AASVI

Accessible & Adaptive Systems for Visually Impaired

Part 4: Evaluation

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Introduction

We begin our report with an overview of our project and a brief explanation of the different design stages in the design process that we have followed, things that we have concluded at each stage and have taken forward towards our final design.

In the second section, we start by describing method that we have chosen for the evaluation of the prototype and rationale behind various tasks and materials chosen for the testing.

After this, we explain various qualitative and quantitative metrics that we want to infer from our evaluation, describing the rationale for acquiring specific metrics from the users. Then we went ahead to describe the usability testing process that we have conducted at CVI (Center for the Visually Impaired).

In the next section, we laid down the qualitative metrics collected during the poster sessions and cognitive walkthrough with the users during brown bag session at CVI. Then we detailed out quantitative metrics collected during our usability testing.

Lastly, we discuss the implications from the data collected along with a future scope and brief conclusion.
Project Overview

Introduction
In this section we will describe briefly the process we have followed before coming to the evaluation. The process that we have followed is also shown below in Figure 1.

![Figure 1: AASVI Design Process](image)

We started the project with the visually impaired as our target user group with a very wide scope which would cater to the accessibility issues of visually impaired users.

We surveyed potential users and conducted a focus group study with different age groups and types of people. Based on literature reviews we prepared a questionnaire that could provide us with insights about the accessibility problems and other issues faced by the target population in activities of daily living. Once we identified the potential problem areas, we came up with the following design description:

“The main objective of our project is to enhance the accessibility of various products for users with impaired vision. The developed system would help the users make efficient use of different products and appliances such as microwaves, TVs, ATMs, vending machines, and various other electronic devices. We intend to build an assistive system which will enhance the accessibility of using these devices.”
Our aim is to take the ‘Dis’ Out of ‘Disabilities’ for visually impaired users, that is, to achieve equitable access to technologies for our target user group.

Through the system that we come up with users should be able to access the control panels of various electronic devices around his environment.”

We continued to identify various electronic devices that users utilize in public and in private environments. Electronic devices like microwaves and exercise equipment were selected as benchmark devices for designing and testing purposes, though, with the aim of making all the electronic devices easily accessible to the user group. We then built scenarios based on user walkthrough from the initial survey and our initial understanding of how users currently use these systems.

Requirement Analysis
These scenarios (as shown in Figure 2) were used during task analysis to identify the potential pain-points with the existing system. Based on various identified tasks and our initial study we came up with various functional, non-functional and usability requirements.

Functional Requirements
1. The system should be flexible enough that visually impaired users can access different devices.
2. The system should be able to consistently interact with the devices it is intended for.
3. The system should relatively seamlessly integrate or blend with user’s environment.
4. The system should be able to provide auditory or tactile feedback mechanisms.
5. The system should provide access to basic functionality of the devices through a relatively simple interaction behavior.
6. The system should not prohibit users from using their current assistive techniques while using devices, such as labeling appliances with hints, codes, etc.
7. The system should accept voice input from the user.
8. The system should allow for customized output based on user preferences. There are two subgroups in our target user group. Users may prefer large text rather than Braille or vice versa; our system must be able to customize these options for the user.
9. The system must assist users in reading and interacting with what is presented to them over the interface without requiring changes to existing equipment.

Non-Functional Requirements
1. **Reasonable cost** - It is important to ensure that both initial cost and upkeep are realistic.
2. **Socially acceptable** - the technology should not stigmatize the user and should be acceptable to other un-impaired occupants of the home.  
   **Choice** - Where possible, different designs should be offered to reflect personal tastes because all users have their own personal tastes and tend to follow them.  
   **Compact and portable** - The system should be small, relatively unobtrusive, and robust enough to withstand frequent usage.  
3. **Comfortable** - the system should be made of lightweight, comfortable materials  
4. **Independence** – The device should be able to assist users in various ways to gain and maintain their independence.  
5. **Non-hindrance** - System should not hinder hearing (ear plugs that may compete with external sounds.) Audible menus should not interfere with basic activities.

**Usability Requirements**
1. **Simple to Use** - The system should be easy to use. This should not be at the expense of overall functionality.  
2. **Interoperability** - System should provide only required information allowing the user to seamlessly interact with/switch between all the devices.  
3. **Flexibility** - System should provide user with multi modalities for input and output to suit his preferences which he can customize accordingly.  
   a. **Consistency** - The system should provide consistent interaction with different devices.
4. **Simple and Natural Interaction** - The system should require a minimal number of steps to complete a task. System should provide affordances to aid users in interacting. The system should decrease cognitive overload for the user during the interaction.  
5. **Visibility of System Status** – The system should provide the users with tactile or auditory cues about the things that are happening while interacting with the device.

**Prototype Description**
Taking all these requirements specifications, scenarios and task analysis into consideration we came up with a design space and started exploring ideas. From the brainstorming session several ideas were selected for further exploration, also shown in Picture 3. Based on the sample scenario and the design rationale we rated each of these three short listed ideas and chose to go ahead with the idea named *Feel It!*

Now comes the important question of why we chose this idea? First of all, *Feel It!* is a direct access (perceive-interpret-manipulate) assistive device. It is independent of the environment since the device doesn’t need to exchange information or communicate with the system environment or product. This feature makes this concept highly feasible in the present scenario. Other ideas were more based on an indirect access assistive device (like a Universal Remote Control), which mainly depends on the information exchange/transfer between the assistive device and the system/device being accessed. This would be a major infrastructural change or a paradigm shift in the design of every system that a visually impaired user will use and certainly it won’t be feasible currently. Consequently *Feel It!* comes out as a most feasible option to cater to the present scenario.  

Another reason we chose this design is because of its simplicity and effectiveness. This device maps with the user’s current mode of accessing the electronic devices, making it easy to use and is, thereby, very quick on learning curve. This system doesn’t calls for expensive add-ons or additional peripherals for working. Other alternative design, *IntelliPad*, called for a device with a reader and a separate handheld.
This design is also less obtrusive compared to other design alternatives. One of our other designs was a device that would cover the handle of a user's walking cane. This would make the handle more bulky as well as change the vibrations the user received as feedback from their cane.

Lastly, relative to the other designs, Feel It! also has a high cost benefit ratio. Other ideas and alternatives used components like Braille display, which are expensive. Compared to present assistive devices available, this device proves to really useful in terms of affordability and usefulness.

**A Brief Introduction of Feel It!**

A major problem that users face while interacting with the electronic devices in the public environment is the absence of mode which visually impaired people can perceive. Generally, the electronic device interfaces/control panels comprise of physical buttons or touch screens, a few of which have Braille on them. In this design, we attempted to come up with a solution which can convert the physical interfaces to speech interfaces. This system read the things through optical image recognition from the camera feed, which is embedded into the device. It acts as a converter, translating the user environment into a more easily accessible format.

Our proposed solution is a wearable device which can be used on either wrist or hand, depending on context of use and user comfort. User scans the area which he wants to 'read' using his hand and the device converts text in that area to audio.

