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# Voicer: a Sign Language Interpreter Application for Deaf People to Better Communicate With Others

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# Voicer: a Sign Language Interpreter Application for Deaf People to Better Communicate With Others

BY

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## Abstract

In the past two decades, the rapid development of technology has made our daily life has changed dramatically. Everything has become easier and more convenient. However, while we can already communicate with people anywhere in the world in real time, most deaf and hard of hearing (HOH) people still need the intervention of a sign language interpreter to carry out their daily studies and work. Undeniably, Internet technology and smartphones have also significantly changed the lives of deaf people. But the barriers between them and the hearing world still exist. A significant number of studies have pointed out that cultural identity issues among the deaf community are increasing due to difficulties in communicating with the hearing community. Communication difficulties also pose problems for the deaf community in areas such as education, health care, employment, etc. I believe that the advancement of technology should benefit everyone. Therefore, this project will focus on the communication problem between deaf and hearing people.

Voicer is an application designed to make everyday communication easier for deaf people. The core function of this application is detecting and interpreting American Sign Language (ASL). Many researchers have attempted to address the communication problems of deaf people from this perspective in the past, but the results have been less than satisfactory. In recent years, electromyography (EMG) sensing technology has been rapidly developed. Movements of the arms and even the fingertips can be detected precisely by EMG sensors. This provides a new direction for solving the communication problems of deaf people. The design of Voicer is also based on the development of EMG sensing technology.

## Keywords

Mobile Application, Wearable Device, Deaf, Communication, American Sign Language(ASL), Electromyography(EMG), Textphone, Inclusive Design,

## Introduction

The deaf community is a large and growing group, and they do not receive enough attention from our society. According to a survey conducted in 2018, there are approximately more than 11 million people in the US are deaf or have serious hearing issue. That is nearly 3.6% of the total population in the US. Also, nearly two million people among them are unable to hear anything even with hearing aids. To communicate with other people, they use American Sign Language (ASL).

ASL is the mostly used sign language in North America. Also, it is the 3rd most common language in the United States. The main component of American Sign Language is the movement of the arms and hands. In American Sign Language, words are represented primarily by morphology and fingerspelling. However, the grammar of American Sign Language is different from the grammar of English. This is a very difficult part of learning American Sign Language. Because learning American Sign Language is not easy, many deaf people who have lost their hearing later in life do not choose to learn American Sign Language. As a result, there are only about half a million deaf people who are proficient in American Sign Language. It is a very small amount compared to the total number of deaf people mentioned above. It can also prove that the language communication issue among the deaf community is serious and significant.

Since the 21st century, there have been many research institutions and researchers who have tried several different approaches to interpret ASL to make it easier for deaf people to communicate with hearing people. The most common solution is to analyze the movement of the user's hands and arms in the camera feed based on image recognition. In the following sections I will detailedly introduce some designs based on this solution. The result shows that this solution is not widely accepted by the deaf community, because it is a terrible experience to use, even if it is feasible.

This thesis documentation will focus on how to design a feasible and excellent experience of sign language interpretation application based on EMG sensing technology. Of course, the discussion about related technologies will not be the only or main topic of this article. In following sections, the essay will introduce the design context, background research, design methods, and the design deliverables. As the end of this section, it needs to be claimed that this thesis documentation is meant to bring a new idea to the domain of deaf technology. To solve the communication issue of deaf people, it needs various types of talented people to work together.

## Context

To initiate this thesis project, desk research can be a good start. There are many aspects of this project needed to be understood. First of all, the target user group needs to be defined.

### The Deaf Community

Usually, for most of us, we consider anyone who cannot hear or speak as a deaf person. However, the deaf community is much more complex than we think. According to the National Association of the Deaf (NDA) , there are many variations in how a deaf person identify himself or herself, such as the level of hearing loss, age of losing hearing, the reason of losing hearing, and etc. Commonly, the most used labels among deaf community are “deaf”, “Deaf”, and “hard of hearing (HOH)” .

