A Note from the Editor

Dear SIGACCESS member:

Welcome to the first issue of the SIGACCESS Newsletter in 2010. This issue mainly reports the research work of the doctoral students who participated in the ASSETS 2009 Doctoral Consortium (Pittsburgh, PA). As always, the students are very enthusiastic about their experience at the DC. Some of their comments are included in p. 3 of this Newsletter. Finally, this issue includes two announcements: one for the ASSETS2010 Conference; the other for the second ACM SIGACCESS Award for Outstanding Contributions to Computing and Accessibility.

Sri Kurniawan
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Newsletter editors
Who we are

SIGACCESS is a special interest group of ACM. The SIGACCESS Newsletter is a regular online publication of SIGACCESS. We encourage a wide variety of contributions, such as: letters to the editor, technical papers, short reports, reviews of papers of products, abstracts, book reviews, conference reports and/or announcements, interesting web page URLs, local activity reports, etc. Actually, we solicit almost anything of interest to our readers.

Material may be reproduced from the Newsletter for non-commercial use with credit to the author and SIGACCESS. Deadlines will be announced through relevant mailing lists one month before publication dates.

We encourage submissions as word-processor files, text files, or e-mail. Postscript or PDF files may be used if layout is important. Ask the editor if in doubt.

Finally, you may publish your work here before submitting it elsewhere. We are a very informal forum for sharing ideas with others who have common interests.

Anyone interested in editing a special issue on an appropriate topic should contact the editor.


ASSETS 2009 Doctoral Consortium

On Sunday, October 25, 2009 eleven Ph.D. students gave presentations of their research projects to each other and to a panel of distinguished researchers including Chieko Asakawa (IBM Tokyo Research Lab), Krzysztof Gajos (Harvard University), Henry Kautz (University of Rochester), and Richard Simpson (University of Pittsburgh), and Richard Ladner (University of Rochester). The panelists gave feedback to the students on their projects. The students also attended the ASSETS conference for the next three day and presented posters on their projects at a poster session.

Some comments from participants included:

"It gave me a lot of confidence on my work. I had some very good feedback on certain implementation issues I had overlooked. The poster session during the main conference was also extremely helpful as there were some very good questions and feedback there as well."

"The feedback that I received from the Doctoral Consortium was positive and the criticism was constructive. Panelists' comments were encouraging in that they confirmed that I am on the right track. I also received a number of valuable suggestions on how to evaluate my work so it amounts to a good research contribution. I am very grateful for the opportunity!"

"I really appreciate the feedback, comments and critique from the faculty and other students at the Doctoral Consortium. They gave me a more clear vision of my research and helped me to refine a focus for my dissertation. Also, attending the conference gave me an invaluable opportunity to know more about assistive technology for people with disabilities and to make connections with other researchers working in the field."

"It was very helpful to receive the feedback that the panelists provided. Their concerns put things in perspective and reminded me of the important components of the research. Also, being exposed to my colleagues' similar research was very inspiring and I was happy to meet them and talk about their approach to research in an informal setting too."

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Persuasive Mobile Exercise Companion for Teenagers with Weight Management Issues

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ABSTRACT
Obesity is a grave problem in our society. A significant increase in prevalence within the last 20 years has resulted in greater mortality, increased stress on our healthcare system, and a decreased quality of life for people dealing with obesity and overweight issues. My dissertation concerns a mobile application that assists teenagers in leading physically active lifestyles to try and combat the risk of becoming obese or overweight as adults. I hope this research will prove to be a viable option to prevent or reduce the risk of obesity for teens so that they lead healthy lives. By reducing the risks of obesity and overweight problems, we also reduce the risk of these individuals developing debilitating diseases such as diabetes and cardiovascular diseases.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation]: User Interfaces – evaluation/methodology, graphical user interfaces (GUI), theory and methods, user-centered design.
J.3 [Computer Applications]: Life and Medical Sciences – health.

General Terms
Design, Human Factors, Theory

Keywords
Physical Activity, Persuasive Technology, Mobile Devices, Assistive Technology, Lifestyle, Interface Design

1. INTRODUCTION
Obesity is a serious problem in the United States, due in large part to increased sedentary activities and lifestyles. An estimated 31-35% of adults are obese and 16.3% of adolescents are obese [2]. Obesity affects the quality of life of adults and is caused in part to a lack of physical activity. Obesity and overweight individuals are at greater risks of developing heart disease, diabetes, high blood pressure, and various cancers [2]. Not only does obesity affect an individual’s health but also puts economic pressure on our healthcare systems.