Some of the major features of this concept and design are as follows:

- Small speaker for audio output
- Speech based search input using microphone,
- Camera for scanning the control panel display,
- Optical character recognition for extracting the text from camera feed,
- Text to speech conversion,
- Start/Stop button plus proximity sensor to activate the device when started by the user and when it is near to the surface.

Strengths:

- User independence without changing the environment or external help,
- easy to carry and use,
- maps with the current mental model of reading an interface,
- consistent usage for all the devices

There are two major features/ modes that were conceptualized, also depicted in the following scenario diagram. In one, the user says “Scan” and the moves his hand around the device and Feel It! reads out the options available on the control panel to the user. In the second mode, the user just says “FIND <word>” and starts scanning the target device for the occurrence of the <word>. Once the desired search string is found on the panel, Feel It! alerts the user by making a sound and reads the option aloud for the user. This is also shown in Figure 4 below.
The user can turn it on/off, and adjust the volume of the voice output depending on his preference and needs.

**Prototype:** We tried to prototype the system as closely to the intended system as we could within the constraints of the project. The final system prototype is shown below in figure 5.
1. User interacts with the device control panel
2. Camera with four surrounding LEDs to provide light source. Camera will provide live feed to the processing unit.
3. Device can be pulled up and down on the hand. Hence user can wear it as a wristband and pull it down on the palm whenever he wants to use it.
4. This is a processing unit which has software for image capture from live camera feed, optical character recognition and text to speech.

*Figure 5: Prototype of Feel It!"*
Evaluation Process

Overview
Since the prototype of our system is still in initial stages we planned to use a tailored evaluation plan to examine the usability of our system. Formative evaluation techniques like Wizard of Oz and cognitive walkthrough were performed with the target user group. The evaluators were asked to speak aloud as they used the prototype to allow us to more accurately capture their feedback. We also utilized classroom sessions and opportunities for brown bag presentations to help in evaluating our design.

In this particular evaluation phase, we focus on direct manipulation of devices through an external interface such as a control panel. Here we are trying to come up with scenarios with Feel It! over multiple devices on which there are control panels. Since we chose a microwave and exercise equipment as two representative devices, the scenarios that we focus on are:

1. Programming a microwave or exercise equipment through program mode

2. Setting the heating or cooking time in the case of the microwave or setting up time, distance, speeds, target heart rate, target calories etc. based for exercise equipment.

User Description
Our target user group and final design evaluators were visually impaired adults with visual impairments ranging from limited vision to total loss. User’s visual impairments were either present at birth or occurred in the late-teenage years or early adult-hood. All users have been visually impaired for over a decade.

Rationale for Materials
We choose Wizard of Oz technique to evaluate the prototype due to technical limitations: There are many features that we have intended for the device which are very difficult to implement or are time consuming like the intelligent OCR software. It is very difficult to come up with a accurate software which can convert an image into text as there are many other things that needs to be taken care of, like the image distortion, blurring, light intensity of the image captured etc.

Building a complete prototype is definitely time-intensive, so we chose to go back to the user and evaluate our design before we actually implemented the full functionality. We wanted to ensure that we were in sync with the perception user has and if there are any major changes or additions that needs to be done, then they can be easily embedded.

We narrowed down the test scope by a large extent and chose microwave and exercise machines for the testing purpose several reasons.
- We want to choose devices with control panels which are present in different places, like private and public places.
- The devices are fairly simple to use with relatively simple interfaces.
- Options that are available over there devices are fairly consistent, like touch screen buttons, display, push buttons, START/STOP button etc.
- These are the devices which are often tweaked in by the users according to their own personal preferences. It is also often customized for personal use by our target users.
- A paper mock-up of the microwave was used because we were unable to bring an actual microwave to the test site, and the microwaves already present were ones users were already quite familiar with.
- An exercise machine is a common device, but somewhat less prevalent in private situations.
- Among the target users, a large portion of them are blind due to diabetes, and they are advised to exercise as often as possible. Many of them are prone to use the exercise the equipment frequently.

Rationale for Tasks
We tried to take one of these devices and elaborate the scenario such that it can be extended to other devices. We were not targeting specific options available to a device, we are trying to see how far the
Feel It! system is able to help the user achieve their goals without changing the option currently provided by the devices.

Based on the above argument, a benchmark scenario was chosen where the user interacts with microwave control panel. Microwave control panels provide various options to users based on the kind of microwave and how much customizability it provides to the user.
Evaluation Methodology
For this evaluation, we decided to do a combination of both qualitative and quantitative evaluations. We felt that a qualitative evaluation would provide a better idea of how users felt while evaluating our system. In this particular domain, speed, efficiency and other quantitative measures are only a partial determination of the success of the design. Users must be comfortable and confident with the design. Determining this level of comfort and confidence is better facilitated with open-ended questions and a think-aloud cognitive walkthroughs. These allow us as designers to better understand the design’s effect on thought process of the users. In this way we are able to determine some of the ways in which the design conflicts with or complements the users’ normal course of action when performing the given tasks.

Qualitative Evaluation

Classroom Session
There was a poster and a demo sessions held in class. During these events, we had the opportunity to get some peer feedbacks and comments on the system. We presented our system to the class, who are pretty familiar with principles of HCI and accessibility design. These peers served us as experts in the cognitive walkthrough for the representative tasks taken to represent the sample scenario. The process we followed during this session was as follows:

1. Giving an overview of our prototype.
2. If the user is visually impaired then he is asked to perform tasks using the system. We have a microwave oven along with us at CVI brownbag session. Else we have a printout of the microwave control panel with which exhibition participants can interact with.
3. Then we have collected all the comments participants have regarding the functionality and future scope.

This was particularly helpful in the way that there were usability experts and clients who work along with CVI apart from end users. We got comments from different perspective as the clients were thinking more in the sense of futuristic scope and its implication with the current trend in this field.

Brown Bag Sessions
We got a chance to get a pre-evaluation feedback from the user by presenting the prototype of our system in one of the brown bag session was held at CVI (Center for Visually Impaired). This even happened much before the actual usability tests occurred thereby giving us valuable qualitative feedback from the subject experts and target user group.

Quantitative Evaluation
Usability Testing and survey questionnaire helped us in refining the system requirements laid down during the earlier phase of design process. The following information was measured during from the evaluation results:
1. Effectiveness
2. Efficiency
3. Satisfaction
4. Ease of Use
5. Consistency
6. Robustness
7. Learnability
Effectiveness
Effectiveness relates the goals of using the product to the accuracy and completeness with which these goals can be achieved. Common measures of effectiveness include percent task completion, frequency of errors, frequency of assists to the participant from the testers, and frequency of accesses to help or documentation by the participants during the tasks. It does not take account of how the goals were achieved, only the extent to which they were achieved. Efficiency relates the level of effectiveness achieved to the quantity of resources expended.

Completion Rate: The completion rate is the percentage of participants who completely and correctly achieve each task goal. If goals can be partially achieved (e.g., by incomplete or sub-optimum results) then it may also be useful to report the average goal achievement, scored on a scale of 0 to 100% based on specified criteria related to the value of a partial result. Another method for calculating completion rate is weighting. The following information was collected: “The percentage of participants who are able to perform the task completely with accuracy was measured.”