The deaf with lowercase d is used to describe the physical condition of not hearing. This is comparatively close to our definition of deaf people. The Deaf with uppercase D is referred to a cultural identity for people with hearing issue. People who identify themselves as Deaf usually consider ASL as their native language. They also actively engage with the Deaf community. Hard of hearing is usually used to describe moderate hearing loss.

It is evident that the target user group of this thesis project should be the d/Deaf communities. Most of them are proficient in sign language because they are unable to enhance their hearing with hearing aids. Thus, their communication issue is most urgently needed to be addressed.

### The Problem Voicer Will Solve

Technically, Voicer focuses on solving the problem of the Deaf community's difficulty in communicating with hearing world.  ASL is the native language of the deaf community, but only a small percentage of hearing people can use or understand this language. Therefore, the root of this problem lies in the communication limitation of ASL.

When we take a wider view, this problem leads to many more profound problems. For example, employment difficulties, social isolation, and self-perception of identity.

Also, as noted above, only about a quarter of Deaf people are proficient in ASL. The majority of this group was born with a congenital loss of hearing. According to the interviews with some Deaf people who do not know ASL, there are two reasons why they do not learn ASL. First, ASL is not easy to master. Secondly, ASL does not help them communicate with hearing people more easily. Since this group of people lost their hearing later in life, they are often the only Deaf person in their own family. Therefore, there is no point in learning ASL if their own family and friends do not understand it. However, if they have the ability to make ASL understandable for hearing people, they probably would spend time learning ASL. And this is the major design objective of Voicer.

## Methods

In this thesis project, the mainly applied design methodology is the Double Diamond Process. Therefore, this part will be divided into four parts. Each part will be described in detail.

### Phase 1: Insight into the Problem

The objective of this phase is understanding the problem. To accomplish this objective, I conducted two sets of semi-structured interviews with some Deaf students and ASL interpreters. Also, I obtained some macro-level insights through literature research.

For the first set of interviews, I invited several ASL interpreters working in RIT and talked with them individually. In these interviews, I focused on how they help Deaf students learn and communicate during classes, and how Deaf students communicate with hearing people. After this set of brief interviews, I gained an initial understanding of how deaf people communicate on a daily basis and the quality of their daily communication.

In the second set of interviews, I reached out to several Deaf students through the ASL interpreters I interviewed in previous interviews. This set of interviews were all conducted with the help of those ASL interpreters. This time, I asked invited Deaf students many questions about their terrible experiences of communicating with people who do not know ASL. And the results were basically aligned with what I learned from ASL interpreters. Deaf people have very limited ways of communicating with hearing people. Some of them would communicate with others by writing notes, while others chose to use social networking software as much as possible. A few mentioned that they would directly talk with others, but the results were less than ideal. Most of them agreed with the opinion that the difficulties of their communication with hearing people limit their social life.

As for the literature research, I read many books about ASL and deaf community. According to existing materials, the communication difficulties of Deaf people have led to their increasing social isolation. In addition to the problem of social isolation, there are a large number of various social problems that occur among Deaf children and elderly people, such as education, medical care, identity recognition, mental health, and other issues.

### Phase 2: Explore and Define the Problem

In this part, competitive and trend analysis is the main role. I learned about a number of assistive products designed for solving the communication problem of Deaf people by reviewing related articles and asking relevant people. Among these solutions, there are two solutions I would like to talk about.

MotionSavvy UNI is the first related product I learned about. It was designed and developed by a student team in RIT. This product works very much in line with intuitive thinking - translating ASL into spoken English while converting speech into text. MotionSavvy UNI consists of two parts, a tablet and a tablet case which is installed with two 3D motion recognition cameras. The software pre-installed in the tablet works with the cameras to recognize users' sign and interpret into spoken English. Meanwhile, hearing people's speech will be converted into text and be displayed on the screen. In my opinion, MotionSavvy UNI solves the two-way communication problem in an excellent method. However, this solution's scope is not large enough. It only focuses on the face-to-face

communication scenario. In fact, there are more than just one occasion where Deaf people cannot communicate with hearing people. Also, it requires good lighting conditions so that the cameras can work properly, which as well limits the usage scenario.

