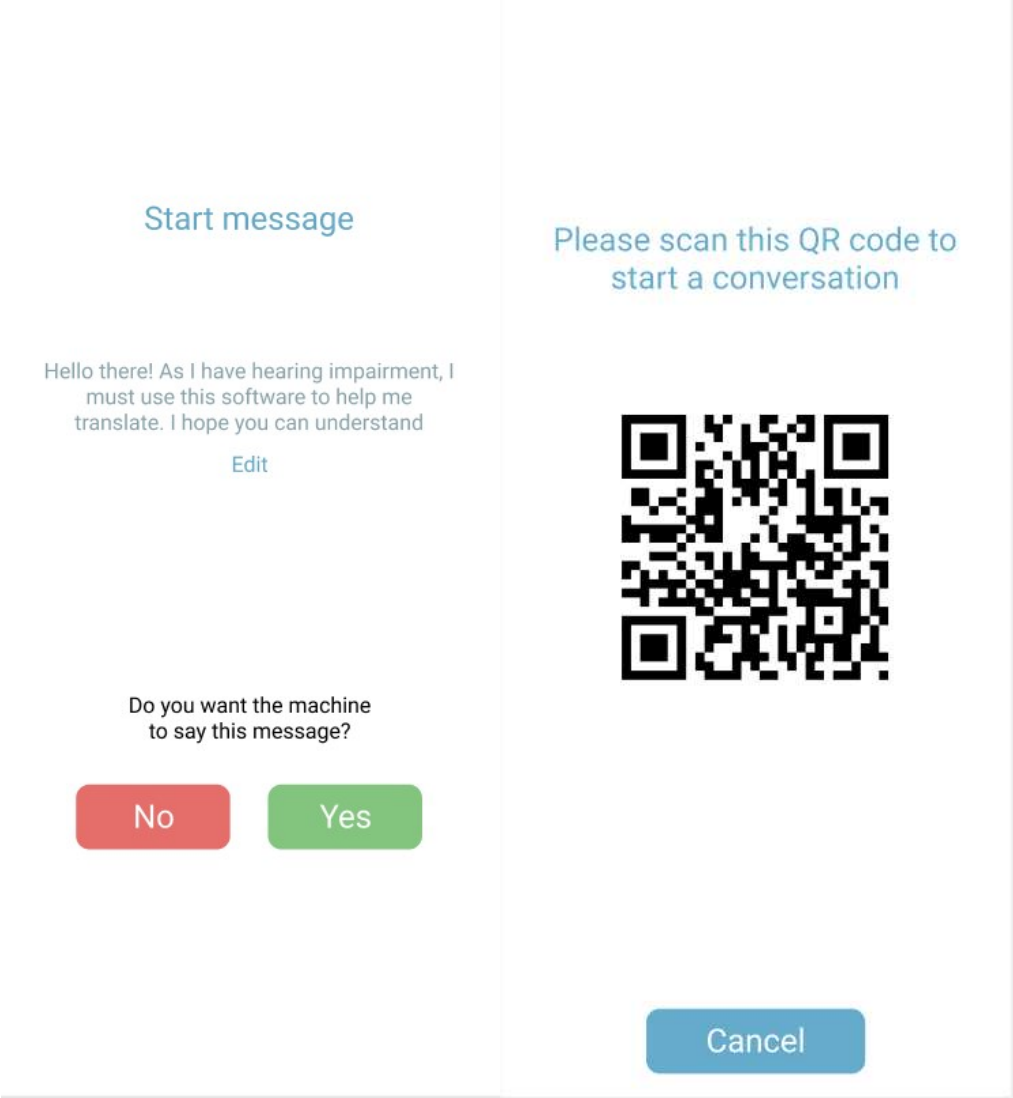


Figure 9 - Quick message

Figure 10 - QR code sharing


Start message
Hello there! As I have hearing impairment, I must use this software to help me translate. I hope you can understand
Edit
Do you want the machine to say this message?
No
Yes
Please scan this QR code to start a conversation
Cancel