Errors: Errors are instances where test participants did not complete the task successfully, or had to attempt portions of the task more than once.

Assists: When participants cannot proceed on a task, the test administrator sometimes gives direct procedural help in order to allow the test to proceed. This type of tester intervention is called an assist for the purposes of this report. The following information was collected: “The unassisted completion rate (i.e. the rate achieved without intervention from the testers) as well as the assisted rate (i.e. the rate achieved with tester intervention) where these two metrics differ.”

For example, if a participant received an assist on Task A, that participant should not be included among those successfully completing the task when calculating the unassisted completion rate for that task. However, if the participant went on to successfully complete the task following the assist, he could be included in the assisted Task A completion rate. When assists are allowed or provided, the number and type of assists shall be included as part of the test results.

Efficiency
Efficiency relates the level of effectiveness achieved to the quantity of resources expended. Efficiency is generally assessed by the mean time taken to achieve the task. A common measure of efficiency is time on task. The following information was collected: “The mean time taken to complete each task, together with the range and standard deviation of times across participants.”

Satisfaction
Satisfaction describes a user’s subjective response when using the product. User satisfaction may be an important correlate of motivation to use a product and may affect performance in some cases. Questionnaires to measure satisfaction and associated attitudes are built using Likert scale. The statements that we asked users to rate according to the scale are:

- I am satisfied using the system.
- I felt confident in using the system.
- I would like to use this system frequently.
- It works the way I want it to work.
- I would recommend it to a colleague.

Ease of use
How easy the product is to use and whether the product will be acceptable in the real world. We asked users to rate following statements to evaluate this metric.

- I found it easy to complete the task using the system.
- It was simple to use.

Consistency
This can be evaluated on five criteria; information presentation, input and output (stimulus-response compatibility), across context and on any platform (cross-platform compatibility), what one person sees
should be consistent with what another person sees, so that they can effectively communicate about it (the WYSIWIS principle), an application should behave consistently with the metaphor that it presents. Statements used to evaluate consistency of AASVI system are:

- I find system consistent in interacting with two different devices.
- I find the interaction consistent in completing different tasks on the same device.
- The terminology was familiar to me.

**Robustness**

The level of support provided the user in determining successful achievement and assessment of goal directed behavior. How easy is it to evaluate whether the goals have been achieved? The statements used to evaluate the robustness of the system are:

- I was able to accomplish what I wanted to do quickly.
- It makes the things I want to accomplish easier to get done.

**Learnability**

It is the capability of the product to enable the user to learn it. Learnability metric should be able to assess how long it takes for the user to learn how to use particular features. This measures how easy it is to begin productively using the product. We have users to rate the learnability of the product based on following statements:

- It is easy to learn to use it.
- I can remember easily how to use it.
- It is easy to explore new scope of interactions and the features which system has.
Evaluation Procedure

We chose the Wizard of Oz implementation technique to test the real end users. This method was particularly useful as our system prototype is not in the final form and this type of evaluation technique is good for analyzing the prototypes which are in low fidelity levels and also it is quick, easy and inexpensive.

We recruited six visually impaired people, our end users, to participate in this system evaluation study. Approximately half of our participants are the user with low vision and other half population with complete visual impairment. Two of our team members acted as 'wizards', sitting quietly near to the user, observing the user's actions, and simulates the system's responses in real-time.

For this test, a paper mock-up of a microwave control panel was used and an actual exercise bicycle was used. The “wizard” was to record the user’s action and input from both the video feed (of the camera) from the system or just by observation from a distance and perceived the user's input. The wizard simulated the effects of the observed manipulations by providing the required auditory feedback or performing the action on the machine.

First we explained to the users their role in the study and the purpose of this study. A sample script for the same reads as “Thank you for participating in this study. Your inputs and feedback are very valuable to us. These would be used to evaluate the Usability of the AASVI system. The goal of this study is to evaluate the ease of use of the product, feel free to give me your honest opinion. Please remember, there are no rights or wrong ways to do a task, the evaluation is simply to understand the experience users go through while using the system.”

We then explained the testing process, by saying “I will first ask you a few questions about you, for statistical purposes. After this, I will request you to complete the set of tasks. The study will end with a short interactive session, where you can voice your opinions about your experience using the product.”

Then we obtained the signed consent form from the users asking their permission to start this test, and make sure that we have followed strict IRB process before going through the test. A general questionnaire, after briefing the user about the evaluation plan, yielded us demographic information. These help a lot in gathering qualitative as well as quantitative data about the user and usage of the system. The genre of question varies from general questions like age, gender, sex, etc to open-ended and scalar questions. These questions are mentioned in the IRB protocol document; please refer to the Appendix for more details (Appendix 1).

After the user agree to participate in the test, we proceed further by explaining the prototype in detail, mentioning its functionality and features. We started the usability test by assigning the user a particular task and asking him to think aloud while performing the task using the prototype. Next, we gave the participant a set of tasks. The general sets of tasks performed by the users are as follows:

- Start the AASVI system
- Set the microwave to cook or reheat dinner (whichever you prefer)
- Set the timer to however long you would cook your dinner
- Start the microwave
- Set a workout program on the exercise machine
- Start the workout
- Decrease the speed or intensity of the workout
• Stop the machine

While user performed the task we noted the time taken to complete it and ease of completion, and if he
needed any assistance in completing it. We repeated for the same procedure for other tasks. Then we
asked the user to evaluate the ease of use, general usability, and learnability of the design for the tasks
that they have currently performed on a scale of 1 – 7 with 1 being “strongly disagree” and 7 being
“strongly agree.”

Next, we asked the users to evaluate their experience using the device through a set of debriefing
questions. Questions included in this debriefing session were as follows:

• What did you like the best about the AASVI system? : This question was asked to get retain the
  best features that user felt while using the AASVI system also to get to know where users actually
  felt delighted and were more keen on.

• Was there anything in AASVI system you particularly did not like? : This is to give us a brief
  understanding of the features that needs to be either modified or removed completely. These may
  also include the cases where user might not have been satisfied even after using the system but
  for some reason hadn’t revealed it during the test.

• Is there anything that you would have liked to see in this system, but wasn’t there? We are trying
  to access the number of features that were provided with in the system and also see the future
  scope of this system

• Was there anything within the system that confused you or anything that’s was ambiguous? This
  will make us understand the situations or tasks which user felt were very confusing while he was
  working with.
**Evaluation Results**

**Qualitative Evaluation**

As mentioned earlier, we got valuable qualitative feedback about our prototype from the class poster session and CVI brown bag session. We did a cognitive walkthrough with the visually impaired users at CVI, and also had an opportunity to detail out our project with various clients and program managers at CVI. The feedback obtained from the classroom session and the brown bag sessions at CVI are as follows:

**Cons:**

1. Feather touch buttons are accidentally clicked while scanning the device without the knowledge of user. As many of the modern day devices have controls which are either touch screen or feather touch, when user tries to scan his hand (on which feel-in is worn) onto the control panel, these button being sensitive might accidentally be pressed.

2. Many of the experts felt that it definitely require some sort of initial help when user is using this device for the first time, but once he gets habituated it should be very easy for him to use.