Another solution I noticed is called SignAloud, a pair of gloves that can translate ASL into speech or text. SignAloud seems to be similar to MotionSavvy UNI and only has half of the functionality of the latter. But it uses EMG sensors to recognize gestures. This technology greatly expands the use scenario. Of course, SignAloud's design only takes into account how to make hearing people understand ASL, which is its biggest flaw.

## Conclusion of Phase 1&2: Design Goals

After phases 1&2, the problem can be clearly defined, which is how to help Deaf people to conduct two-way communications with hearing people. To solve this problem, three design goals must be accomplished. The first one is to make ASL understandable for hearing people. The second is to make spoken English understandable for Deaf people. The last one is to be applicable to as many usage scenarios as possible.

## Phase 3: Define the Solution

In this phase, the methodology is to initial potential solutions and choose the most valuable and feasible one to develop. According to the design goals, the solution I chose is a mobile app working with a pair of bracelets that can recognize gestures with EMG sensors. In my concept, this application can interpret ASL into text and spoken English, and also translate spoken English into text for Deaf people to read.

According to my interviews with Deaf students, Another two greatest pain points are making phone calls and asking strangers for help in unanticipated situations. Therefore, this solution also includes functions that focus on these two user needs.

## Phase 4: Develop the Solution

In the last phase, I completed my design solution and made necessary showcase materials for explaining my solution. The deliverables including sketches, wireframes, final screens, interaction prototype, etc. As the results of this thesis project, they will be presented and discussed in the next section.

## Results

In this section, the final body of my work will be presented in three user flows. These four user flows are able to demonstrate all the usage scenarios and functionalities.