Studying obesity among adults is just as important as studying it in children and adolescents. Furthermore, previous studies have found that if at least one of the child’s parents is obese then there is an increased risk and trend for the child to also become obese [7]. Implications of such findings suggest that obesity trends and mentalities that promote lifestyles leading to
obesity can start at a young age. If healthy attitudes and practices are learned and enjoyed at a young age, then it is our hopes that teenagers will continue these healthy practices well into adulthood and can lead to healthy lives as adults.

A better understanding of the design requirements for persuasive applications for this group will be necessary in developing effective systems to assist them and motivate them to lead healthy lifestyles. Our work will use well established theories from health research and psychology to guide the design of our application. In the following, we discuss previous work in this area, the theories used to guide our system design, and propose a system that translates these theories into design elements.

2. PREVIOUS WORK

In the literature, there exist studies and applications developed that address increasing or maintaining healthy physical activity levels in individuals by using game-like approaches, friendly competition, or physical activity awareness and monitoring. In the following, we describe a few of these prior studies.

Motivation is an essential factor that can cause a person to start physical activity, increase physical activity, and continue their physical activity routines. One approach to increase motivation includes encouraging friendly competition. An example of such an application is Chic Clique. Chic Clique is a mobile application that was developed to encourage teenage girls to be more physically active by having them record their step count and share it with their friends [12].

Other approaches include physical activity based games. Neat-o-games is a collection of games used to try to encourage physical activity [4]. The game is controlled with data from an accelerometer. Accelerometer data is from step count and is thus associated with physical movement. Participants found the games to be “fun,” which was a motivator for them to continue using it.

In other studies, music has been used to increase physical activity. When exercising, music can affect pace of the runner, endurance, and perception of exercise [9]. MPTrain is a system that uses heart rate and motion data to determine what song to play next on the mp3 player. The application assists the users in their running routines.

UbiFit Gardens is an application that was developed according to several theoretical guidelines including those from Cognitive Dissonance Theory and the Transtheoretical Model. Their application was targeted on the individual and creating a non-intrusive technology that would blend into the user’s everyday life. Their user study was with adult participants and results showed a positive reaction to the system [3].

Most of the literature on physical activity applications were targeted towards adult users. More studies need to be conducted with teenagers to get a better understanding of their needs and to translate motivators for them into system design.

To our knowledge, little work has been done in addressing and predicting technology designs that would motivate teenagers to become or continue being physically active. The proposed research attempts to further research in this area by approaching the design of such a system from two theoretical models that will shape different aspects of system design and personality theory that will help to individualized motivational design elements of the application.
3. THEORIES USED IN OUR SYSTEM

Our proposed system was based on several theories which include: The theory of Planned Behavior, Theory of Meaning Behavior, and Personality Theory. Each of these theories are briefly described in the following.

3.1 Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is a theory that is used to predict and explain behavioral intention and behavior adoption (see diagram in Fig. 1.). This theory says that behavior is affected and depends on behavior beliefs, normative beliefs, control beliefs, and intention; where each means the following [6, 5]:

1. Behavioral Beliefs: refer to the belief that a perceived outcome will occur as a result of doing the behavior and the attitudes towards the behavior
2. Normative Beliefs: refer to the individual’s perception of what people he or she cares about will think about the behavior in question
3. Control Beliefs: refer to the perceived obstacles or ease of performing the behavior and their perceived capabilities and abilities to perform the behavior
4. Behavioral Intention: refers to how much a person plans to do and wants to do the behavior [8]

![Figure 1. Model of Theory of Planned Behavior [1]](image)

TPB has been used extensively in health-related behavior adoption studies in the past, including physical activity. In particular, some studies have also found that TPB applies over a range of population groups and they recommend it should be considered when designing health-related interventions [8].