3. There is no help document provided for the user so he requires some initial training while using the Feel It! to get a know-how of all the features and to be able to effectively use them.

4. Though the Feel It! device can give the user the orientation on the control panel, it is difficult for him to initially locate the control panel on the device. In the sense, how does a visually impaired user know that the control panel is located at a particular place over the device? (currently he has done it through trial and error and was mostly successful)

5. There are some problems that occurred with the camera orientation on the hand, if the user doesn’t scan over the control panel with a vertical hand then camera might not recognize the text beneath it, as it is tilted at an angle.

6. If the microwave is place very low and the user might end up using the Feel It! in a very awkward pose and this might lead to strain when used over a long period of time.

**Positives**

1. Users found the device a novel concept and were enthusiastic of using it. Even among non-visually impaired individuals, clients were very excited about the novel concept. Some of their comments were “this device can definitely make a significant change in their life style,” and “It’s like a third eye or virtual eye for the visually impaired user.”

2. The device is very easy to learn and it is not so complex and there is no customization, so user can easily get accustomed with it.

3. Learnability is very high as observes in the iterative interaction session which took very less time, as user gets accustomed he required very little assistance and very less number of errors occurred.

4. Device maps with the natural way the user group interacts with control panel but some suggestions include embedding this device on the index finger or a mobile phone.

5. When implied over the cost of this product, users were very happy as they found that there is huge return of investment with the kind of functionality that this system provides. Cost versus features rate is very high.
Usability Evaluation
In all we have tested six users whom we have chosen according to the criteria we have described earlier. The general grouping of these participants includes the two categories of visually impairment, completely blind and partial impairment. The results from evaluations conducted on the prototype are mentioned below.

Demographics Information

User Statistics

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<th>P3</th>
<th>P4</th>
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<td>Entrepreneur</td>
<td>Electrical Contractor</td>
<td>Instructor</td>
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<td>Adaptive learning</td>
<td>Car Dealer</td>
<td>Engineer</td>
<td>Teaches Braille</td>
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<tr>
<td>Professional Experience</td>
<td>31 years</td>
<td>23 years</td>
<td>18 years</td>
<td>16 years</td>
<td>25+ years</td>
<td>2 years</td>
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</tr>
</tbody>
</table>

Descriptions of some of the demographic information:

‘Occupation/role’, describe the user’s job role when using the product.

‘Professional experience’, give the amount of time the user has been performing in the role.

‘Computer experience’, describe relevant background such as how much experience the user has with the product domain.

‘Product experience’ indicates the type and duration of any prior experience with the product or with similar products.

Microwave Usage:
Many users have Braille script written over the microwave at their home. They usually use it daily for warming up leftovers. All the users have been using microwave very often. Many use puff paint to manipulate the microwave at their home according to their need. They usually use minimal functions like automated programs to configure microwave.

Exercise Equipment Usage:
Many of the users have to use the treadmill or any other exercise equipment as it is prescribed for them but they rarely uses it. Some of them haven’t been to gymnasium for the past six months. Out of six participants only one of them go for the work out regularly (twice a week). Users required people’s help while using treadmill.
Task Analysis
The feedbacks from the users are categorized on the basis of individual task that they were asked to perform. These feedbacks and comments are summarized below:

Wear the device
One user seemed to face some difficulty while wearing the device, as his initial orientation towards the system isn’t yet formed. However, he said that he did not face any difficulty asked about it. Instead he felt it was very easy. One user was a bit concerned about the material used in the prototype, she felt that it was too soft and flexible her and she was having some difficulty wearing it over a long time.

After giving some instructions the user was easily able to wear the device over their hand. It was misleading for him when we said “wearable glove”, as he thought it would completely cover his hand. The user was able to repeat the same task successfully, when given some time. But he wore the device first with the camera facing upwards and turned it afterwards to adjust it. These results imply that there are some major ergonomics issues with the AASVI system.

Start the system
Starting the system wasn’t very intuitive, as the user says he could not understand that the specific element is used as button to start the system (specifies the need to use different places for putting up buttons for start/speaker). User took some time to search for the button, as he has no help. He was inclined towards starting the system once he says “start” as there is already speech recognition systems embedded into the device. One of the users felt that he need not require specifying any start command and immediately started scanning over the control panel. User needs an initial understanding of the system, as he feels there is no special Braille script which says “start”. But once found the button he was able to replicate the task over and over again, when asked to start it while using the exercise equipment.

Program mode
User quoted that he uses it normally for warming up the food, he says that there is a particular fashion that all the microwaves follow from the numbering perspective it uses numbering similar to conventional calculator. He usually searches for popcorn and the microwave automatically starts itself with a programmed times mode, he need not even need to press start button. (This mostly depends on the kind of options available over the microwave and features that it provides). User doesn’t like the idea of the device being always turned on and lying over her hand. Users especially who have some kind of visual perception use almost all the options available on the microwave.

Start the microwave
Users have a sense of where the start button should be so users were easily able to trace it over. Some of the users were easily able to follow the process of searching for start button, but took some time while scanning the device. As she moved the hand briskly while scanning she was also scanning the parts which where there are no buttons so she missed the start twice; she was very close to start but did not actually scan over it. This implies that there should be some kind of feedback to the user if he is scanning over empty spaces.

Treadmill
Here we tried to test weather user can apply whatever he has learnt about the device till now while performing the tasks over the microwave. Some of the users have been using the exercise equipment at CVI very often, so they know the options available. One user felt that the options like time, target heart rate, and intensity are very difficult to access. And she never uses it for this same reason. Users definitely want to have access to all these options without external help which they currently reply upon.
One user tried to search the system to find the various options available over it, but wasn’t able to find the button to start it, he finally has to resolve for help. This might probably be the problem with the exercise equipment as the buttons are at the bottom of the control panel. He tried to first find the start button through the scan mode and later shifted back to the search mode as he felt that it was taking lot of time. User was easily able to remember the other options and use it intelligently. All the users who aren’t familiar with the treadmill said that they are going to scan their hand over the control panel to know all the options available. Users who are already familiar said that they will just try to find the particular option.

Many of the users scanning speed was very fast. The intelligence which is embedded into the system must be able to scan the words as fast and possible and also be reliable. When asked to increase the speed, they searched for “find speed”, but actually there is no button which says speed so she searched for some time and was confused, so it implies that we need to take care of the queries user says intelligently or user will be confused. But in any case user renders back to “Scan mode” and hears the “up” options and immediately identifies that it is the options that he is looking for. He searched for the different program buttons over the control panel, and all of them were successful in doing so and also took very little time.

**Search for heart rate**

They searched for options through which they can set their heart rate and found two of them. The problem here is that, the options that are available over the control panel are marked “HR” instead of whole phrase “heart rate”. As we were the ones are speaking out, were able to easily identify the users intentions, there should also be some capability of this sort inside the system. Search mode is very time consuming; they want some sort of mechanism which can constantly tell her that the device is searching/doing something. Users feels that there should be some auditory cue or else they have a feeling that device is not working. User also feels that there should be more auditory feedback rather than just beep sound when a particular option is found over the control panel.