### User Flow 1: Chat with Friends

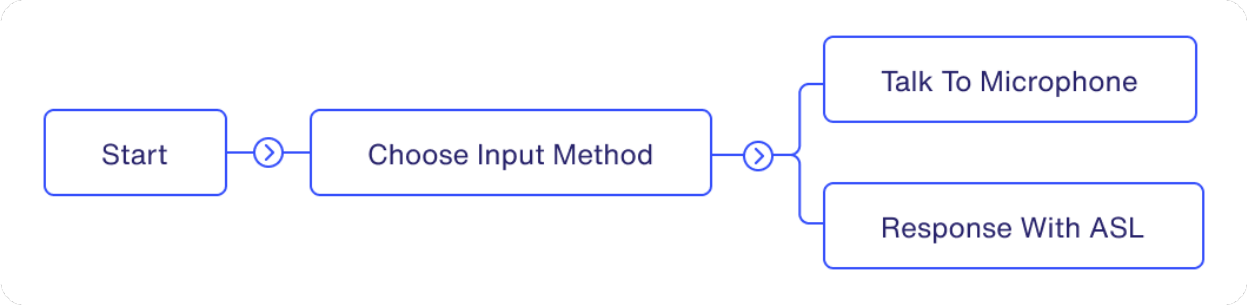


Fig. 1. Diagram that presents how chat function works

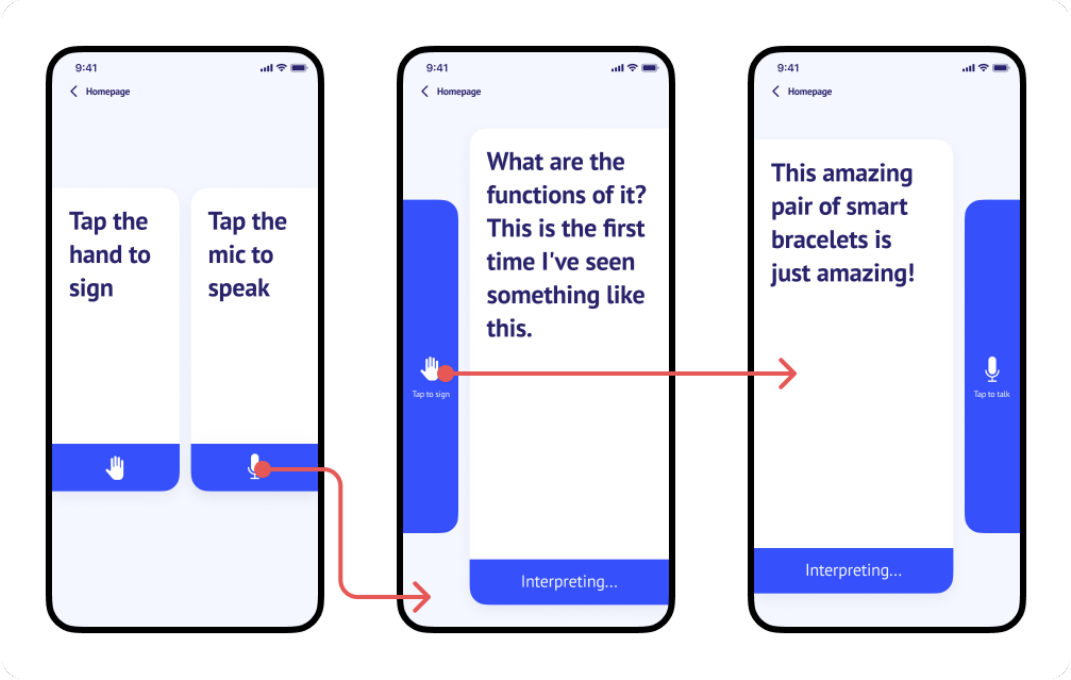


Fig. 2. Task Flow of chat function

This flow (figs. 1&2) is simple to understand. First, the Deaf user opens the Voicer app and enters the Chat page. There will be two text areas and each has an input button at the bottom. Then, the hearing person decides to talk first, so he/she taps the microphone button and starts talking. Voicer recognizes and converts the speech into text, then displays on the right text area. After that, the Deaf user taps the sign button and replies in ASL. Voicer interprets the gestures into text and displays it on the left text area.