3.2 Theory of Meaning Behavior

The Theory of Meaning Behavior (TMB) is a theory that presents two types of motivational incentives that promote behavior change. These types are called internal and external motivators [11]. External motivators can be thought of as external rewards for behaviors, such as getting a treat if you get good grades, verbal congratulations from a teacher for a job well done, or a medal if you participate in sports.

Internal motivators are motivators which have been internalized and associated with personal rewards. Personal rewards include things like feeling happy, feeling joy, and feeling
excitement as a result of doing the behavior. An example of an internalized motivator is demonstrated in the following scenario: suppose someone eats a lot of candy. This person knows that candy is bad for their teeth and health, but they continue to eat large amounts of candy. The internal motivator for such a person might be that eating candy makes him or her feel happy. This personal internal motivator of ‘feeling happy’ then outweighs the fact that they know candy is not good for them. Internal motivators explain why a person does a behavior without being asked to do it and are primary indicators of behavior adoption.

Previous work in the area of the Theory of Meaning Behavior showed that using this theory to formulate survey questions successfully predicted adolescent behavior 78% of the time [11]. The behavior in question for this study were eating habits during and outside of school, as well as sleeping patterns. The authors believe this theory better predicts behavior in adolescents because it takes into account an adolescent’s emotional worldview. This ‘emotional worldview’ is the belief that adolescents do not act, behave, or take action in a ‘reasonable’ way. Often times, their actions and behaviors are largely due to the emotions that these behaviors encourage, and so reason is overruled by emotion.

3.3 Personality Theory
The last theory that informed our design is the Five-Factor Model of Personality. This model says there are 5 basic traits that can completely describe an individual’s personality. These personality differences suggest that individuals with specific traits prefer activities that appeal to these traits. Personalizing a system for improved enjoyment can make use of personality profiles so that different interventions and persuasion styles will be more effective for people with different personality traits. The personality traits for the 5-Factor Model of personality are the following [10].

- Openness to Experience: refers to the depth, complexity, and quality of a person’s mental and experiential life.
- Conscientiousness: extent and strength of impulse control.
- Extroversion: refers to the extent to which a person actively engages the world or avoids intense social experiences.
- Agreeableness: refers to an individual’s interpersonal nature on a scale from compassion to antagonism.
- Neuroticism: refers to the extent to which a person experiences the world as distressing or threatening.

4. OUR SYSTEM
Our application was created for Apple’s iPhone and iPod Touch. These devices were chosen because of the sensors on board and the availability of free games that require physical movement as input. Using such an approach allowed for a quick prototype of our application. The application contained the 10 -Item version of the Big 5 personality test, which the user was asked to answer prior to using the application. An animated agent was also included that says motivational phrases. The system also presents a list of games based on the personality profile of the user. Finally, the application has the capability to log game play.
Interaction between the user and the system is as follows:
1. First the user creates a user profile which contains the 10-item personality test
2. Then the user enters the game mode
   a. Game Mode: Presents the user with a list of physical activity based games
      i. The games are chosen based on personality
   b. The user is asked to go play one of these games
3. Application exits and the user clicks on the icon for one of the games from the list
4. After playing the game, the user goes back into the application
   a. First screen presented to the user is a logging screen
      i. On this screen the user is prompted to select the amount of time they spent playing the game
5. Game mode is again presented to the user (go to step 2)

The system will also have a second component which will be a desktop application that provides a physical trainer or physical education instructor the functionality to remotely set goals for the teenager. They would also be able to provide feedback on the teenager’s progress, and view the activity log for the current user.

5. THEORIES AND DESIGN

When designing the application for teenagers, we want to emphasize a fun and entertaining experience which appeals to intrinsic motivators. In this manner our design focuses on the Theory of Meaning Behavior and its finding that says intrinsic motivators are immediate predictors of behavior.

Games that require physical activity input modalities, are used as the medium to encourage the association of physical activity with “fun” and “entertaining." The idea here is that we do not want physical activity to be associated with “hard work” and “routine-like” activity.

The design element that appeals to TPB, includes the animated agent and games used. The animated agent appeals mainly to control beliefs, by providing the user with positive reinforcement in their ability to do the behaviors. Examples of the phrases spoken by the agent are:

- “You have been working really hard! Great Job!”
- “You’re the best! You really are on top of things!”
- “Let’s keep playing you’re doing great!”