**Stopping the system:**

Most of the user felt that this task was very easy; some of them explained the way it should work immediately and were successful in performing the action. Users were also able to stop the system very quickly as this is the task which should require very less amount of time as in the actual scenario user would be in a very exhausted state and would want to stop the system as quickly as possible. They also have a visual cue of where stop was while he was scanning the device earlier. (Just beside the start)

**Debriefing**

**What did you like the best about the AASVI system?**

- All the users really liked the voice activation feature. The fact that system translates user’s natural language queries and responding accordingly.

- Some of the users who have become visually impaired recently liked the voice output as they felt that all the devices which are designed for visually impaired come with Braille, which is difficult for them to read as they are new to it.

- According to users scanning and searching features are both equally important and usable.

- Concept is very simple to understand.

- Users were able to learn the system easily.

- Users like the idea that he doesn’t require to program or customize anything and wants us to maintain the same even if we are adding any new features.

- Independence and confidence it bestowed.
Was there anything in AASVI system you particularly did not like?

- Users found that the system is huge on their wrist, Should be much smaller, one of the users commented that “it looks like a ghost over his hand”.
- Users wanted different voices for different kind of text over the control panel like screen/ button.
- They don’t want all the wires hanging over the AASVI system.
- Few users felt that it is uncomfortable to wear over their wrist, there is problems with ergonomics of the product. This might also be due to fact that the system that we have designed is for left handed users.

Is there anything that you would have liked to see in this system, but wasn’t there?

- User wants to see a feature through which they can customize the voice like changing pitch, male/ female.
- He would like the system to speak as fast as possible, as one can see in the screen reader, as user is habituated using such kind of system.
- User would like to see the same system to be worn over their fingers like a ring, and use it whenever required.

Was there anything within the system that confused you or anything that’s was ambiguous?

- User wants to see the system in some other material than the one which is currently used as they felt uncomfortable wearing it.
- Users felt that it was very efficient to use and were able to work faster.

Is there anything that you feel, can help us improve the product?

- Users felt that the device was very helpful and were delighted to see that this kind of system can be built in such cost efficient way.
- User wants to see the system in a smaller form factor, probably a smaller camera.
Usability Metrics Results
In this section we are going to give the results based on seven usability metrics that we have defined that we have defined earlier. Each section is

Effectiveness & Efficiency
Percentage of task completion with respect to assistance and errors and time taken to complete the tasks

Task 1: Start the AASVI system

- Wear the glove over left hand
- Orientation of the glove
- Search for start button
- Press the button

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Max: 75 100 120 4 2
Task 2: Set the microwave to cook or reheat dinner (4 mins)

- Search for heat
- Press heat
- Search for 4 mins
- Press the button

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Task 3: Start the microwave
- Search the Start button
- Press the button

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Mean
- Unassisted Task Effectiveness: 25 (\(\%\)Complete)
- Assisted Task Effectiveness: 100 (\(\%\)Complete)
- Task Time: 93.33333333 (min)
- Errors: 1.166667
- Assists: 0.666667

Standard Deviation
- Unassisted Task Effectiveness: 27.38612788
- Assisted Task Effectiveness: 0 (\(\%\)Complete)
- Task Time: 57.50362307 (min)
- Errors: 0.408248
- Assists: 0.516398

Min
- Unassisted Task Effectiveness: 0 (\(\%\)Complete)
- Assisted Task Effectiveness: 100 (\(\%\)Complete)
- Task Time: 30 (min)
- Errors: 1
- Assists: 0

Max
- Unassisted Task Effectiveness: 50 (\(\%\)Complete)
- Assisted Task Effectiveness: 100 (\(\%\)Complete)
- Task Time: 200 (min)
- Errors: 2
- Assists: 1
Task 4: Set a workout program on the treadmill machine
- Search heart rate
- Press the button
- Search for increase button
- Press the button

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Task 5: Start the workout
- Search the start button
- Press the button

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Task 6: Decrease the speed or intensity of the workout
- Search for increase speed button
- Press the button

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Standard Deviation: 25.81988897  27.38612788  49.29503018  0.408248  0.408248

Min: 0  50  60  1  0

Max: 50  100  180  2  1
Task 7: Stop the machine
- Search for Stop button
- Press the button

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Min | 50 | 100 | 10 | 0 | 0 |
Max | 100 | 100 | 60 | 1 | 1 |
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</table>

| Min   | 0                                             | 0                                             | 10                   | 0      | 0       |
| Max   | 100                                           | 100                                           | 480                  | 4      | 4       |

### Interaction Summary Table (task wise)

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Mean Task Completion Percentage for Unassisted Task Effectiveness</th>
<th>Mean Task Completion Percentage for Assisted Task Effectiveness</th>
<th>Mean Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>29.166666667</td>
<td>83.333333333</td>
<td>76.666666667</td>
</tr>
<tr>
<td>T2</td>
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<td>66.666666667</td>
<td>340</td>
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<tr>
<td>T3</td>
<td>25</td>
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<tr>
<td>T4</td>
<td>8.333333333</td>
<td>75</td>
<td>290</td>
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<tr>
<td>T5</td>
<td>33.333333333</td>
<td>58.333333333</td>
<td>117.5</td>
</tr>
<tr>
<td>T6</td>
<td>16.666666667</td>
<td>75</td>
<td>135</td>
</tr>
<tr>
<td>T7</td>
<td>75</td>
<td>100</td>
<td>28.333333333</td>
</tr>
</tbody>
</table>
Summary Graph: Efficiency for All Users

Effectiveness – Complete Interaction Graph
Interpreting the data:

The graph above is plotted between percentage task completions vs. all the tasks. The percentage task completion is the mean of the percentages of task completion of all six participants.

As you can see there are two lines: above one is for assisted interaction and the lower one is for unassisted interaction. It is easily noticeable that with assistance the percentage task completion increases as the line shifts upwards.

Also graph shows a down slope in task T2 and T4 in both the cases (assisted and unassisted). This is because both task T2 and T4 involves use of both possible modes of interaction (scan the interface with the device and then find a particular option of interest and also executing the option). Since T2 and T4 are complex tasks (but implicit for all interactions with the device), hence the downward slope was expected which is proven by the evaluation.

But still if we consider the figures the users were able to complete the tasks T2 and T4 (involving 4 subtasks) approx up to 65 % with assistance(less than 2 assists per task) which is quite high considering the fact that users were quite novice accepting a new technology.

Also consider the upward slope in the graph from task T2-T3 and T6-T7. It is again supporting the learnability factor. As user has already used the device once in performing the subtasks in T2 and T6, hence he is able to apply this accumulated learning in achieving the task T3 and T7.

Please note that Tasks T1 to T3 involves interaction with one system (microwave oven) and then user moves to another completely different system (treadmill).Therefore a predicted dip is also observed in the data-analysis where both assisted and unassisted interaction shows a downward slope in moving from one system to another.

As the user proceeds with performing the tasks the unassisted task completion time increases tremendously, we can conclude that user took some time to adapt to the new system and was easily able to accomplish tasks.