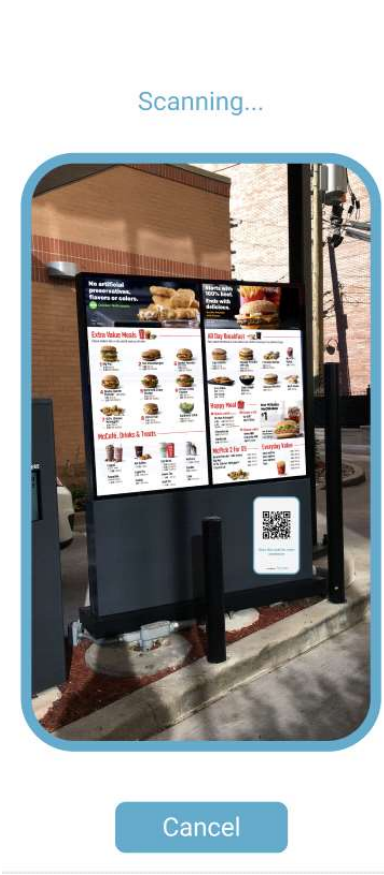


Figure 11 - Restaurant QR Code scan

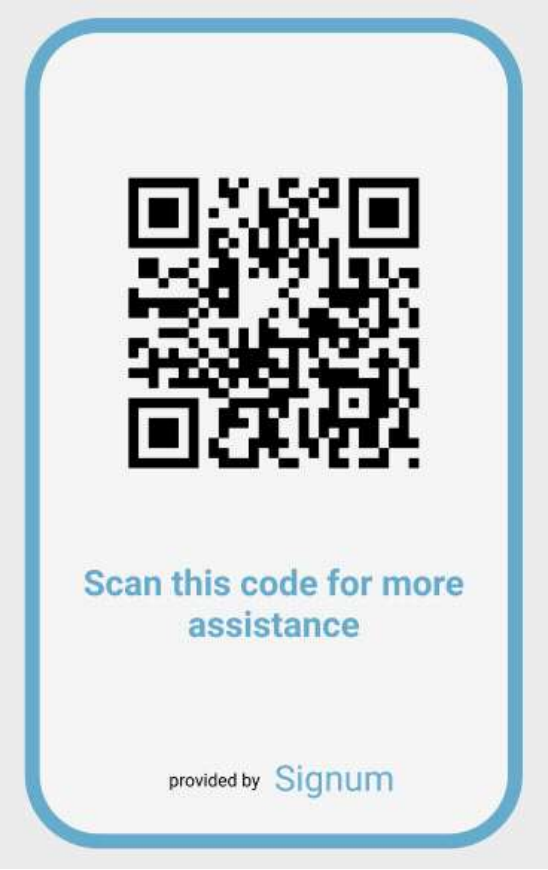
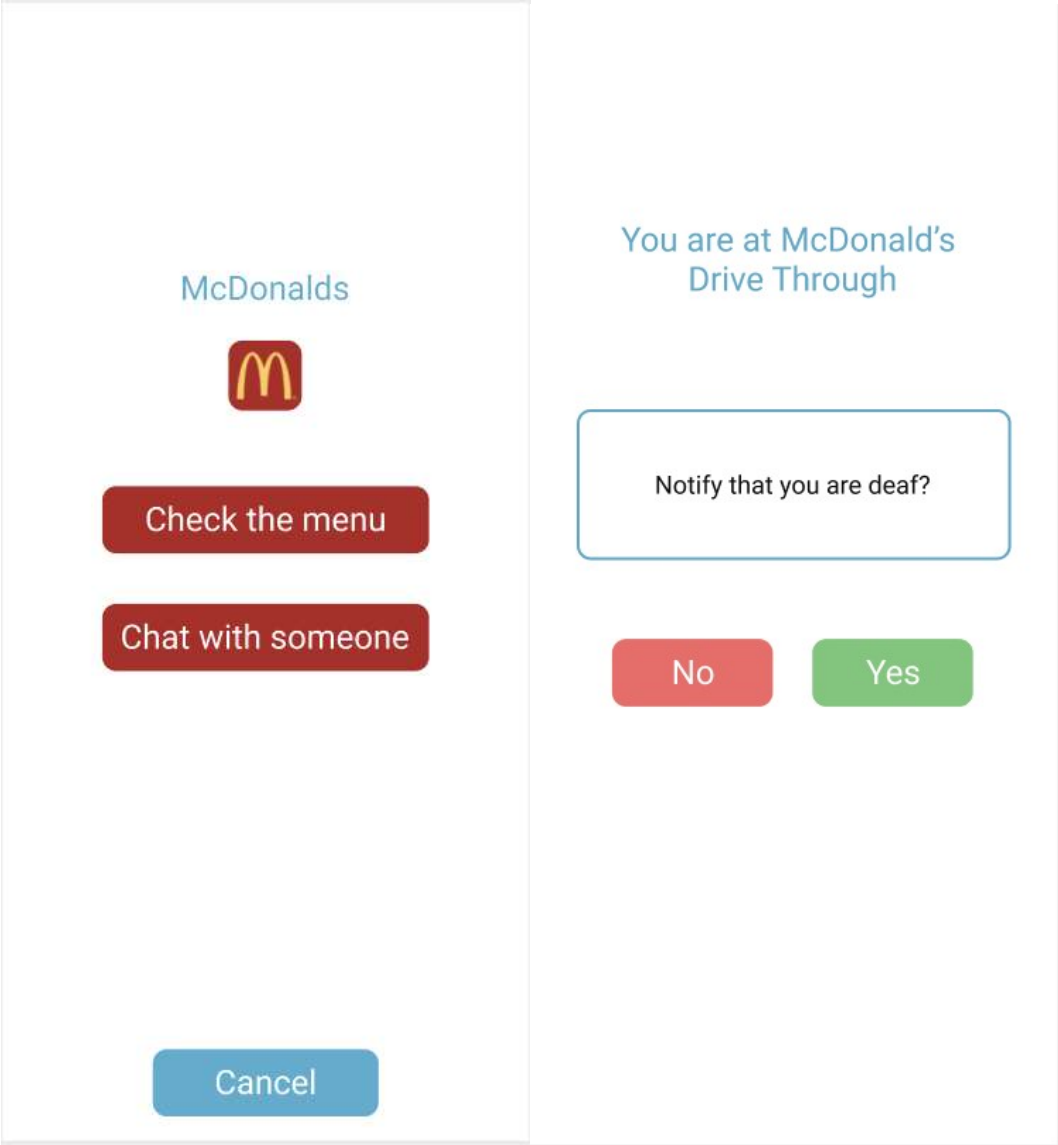


Figure 12 - Drive through QR code

Figure 13 - Notify restaurant employee

Figure 12 - Connect with the restaurant



Figma Prototype Link:

https://www.figma.com/proto/xiq294h09pmLGyuLhUpiVE/Signum?node-id=25%3A0&scaling=scale-down&page-id=0%3A1

Appendix E: Planning

Collaboration and communication strategies

We met every Tuesday from 6:00 - 7:00 PM (Pacific Standard Time Zone) to discuss our final project and schedule interviews as needed. The collaboration platform we used is Miro, which can be founded at: https://miro.com/welcomeonboard/mwIxa3Wjv70aaAsL2di914Q5YVXhEhlL0NIpvWGXLIK9ZCHvr4wWto9tsSiuhXSF