For the case of TPB, using games and choosing games that are socially acceptable, engage others, and are simple enough for the user to accomplish were chosen due to TPB’s normative beliefs and behavioral beliefs. We argue that games that can be played with others and that are appropriate for the targeted population will result in positive normative beliefs. Games that are engaging and “simple” or “easy to learn and play” will improve behavior beliefs that have to do with the user’s belief in their ability to play the game successfully.

Finally, we try to make the application experience as more “enjoyable” by appealing to an individual’s personality traits. We argue that differing personality traits will react to different game activities more positively or negatively depending on these traits. For example, someone with higher levels of extroversion would enjoy activities where they can be in social situations than someone in the lower end of the spectrum who enjoys less social situations. In
this case, a game for someone with higher degrees of extroversion would be presented with a
game that is played with many people.

6. RESEARCH PROGRESS

This research is a works in progress. Currently, we have received approval by our campus’s IRB. We have also recruited teenagers to complete questionnaires and surveys that ask questions related to the tested theories (e.g., personalities, things that motivate and demotivate them to exercise, etc), recruited teenagers to participate in focus groups, and teenagers to test the prototype application. The prototype application has been completed and tested through a pilot study conducted over the summer. The results from this study have been submitted for publication.

The next phase of this research will be to revise the design of our application as needed. Then a longer larger study will need to be completed to test the effectiveness of our application in promoting long term behavior change. For this study, we need to recruit more participants and will have different versions of our system to test the validity of the different design elements, i.e. animated agents and games.

We envision that this project will contribute design requirements for applications that motivate and assist teenagers in attaining recommended physical activity levels. The application itself will encourage and assist in the adoption of long term behavior change towards a more active lifestyle which in turn should improve the adult quality of lives for teenagers. We hope our translation of theoretical choices to design elements will prove to be good predictors for long term behavioral change.

7. ACKNOWLEDGMENTS

I would like to acknowledge and thank Mo Kudeki and Adrienne Woodworth’s participation and help with development of the prototype application.

8. REFERENCES


Widget Identification and Modification for Web 2.0 Access Technologies (WIMWAT)

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ABSTRACT

Rich Internet Applications (RIA) encourage World Wide Web (Web) content to be extracted and remixed from different sources, so that presented content can be updated in small chunks, rather than reloading the entire Web page. These concepts change the way Web pages are created and how users interact with them. Hence, these changes will require assistive technologies to adapt to them. We introduce the concept of identifying and modifying embedded code within a Web page (widget) during development, so that widgets that are not in an accessible form, and which produce inaccessible content can be modified. Our concept can be also applied as an enhancement for screen readers, so that they can provide a preview facility of the types of features provided by the widgets. Currently, we are investigating different methods for detecting widgets from the Web page’s source code. An evaluation of our detection methods has been carried out; this was an attempt to search for two types of widgets from the top twenty Websites. The evaluation successfully detected all widgets, suggesting that our identification methods are successful, although some false positives were also detected. Since we are in our initial stage, further investigations will be required to refine our methods, and pursue the observation and modification phases required by the project.

Keywords
Web Accessibility, Code Comprehension, Web Widgets, Web 2.0, Dynamic Micro-content

1. INTRODUCTION

The Web has evolved from a collection of static Web pages that require the page to be reloaded every time the content has changed, into dynamic Web pages that update the content independently in small chunks (micro-content). These concepts form part of the second generation of Web development and design (Web 2.0) concepts that encourage Web applications to gather data and remix them from multiple sources, and to utilize the advantages of that platform to deliver rich user experiences [9]. These methods of delivering information uses code embedded within the Web page, to source and remix data, and to manipulate the displayed content, so that they update in micro-content format.

Unfortunately, assistive technologies such as screen readers often face problems when attempting to cope with the advancement of the Web and the technologies [1]. Web accessibility guidelines and validators do assist Web developers to create accessible Websites, but that the problem with validating dynamic micro-content is the mutated content is often
hidden from validators, and is invisible to humans until it is mutated. Thus, the accessibility of the content relies heavily on how widgets are developed.

Often, to manipulate micro-content, widgets provide features for users to control the way content is displayed. However, even for sighted users, a learning phase will be required before users can fully utilise the widget. This process is even more complicated for visually disabled users. Normally no user documentation is provided for widgets, and micro-content can be updated without being noticed.