Conclusion

A big gap between the percentage completion of tasks with first time users for unassisted and assisted interactions proves the hypothesis that training is required to use this product to an optimum level. We have noted down in our observation that most of the users felt a jump in knowing all the possible features of the product (scan and search mode, speech-based interaction) and in utilizing the knowledge in execution.

Also this has to be noted that this evaluation was based on the Wizard of Oz methodology implementing a speech based interaction. Users found themselves comfortable and active (in control, hence not passive) with such a spontaneous ‘Wizard’ feedback but the proper implementation has to narrow down this gulf of execution and evaluation to a minimum.

We have also interpreted a upwards learning slope in the above graphs which underlines the fact that user is able to use his learning in manipulating the interface of the system further and thus achieving a higher completion rate.

One undesirable feedback is that shift from one system to another system is lowering the task completion. This is undesirable because as expected the interaction paradigm should not change with different interface when using this system and hence there should be an upwards slope supporting the learnability further.

But these trends is based on a very small sample set of participants interaction with the system for the first time therefore we have to consider the usage of the device with an intermediate or an expert user to draw generalization.
But still on the basis of empirical evidence we can conclude that this device lowers the effectiveness (task completion) for a novice user when user moves from one system to another but effectiveness increases on a single system interaction.

Also there is a factor of learning which increases the effectiveness of the system. Learning might play a crucial role in efficiency of the system as we will see later in efficiency metrics.

**Efficiency – Complete Interaction graph**

![Efficiency - Complete Interaction graph](image)

**Interpreting the Data:**

The graph has been plotted between mean time take (for six participants) over the tasks T1 –T6.

As observed from the graph the time taken to do T1 is quite less as it is a simple task but this task requires continuous assistance and errors occurs and hence assistance for a novice user was must to start.

The time taken to do task T2 is considerably high as it was the most complex of task as mentioned earlier in effectiveness metrics. Less time is consumed in task T3 as it was much simpler and learning from previous task played a crucial role for completing this task.

Also there is a system change form T3 to T4 (microwave oven to treadmill). Hence a predicted increase in time was observed. Although T4 was a complex task much like T2 and hence a less time in T4 as compared to T2 is desirable.

From T4 to T7 there has been continuous dip in the curve and that is because of the simplicity of tasks and upward learning curve.

**Conclusion:**

Change in system to be considered causes and increase in time taken and hence we can conclude that device is less efficient in that case. Being more specific, device is less efficient for a first time user interacting with different systems and trying to applying the consistent interaction paradigm on these systems for the first time.
But interacting with a single system, the device efficiency continuously increases as the learning increases.

Certain tasks were obviously more time consuming, as they required more steps. These tasks accordingly took more time to complete. These tasks also were less effectively completed. However, a definitive conclusion may not be possible, as this was a relatively small sample for new users.
Ease of use

Question 1: I found it easy to complete the task using the system
Question 2: It was simple to use.

Summary Table

<table>
<thead>
<tr>
<th>User</th>
<th>Question 1</th>
<th>Question 2</th>
<th>Mean Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>P2</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>P3</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>P4</td>
<td>7</td>
<td>6</td>
<td>6.5</td>
</tr>
<tr>
<td>P5</td>
<td>6</td>
<td>7</td>
<td>6.5</td>
</tr>
<tr>
<td>P6</td>
<td>4</td>
<td>7</td>
<td>5.5</td>
</tr>
<tr>
<td>Mean</td>
<td>6.333333333</td>
<td>6.833333333</td>
<td>6.583333333</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.211060142</td>
<td>0.40824829</td>
<td>0.584522597</td>
</tr>
<tr>
<td>Min</td>
<td>4</td>
<td>6</td>
<td>5.5</td>
</tr>
<tr>
<td>Max</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Summary Graph

Conclusion

Mean Response = 6.58

Users found the device very simple to use and thought that it was very easy to complete the task with this device.
**Consistency**

Question 1: I find system consistent in interacting with two different devices
Question 2: I find the interaction consistent in completing different tasks on the same device
Question 3: The terminology was familiar to me.

**Summary Table:**

<table>
<thead>
<tr>
<th>User</th>
<th>Question 1</th>
<th>Question 2</th>
<th>Question 3</th>
<th>Mean Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>6.66666667</td>
</tr>
<tr>
<td>P2</td>
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<tr>
<td>P3</td>
<td>7</td>
<td>7</td>
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<td>7</td>
</tr>
<tr>
<td>P4</td>
<td>7</td>
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<td>7</td>
<td>6.66666667</td>
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<tr>
<td>P5</td>
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<tr>
<td>P6</td>
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<tr>
<td>Mean</td>
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<tr>
<td>Max</td>
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<td>7</td>
</tr>
</tbody>
</table>

**Summary Graph**

**Conclusion**

Mean Response = 6.72

Users found the device uniformly consistent in interacting with two different devices (microwave oven and treadmill) and also in completing different tasks in the same device. Also the terminologies (search mode and scan mode queries) are familiar according to the user.

**Satisfaction**

Question 1: I am satisfied using the system
Question 2: I felt confident in using the system
Question 3: I would like to use this system frequently

Summary Table:

<table>
<thead>
<tr>
<th>User</th>
<th>Question 1</th>
<th>Question 2</th>
<th>Question 3</th>
<th>Mean Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4.33333333</td>
</tr>
<tr>
<td>P2</td>
<td>7</td>
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<tr>
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<td>7</td>
<td>5</td>
<td>7</td>
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</tr>
<tr>
<td>P5</td>
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<tr>
<td>P6</td>
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<td>4.33333333</td>
</tr>
<tr>
<td>Max</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Summary Graph:

Conclusion

Mean Response = 6.06

Users were satisfied and confident in using the device and were very much enthusiastic of using it in their activities of daily living.

Robustness

Question 1: I was able to accomplish what I wanted to do quickly.
Question 2: It makes the things I want to accomplish easier to get done.
Summary Table:

<table>
<thead>
<tr>
<th>User</th>
<th>Question 1</th>
<th>Question 2</th>
<th>Mean Responses</th>
</tr>
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<tbody>
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<td>P1</td>
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</tr>
<tr>
<td>Mean</td>
<td>5.5</td>
<td>6</td>
<td>5.75</td>
</tr>
</tbody>
</table>

Standard Deviation

| Standard Deviation | 1.224744871 | 0.894427191 | 1.036822068 |

Min | 4 | 5 | 4.5 |
Max | 7 | 7 | 7 |

Summary Graph:

Conclusion
Mean Response = 5.75

Users accomplished their tasks fairly easily and thought that this device will make the intended tasks very easy to complete.
Learnability

Question 1: It is easy to learn to use it
Question 2: It works the way I want it to work.
Question 3: I can remember easily how to use it
Question 4: It is easy to explore new scope of interactions and the features which system has.
Question 5: I would recommend it to a colleague.