## User Flow 2: Make Phone Calls

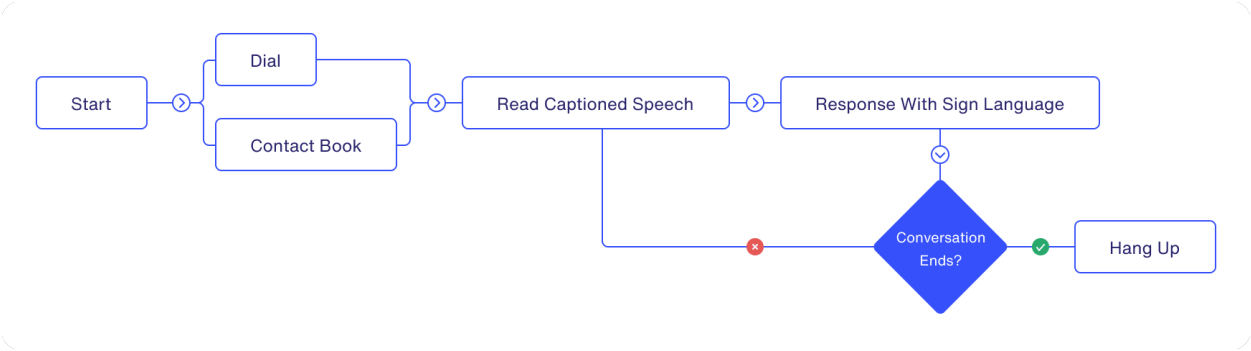


Fig. 3. Diagram that presents how phone function works

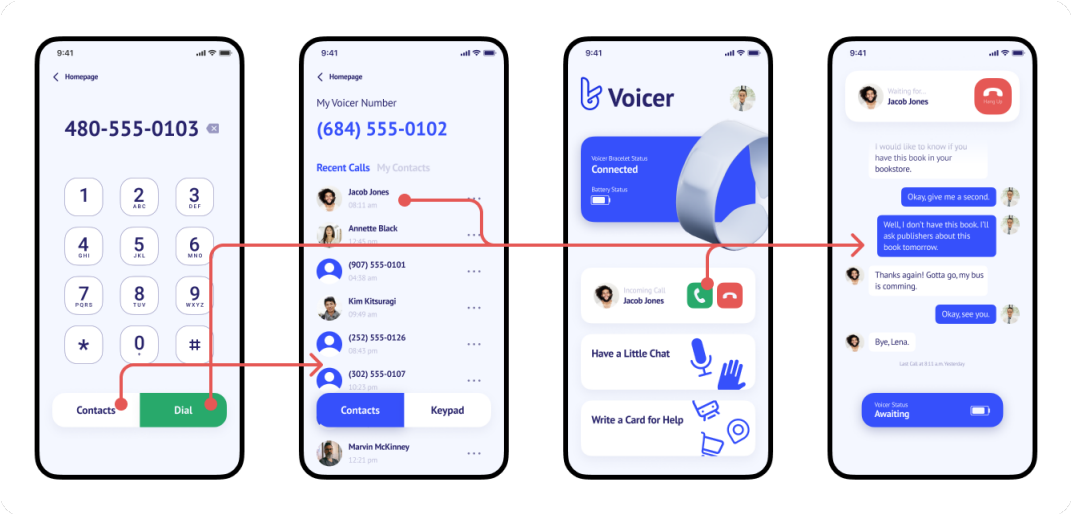


Fig. 4. Task Flow of phone function

The phone function of Voicer takes several usage scenarios into consideration (figs. 3&4) . There are two ways to call someone, dialing the phone number or using the contacts. Also, users can receive incoming calls in Voicer. The basis of phone function is similar to existing web phone applications. While users are communicating on the phone, the screen is like common message applications. There are two parts worth noticing. The first part is at the top, which contains the contact information and the hang-up button. The second part is at the bottom, which is the Voicer bracelet status bar. It indicates the system status, whether it is awaiting or interpreting. Also, it shows the battery status, in case the bracelet automatically shut down before users finishing talking.