An identification and modification process is proposed to fill this gap. This approach identifies widgets written in JavaScript from a Web page. Then the processes of the identified widgets can be analysed, so that widgets producing inaccessible content, or not written in an accessible form can be isolated for modification. We called the proposed approach the WIMWAT project. The outcome of this project is envisaged to be either a development utility, or as a plugin to provide screen readers with information about the widget.

The initial investigations to identify widgets from a Web page proves that our methods are feasible. Our literature survey highlighted the gap and importance of the proposed work. Hence, further investigations to refine our identification methods, and pursue the remaining work proposed by the WIMWAT project is suggested.

2. RELATED WORK

Due to the Web 2.0 concepts, the development of RIAs, has broken the `Page Model' that most users and Web developers are accustomed to [8]. Now content in a Web page can be updated as dynamic micro-content, without requiring the Web page to be reloaded [2, 7]. These changes require assistive technologies such as screen readers to adapt to them [1]. Specifications such as the Accessible Rich Internet Applications (ARIA) [4] by Web Accessibility Initiative (WAI), and Web accessibility guidelines aim to make dynamic micro-content more accessible to people with disabilities. WAI-ARIA tags allow developers to specify the roles of different elements on a Web page, so that screen readers can form semantic relationships between the elements to provide coherent information about the widget to its users. A recent study by Thiessen and Chen demonstrated that it is possible to develop accessible RIA using ARIA specifications [10], and the concept of including WAI-ARIA tags into Web pages seem promising to solve the problem. However, in practice, more work is required to transform existing Web pages into true accessible Web pages with dynamic micro-content.

Code comprehension is a key aspect for our work. By understanding the design patterns that matches a Web widget, different types of widget can be identified from a Web page. Studies by Fukaya and et. al. [6], and Dong and et. al. [5], showed that design patterns can be detected from the source code using different code comprehension techniques. However, these techniques are not foolproof [6], and unlike them our approach deals with the Web, which is of a different scale and degree. The Web is a heterogeneous set of technologies, recommendations, and guidelines that is undergoing constant change, thus the techniques discussed in [6, 5] may behave differently in this medium.

1A technology commonly used to assist visually disabled people to access displayed content on the screen.
3. MOTIVATION

Web accessibility guidelines and WAI-ARIA specification provide recommendations for producing accessible Web content, but due to the complexity of developing RIAs, accessibility becomes difficult and it is often overlooked. Furthermore, widgets often require visual means to understand and interpret their usage or purpose. An example would be the Auto Suggest List widget as seen in Figure 1. In this example, we will assume that this widget does not use WAI-ARIA tags, thus, it is not in an accessible form. Then, users with visual disabilities may not be aware that a suggested list of possible queries (underneath the search field) is generated from the search query entered, and defeats the purpose of the widget.

![Figure 1: An example of the Auto Suggest List widget on Google.com](image)

Apart from these problems, to incorporate WAI-ARIA specifications, Web pages, Web browsers, and screen readers have to support it. As long as one of these components fails to do so, the concept will not work.

The WIMWAT project attempts to provide solutions to these problems. It will be a complete solution that can be applied during development, as well as enhancing the capabilities of screen readers.

3.1 During Development

The project can be visualised as a reverse engineering tool when applied during development. It will be a tool to assist Web developers and authors to check the accessibility of content produced by the widgets when developing RIAs. Beside this feature, it can also assist them when inserting WAI-ARIA tags in the widget's code. Inserting this additional information will allow screen readers supporting WAI-ARIA to gel the different components of the widget together, thus, developing or transforming widgets into an accessible form. Therefore, this utility will not only help to check the patterns of content production by the widgets, but also assist developers to develop more accessible RIAs.

3.2 Enhance Screen Readers

The project's concept can be also applied on the client-side, so that screen readers can be provided with information about the widgets in a Web page. This information includes the different types of widgets, and the features provided by them. With this knowledge, screen readers can provide users with a preview feature, so that users can be aware of the different types of widgets available, and how can they utilise them efficiently and effectively. WIMWAT
can be visualised as a plugin for screen readers as shown in Figure 2. However, no modification to the Web page's source code will be carried out.