Summary Table:

<table>
<thead>
<tr>
<th>User</th>
<th>Question 1</th>
<th>Question 2</th>
<th>Question 3</th>
<th>Question 4</th>
<th>Question 5</th>
<th>Mean Responses</th>
</tr>
</thead>
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<td>0.96055539</td>
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<tr>
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<td>3</td>
<td>2</td>
<td>6</td>
<td>5</td>
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<td>4.4</td>
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<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Summary Graph:

Conclusion
Mean Response = 6.07
According to the users, it was very easy to learn the usage of the device and also to easy to remember how to use it. Also the user found it very easy in exploring all the possible interactions with the device and in using the features that this device provides. Users found that device works the way they wanted it to work (e.g. spontaneous speech feedback, usage of scan and search modes). Users would highly recommend of it to their colleagues.
Implications of Results

Analyzing the results from the previous section, there are few common trends and preferences that can be inferred from the graphs. These are summarized below:

If the user is completely new to the device (control panel), they require initial understanding about it. Once they have it they can easily remember the options available on it. Users have varied options when asked about speaker output, but most of them depends on the task user does, say he would prefer ear phone if he is interacting using AASVI system with ATM machine, they apparently doesn’t like to reveal the information out. They are inclined towards having customization over the voice output, some of the users just suggested to have some options so that they can just change the pitch and speed of the voice. And some others have suggested they should also have male/ female/ accent voice customization. Partially impaired users preferred large text over Braille as she has some vision. Also some of them have recently become visually impaired and so they cannot read Braille. But thing to note is that all of them are taking courses at CVI to learn Braille. Though start button is just to start the AASVI system, some users thought that they need to press the start button each and every time they start performing a new task. While using the any control panel users needs to have an initial orientation, like once she knows about the device she is comfortable using it. User is always prone to use the search system, some users have even forgotten at one instance that scan option was available; we had to instruct them in that case. There are many different texts over the control panels apart from the text on regular buttons, the system or the user should be intelligent enough to omit all these. User should be able to differentiate between a button and regular text. One of the users suggested having different voices for text over buttons and text over display & control panel (Interactive & non interactive text). Use felt that the option of using this system to read out the control panel display is very useful, as they always look for some cues which can suggest then the stage they are at while using control panels. User likes to have this device over her fingers or on some device that she often carries with them like key chain or mobile phone, which is more accessible for them rather than carrying this device all around wearing over their hand or wrist. Users thought this device is pretty cumbersome to wear it over their hand for a long time. One of the users liked the concept of the prototype, but if she is going to wear this device then it is going to be for doing multiple tasks. In that case, she definitely requires wearing it very often. So user feels that he is rarely going to wear the device over his wrist and it will always be on his hand. Some of the users have queried about using this system without wearing it. Like holding the camera part of the AASVI system and scan it on the control panel.

All the users even the ones who can read Braille preferred voice as their primary output mode. They did not prefer to have any Braille output because they felt that it’s very expensive, but for some users it is always their primary mode of interaction. The devices which they have seen in their surrounding and which have Braille embedded like Braille computers come for around 5000$ and they feel that all the users cannot afford that huge amount. One of the blind persons had a perception that low vision persons might be able to use this system better initially when we explained the system, but once they started performing the tasks he felt it was comfortable for him too.

User felt that the system is definitely helpful for her to make the devices more accessible. However, in a general scenario where user can customize the things around them like microwave, she would use this device once and if it’s too time-consuming then she would not use the AASVI system. yet for accessing general devices around her environment like ATM machines, vending machines she felt that this would be very helpful. Some of the right handed users note that the device is left-handed one they found that it should also be compatible for right-handed users, but they weren’t uncomfortable while using the system. This they thought was probably because of the flexible material which was used. This happened with all the users, they weren’t able to understand the affordance of the device, like they weren’t sure whether the thumb is inside or outside. There is problem with the ergonomics of the AASVI system.
Users want to have a different voice for scanning over a display screen and a button so that they can differentiate between the two of them easily. One user felt that he has been using his hands so much, once he has something over one of his hands, he felt a little crippled as he can’t use both his hands now. Users also felt that there should be a way to stop the device automatically when not in use like lock/sleep mode in mobile phone.

Conclusions

- Users prefer smallest, lightest design possible
- Users like simple, easy-to-use easy-to-learn designs
- Users like what is familiar to them and want to use it
- Users prefer to use things that allow them to be independent and confident
- Users prefer audio output, but with a customizable voice and speed
- Users expect scan to be automatic, default mode
- Fully implement ideal design; lighter, stronger, smaller materials
- Add multiple voices for different types of data read ex; paragraphs or non-interactive text should have one voice, displays have another, interactive buttons have another; increase or allow customization of audio feedback
- Target words for the find function should have the surrounding text read as well

Discussion of Usability Metrics

According to the completion efficiency and accuracy from the quantitative efficiency test, the device was successful, but not overly so. While assisted task completion was over half, unassisted task completion was consistently less. On these results alone, one may draw a less than stellar evaluation of the system. However, these results are not tempered by statistics on the efficiency of visually impaired users using new devices without our system. It was also a first time for all of these users.

Also, the usability questionnaire tells quite a different story. Almost all the users were greatly pleased with the effectiveness of the system. In this particular case, this is a very important result. This solution is one that is a step in a direction that will be greatly useful to a large amount of people.
Conclusion and Critique of Evaluation Techniques

Since user evaluation was last step of the project for which all of us worked very hard for whole semester, had to be rewarding from learning and feedback point of view. We gained valuable insights from people who used our system just for 30 minutes or so which we have never even considered in our discussions. For example we haven’t even considered that there might be some arbitrary text which can be over the control panels which the AASVI system might detect accidentally. In the end we learnt that the system should be intelligent enough to differentiate between different kinds of text.

Also we have chosen to use a printout of the microwave control panel for evaluation; there might be some potential problems with ergonomics of the users hand position while using the device in actual environment. So it would have been ideal for us to actually carry the test in an ideal kitchen with a microwave placed, which would have made our test more realistic.

There were some questions that we asked users to rate and describe after our usability test, users were reluctant to answer some of them as they thought they can evaluate the product better if it would have been in a working condition.

Initially we thought of asking users to perform the tasks which users typically would perform on the microwave and exercise equipment control panel. But during the actually testing we had to actually minimize the set of tasks as we haven’t taken that much appointment time from the user. Also while performing the tasks users aren’t getting much interactive feedback as we have conducted a Wizard of Oz and many of the tasks that we have listed actually applied to an idea AASVI system.

It is not the question of just half an hour but we had to take the appointment of participants 2 days in advance, the hand outs of the system, required equipments, the questionnaire and finally the clear instructions to be given to participants which will give them the clear understanding of the system so that they can use and evaluate the system with interest. It’s good for us that all the users whom we have tested the product with were very much enthusiastic and were keen to participate in the test so we have gained lot of insights into the usability of the product.

We found that recording each and every step was difficult especially time required to complete small steps since every other user is different from previous one and goes in his/her own flow. Initially we decided to keep track of time required to complete each step but most of the users were completing the steps within seconds and sometimes taking different sequence of actions as we initially thought of. Some of the users were not vocal while using the system so it was difficult to tell whether they were lost or they were thinking something else.

In order to gain better assessments on the usability of our system with the presence of many constraints (i.e. time, labor,) we recruited potential target users as our evaluators and they were involved in the Cooperative Evaluation and structured Interview. And there were many HCI experts that we have consulted with during our poster session who conducted an informal heuristic evaluation of the AASVI system. The combination of these two assessments allowed us to examine the system from various perspectives. The results we received from these evaluations help us identify usability issues along with their severity levels and make corresponding changes in our design.