## User Flow 3: Emergency Cards

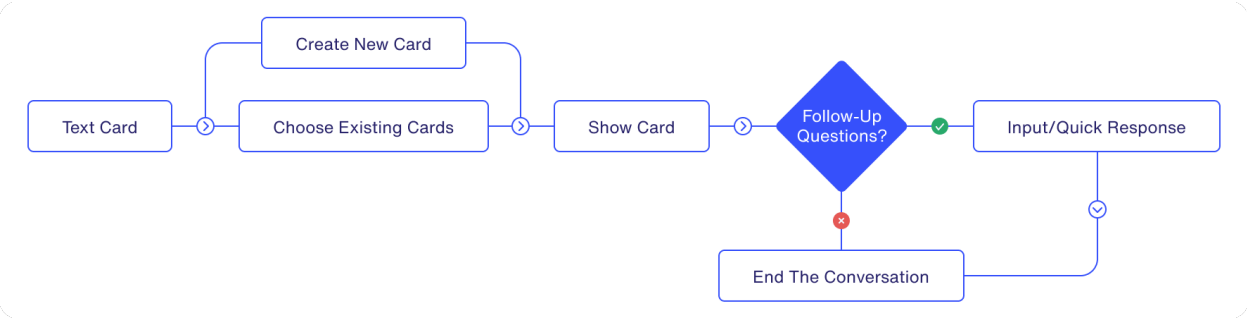


Fig. 5. Diagram that presents how card function works

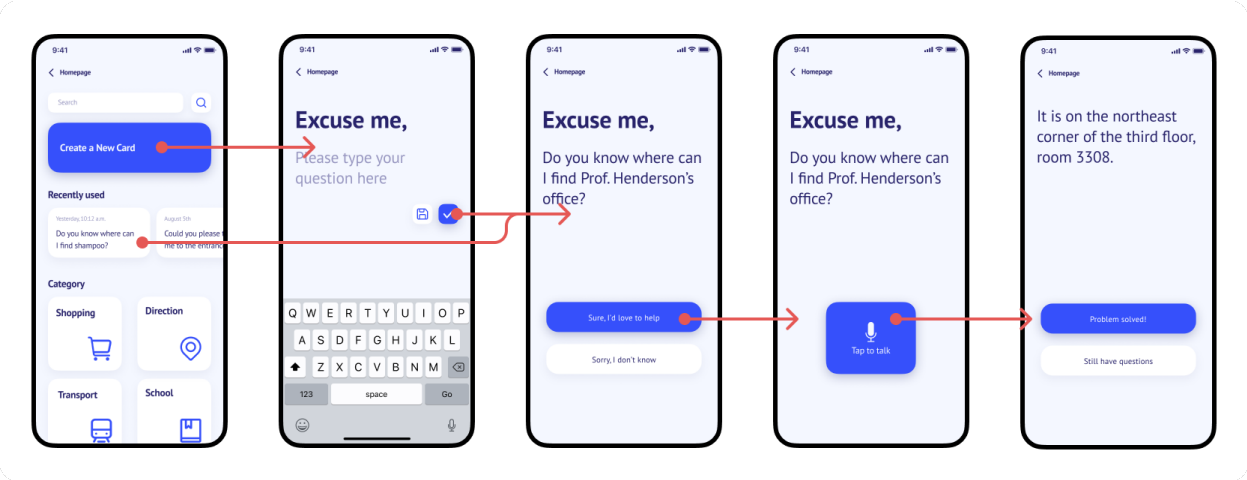


Fig. 6. Task flow of card function

This flow (figs. 5&6) is functionally different from another two flows. It does not interpret ASL, because in most usage scenarios of this function, users have to hold their mobile phone. So, this function mainly needs users to input problems they want to ask manually. This is designed for emergency situations where users need to ask strangers for help. To start using this function, there are two ways, creating a new card or selecting an existing one. After showing strangers the question card, the stranger will choose to help or not. If the stranger agrees to help, he/she needs to long press the microphone button to input their reply. The reply will be displayed as text on screen. If it solves the user's problem, the user will tap the solved button to end this workflow.

## Evaluation & Discussion

### Reviews

After finishing the initial design of the solution, I sent my prototype to previous interviewees for reviewing. However, without the bracelets, it is not clear that how Voicer will address the two-way communication problem. So I also sent them a brief design documentation. As a result, the interviewees gave me many valuable feedback, which are listed below.

The first problem is the text size. In many usage scenarios of Voicer, users are not as close to the phone as they usually do. Because they need to use the pair of bracelets to input, in which case the phone has to be maplaced on a table or a mobile phone holder.

The second problem is not being able to answer incoming calls. In my initial design, the phone function only allows users to call others. And some interviewees thought this is not very considerate. In my final design, this function includes answering incoming calls.

The next feedback is about bracelets' status indicator. In the initial design, the bracelets's status indicator only shows whether the bracelets are connected or not. Some interviewees gave examples of their experiences with using bluetooth devices. Sometimes when the battery runs out without notifying them, they would mistakenly assume that the device is broken.

Other feedbacks are, in my opinion, not feasible in this phase. So I consider those feedbacks as future design opportunities, and list them in the next part.

### Possible Future Iterations

The first design opportunity is multi-language support. It is not just about spoken languages like Spanish or French, it also includes different sign languages. Deaf people in different countries use different sign languages. But some sign languages includes non-gesture components. Currently, this idea needs a large amount of research, so it is considered as future design opportunity.

Another future design opportunity is Augmented Realty (AR) based solution. An AR device is more portable than mobile phone. Therefore, if Voicer can work on a pair of AR glasses, its usage scenarios will be largely expanded. Users can almost communicate with hearing people in any occasion. To be honest, this can be the ultimate solution of Deaf people's communication problem.

## Conclusions

This thesis project is mainly about solving two-way communication problem for Deaf people. This problem is also the root of many Deaf people's social problems. When I conducted my literature research, I found out that only few types of technology solutions are design for this problem. I think our society should give more attention to the Deaf community. Also, during the research, I started noticing the value and power of communication. Talking with others is an every day routine for most hearing people. However, we should not ignore its significance because of it appears to be ordinary.

At the beginning of the project, I found it hard to design interactions for Deaf people. Not just because of their limitation of expressing, but also because of my lack of understanding of Deaf community. I knew very few about how ASL works, and how Deaf people communicate with others. After the interviews, my problems were successfully solved. Therefore, it has deepened my understanding of the importance of design research.

In the future, science and technology will continue giving the world more possibilities. I hope the problem which this thesis project is focused on can be solved permanently.

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