![Figure 2](image)

**Figure 2**: Application of the WIMWAT project at the client-side as a plugin for screen readers

### 4. METHODOLOGY

The project is broken down into three stages according to its main processes: the identification stage, the observation stage, and the modification stage. In the identification stage, a Web page is searched for `traits` instances of a widget. Using this method together with rules to help distinguish the different types of widgets, we can be discover widgets from a Web page. In the observation stage, the widget's processes will be analysed and checked for its accessibility. Finally, necessary modifications will be done in the modification stage.

An example of how `tell` signs can help discover a widget from the source code is illustrated with the help of Figure 3. In this example, the process to search for whether a Carousel widget is present in a Web page is described. The four `tell` signs designed to determine whether a Carousel widget exist within a Web page are: Controls, List of contents, Content display window, and Display pointer.

Instances of each of these `tell` signs are searched for within the source code of the Web page. This was done using Perl's regular expression syntax to match for patterns within the source code that resemble instances that could form the `tell` signs. In this example, the rule designed so that a Carousel widget can be assumed to exist in a Web page require all four `tell` signs to be present. To illustrate this, we will focus on searching for the Control `tell` sign. This `tell` sign must include instances of a `next` and `back` button. Now we will examine how to determine if a `next` button is present. The following steps must be considered sequentially:

1) For a `next` button to be present, an object that triggers the JavaScript event will be searched within the source code, and the event triggered should increment the display pointer. The possible contenders of a `next` button object include,

**Form elements,**

```html
<input type="button"...> // button <input type="submit"...> // submit button
```

**Anchor links with text,**

```html
<a  href="...">...</a>
```

**Anchor links with images,**

```html
<a  href="..."><img  src="...">...
```

---

*In this report, the term `tell` signs will be used instead of `traits`. `tell` signs are clues within the code that gives the smell and characteristic of a Web widget.*
In the JavaScript code, instances of incrementing the display pointer will be searched. Variables with `++', or variables that are assigned with a value that will be plus one will be chosen for further analysis, and later determine if they are possible display pointers. When these two instances are present, the likelihood for the object to be a `next' button remains. Hence, further analysis of the object and code identified must be comprehended before the assumption can be ascertain.

2) Next, further measures must be done to isolate the genuine display pointer from the possibilities identified in the previous step. Often in the code, a display pointer will be constantly checked to ensure that it does not refer to a location that is out of range of the list of contents. Hence, instances of such conditions to bound the display pointer value will be searched. The following regular expression was used to conduct this.

```
"/if\([\w\W]*\s*(==|<=|>=|>|<)?\$possible[\$i].\s*(==|<=|>=|>|<)?[\w\W]*\)/i"
```

The concatenated array `\$possible[\$i]' within the regular expression stores the possible display pointer's variable names identified by the previous step.

3) The last measure used to isolate the display pointer is to check if the display pointer is used to refer to a location within a list of content. To cater for different variations of programming styles and methods, the following regular expression was employed.

```
"/\([\_0-9a-z]+\)\\$possible[\$i].\\$/i"
```

Here, the possible lists of content is searched. It should store the different content that the user can browse through. Now, if the true list of content can be identified, so can the true display pointer.

4) To ensure if the list is a true list of content, the location referred in this list should be displayed at the end of the process. This check will also help us to identify the content display window `tell' sign. Hinted in step 3, there are more than one method to update and present the content to the users. Some of these include using JavaScript's innerHTML and CSS to hid-den or show different objects on the Web page. The following regular expressions were applied to search for the respective displaying possibilities:

**Using innerHTML**

```
"/\.innerHTML\s?=\s?\$.displayList[\$plp].\"[\$.possible[\$pdp].\"]/i"
```

**Using styling (CSS)**
Using these steps, the `next' button can be found. A similar process can be used to search for the `back' button, except this time, instead of looking for an increment, a decrement is searched. From both of these processes, the identified likely contender for the list of content, display pointer, and content display window can be compared to justify for its correctness. Once all four `tell' signs are found and the Carousel widget can be assumed to exist. A similar approach can be applied to discover the Auto Suggest List widget from a Web page. However, a different set of `tell' signs will be applied to search for the Auto Suggest List widget. This is discussed in more detail in [3].