Poster session

The biggest advantage we found in using this evaluation technique is that we got a lot of insightful comments from HCI experts. The feedbacks from them are aimed at suggesting potential improvements on areas which are the most critical for the success of our system. This gave us more focused and concise comments which were of great value to us. Another advantage is that we are able to find a relatively large amount of issues with a small number of evaluators. It certainly helped us get good evaluation results with limited resources. One disadvantage is that some evaluators lacked domain knowledge. But still most of the HCI experts were familiar with optical character recognition, Test to speech, speech recognition and proximity sensors. After little explanation they were able to easily access and contribute to evaluation of the AASVI system.
**Brownbag session**

Biggest advantage that we had from the brown bag session that we have conducted at CVI is that session is that we had an opportunity to present this project as an initial concept to many potential users, clients and program managers who work along with target user community, visually impaired. This gave us some time to assess the system and make any changes possible, before we embark into actual user testing.

**Cooperative Evaluation**

From this evaluation, we hoped to get insight from participants on each step of their interaction with the prototype. In particular, we were looking for possible improvements to make the system more intuitive to use without a lot of effort from users themselves. Another advantage of Cooperative Evaluation is that participants were able to have very hands-on interactions with the prototype. The main factor for the success of cooperative evaluation is that the user has to be talkative and open enough to tell even subtle flaws in the system. We found our population quite disparate in this regard. Many of them were talkative to provide feedback at each and every step. But there were some users who were just performing the tasks without actually thinking aloud, in this case we had to ask users some questions by answering which we can make him think aloud, like say “what about the feedback now? How do you like the feedback? Did you understand the functioning? Why did you choose one functionality over the other?”
**Future Work**

Presently, due to technological, timeline and monetary constraints, we had to make some tradeoffs with the features of our design. These tradeoffs were from the prototype or the evaluation plan of the product. Some of these are mentioned below:

Prototype: The prototype could be made closer to the proposed ideal system provided the right support and time. Some of the improvements can be:

- Reducing the size of camera, thereby, making the system comfortable to use. Currently, the camera is big and makes the system ergonomically difficult to use for a long time.
- Wide angle camera with fish-eye lens to read a significant amount of text from the control panel while scanning.
- Integrating the image and character processing within the ‘glove’ using ‘gum stick’ processors.
- A highly sophisticated and intelligent image/character processing algorithm.
- Customization of auditory feedback speed, language and volume based on user preferences.

**Evaluation:** Apart from the survey questionnaire that we choose we thought it would have been better to use the metrics provided by NASA TLX(based on Mental Demand, Physical Demand, Temporal Demand, Effort, Performance & Frustation Level) during our evaluation, but we realized that late and could not add those terms in our evaluation process.

The Wizard of Oz evaluation plan was not perfect. There was a lack of simulation in terms of auditory feedback from the system compared to the ideal scenario. This was an important feedback which can be included in the subsequent evaluations of the system.
APPENDIX

Appendix 1: Tasks to be evaluated during usability testing

Scenario 1: Using a treadmill
1. Start the system.
2. Search for the program mode that enables you to select a customized program. Tell us which program mode is it?
3. Change the program mode
4. Enter your attributes as exercise equipment prompts. (Age, Weight)
5. Enter workout target (Time, Level, Calories, Heart rate, Distance, Speed)
6. Start the workout
7. Assuming that you are in the middle of an exercise, change the speed (increase by 2mph)
8. Stop the equipment
9. Know the workout summary

Scenario 2: Using a microwave oven
1. You are in front of a microwave, and you have all your ingredients ready in a bowl, now you want to program the microwave, start Microwave.
2. Search for the program mode (if it’s available over the microwave) and change the program.
3. Search for the button through which you can change the heat, and change it, tell us the heat that you have currently set to.
4. Search for time and set it to 10 minutes.
5. Start cooking
6. You heard a beep saying that the cooking is done, so just remove the bowl from Microwave.
Appendix 3

Demographic Form

1. Which category best describes your educational level?
   - Primary School
   - Secondary School
   - Under Graduate
   - Graduate
   - Post Graduate

2. What is your current job function:

3. How would you define your primary work responsibility:

4. How long have you been in this field of work?
   - < 1 year
   - 1 – 2 Years
   - > 1 year

5. Have you ever used Microwave by yourselves? If yes how long have you been using it? How often do you use?

6. Have you ever used Exercise equipment like treadmill? If yes how long have you been using it? How often do you use?

7. Have you ever used GPS information systems? If yes how long have you been using it? How often do you use?

8. Did you require assistance to use these applications?
☐ Yes
☐ No

If Yes:

What was the duration of assistance? And which applications require assistance

9. How often do you use the Microwave?

☐ Several times a day
☐ Once a Day
☐ Other __________________

10. How often do you use the Exercise equipment?

☐ Several times a day
☐ Once a Day
☐ Other __________________

A sample task evaluation form which is to be filled by the usability expert/moderator is depicted on the following page.
**Task Evaluation:**

**Easy:** Task completed within estimated time, with no more than 1 extra step, no intervention from the test monitor and no references to Online Help  
**Complete with Difficulty:** Past estimated time / Test monitor intervenes / Participant refers to Online Help  
**Not Completed:** User couldn’t complete the task.

<table>
<thead>
<tr>
<th>Task # 1- Start the system.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample Correct flow:</strong></td>
<td><strong>Start Time-</strong></td>
</tr>
<tr>
<td></td>
<td><strong>End time-</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total time taken to finish the task-</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Potential Problem Areas</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Task Scoring:</strong></td>
</tr>
<tr>
<td></td>
<td>Easy</td>
</tr>
<tr>
<td></td>
<td>Difficult</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
</tr>
</tbody>
</table>

**Subject comments & Notes:**

**Ask During Debriefing:**
### Appendix 5

**System Usability Survey questionnaire**

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ease of Use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I found it easy to complete the task using the system</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>It is simple to use.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Consistency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I find system consistent in interacting with two different devices</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>I find the interaction consistent in completing different tasks on the same device</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>The terminology was familiar to me.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Satisfaction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am satisfied using the system</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>I felt confident in using the system</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>I think I would like to use this system frequently</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Robustness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was able to accomplish what I wanted to do quickly.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>It makes the things I want to accomplish easier to get done.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Learnability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is easy to learn to use it.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>It works the way I want it to work.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>I can remember easily how to use it.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>It is easy to explore new scope of interactions and the features which system has.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
<tr>
<td>I would recommend it to a colleague.</td>
<td>1-------2-------3-------4-------5-------6-------7</td>
<td>NA</td>
</tr>
</tbody>
</table>
Appendix 6

Debriefing Questionnaire

What did you like best about AASVI system?

Was there anything in AASVI system you particularly did NOT like?

Is there anything that you would have liked to see in this system, but wasn’t there?

Was there anything within the system that confused you or anything that was ambiguous?

Is there anything that you feel, can help us improve the product?