After a widget has been determined, further analysis can be conducted to understand its operations. This process will layout the features provided by the widget, and enable us to identify the section of the code where content is produced. Then widgets that do not produce accessible content can be isolated for modification; without the need for developer intervention.

5. RESEARCH STATUS

Currently the investigation conducted occurs in the identification stage, and two types of widgets `tell' signs have been designed; they are the Auto Suggest List and Carousel widgets. An initial study was also done to provide an insight to the techniques used to identify the widgets, and demonstrate the feasibility of our identification methodologies for the proposed concepts. The study consisted of an evaluation conducted on the top twenty websites selected from the list of Alexa's top 500 sites on the Web. This evaluation allows us to compare our automated detection with a manual inspection of the sites.

The evaluation successfully detected all true positives and a few false positives were also detected; these false positives are widgets that exist within the Web page but are not used by it [3]. Depending on the application of WIMWAT, it can be argued that the existence of a widget in the Web page's source code, but not used by it should be considered as a false positive detection. This is because when applying WIMWAT during development, all widgets within the Web page should be picked up for checking. In contrary, this is not always true when applying WIMWAT to enhance screen reader's capabilities. For this application, only widgets that are used by the Web page should be detected, thus, false detection issues will surface, and must be dealt with. This issue suggests an avenue for refining our identification methods, and they will be discussed in our future work plan.

6. FUTURE WORK PLAN

The identification process is the most crucial process. If a widget is not identified at this stage, it will not be processed at all. Once we are able to identify the types of widgets that exist on a
Web page, the next stage is to understand the operations of the widget, and isolate those that are not in an accessible form, or produces inaccessible content. After analysing the widget, the final stage attempts to modify them such that they can be transformed into an accessible form that produces accessible content.

To refine our current work, we propose to use standard static graphs to represent the annotation of the Object Model on a Web page. We intend to use separate graphs to model the HTML code, and the JavaScript code. Using this method, we will be able to group elements related to the widget's interface, with the sections in the JavaScript code that form the engine of the widget. Through this technique, we can segregate the JavaScript code that are not use by the Web page, and reducing issues with false detection.

The modification process should cater to commonly used combinations of programming styles and practices. It should also provide the flexibility to assist developers with customisation of the widgets, and to insert WAI-ARIA information into the code. An evaluation of our concept over a larger set of Websites will test for its diversity and reliability. It will provide us with a thorough evaluation of our investigations, and pinpoint specific problems for future work.

The problems tackled by WIMWAT are significant accessibility barriers, and we hope it is able to help developers minimise them. Our long term plan is to implement the project with the Accessibility Tools Framework (ACTF)\(^4\) to assist development. A plugin version to enhance screen readers capabilities is also envisaged.

7. CONCLUSION

The Web is a heterogeneous set of technologies, recommendations, and guidelines which allows complex combinations of programming styles and practices. Thus, different programming styles and practices were analysed through extensive studies from different design libraries and Websites.

This has helped us to form the definitions for the two widgets investigated. A wider exposure from the Web community, especially researchers working in the area of Web accessibility will provide valuable insights to our work. We envision that our work can assist Web developers with a tool that will provide a conducive environment for them to develop accessible RIAs, and improve the Web experience so that it will be accessible by more people.

8. ACKNOWLEDGMENTS

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\(^3\)http://www.alexa.com/topsites
\(^4\)ACTF is a single tooling environment, on top of the Eclipse framework, to integrate commendable accessibility tools and the extensible framework of ACTF. - http://www.eclipse.org/proposals/actf/
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ABSTRACT
In this paper, I describe the summary of what I plan to do for my PhD thesis on sign language synthesis. The modelling of the skeleton of virtual characters would lead to improvements in the quality of animations. Thus the first step is to study how to build such a model, by analysing corpora data and integrating biological data. Then, we will implement the model and confront it to users to evaluate it.

Categories and Subject Descriptors
H.5.1 [Information Systems]: Information interfaces and presentation - multimedia information systems.

General Terms
Design, Experimentation, Human Factors.

Keywords
Sign language generation, Signing avatars, Statistical modelling

1. CONTEXT & MOTIVATIONS

Sign Languages (SL) are considered to be the most natural way to communicate for deaf people and therefore supposed to be the best way. Since deaf people are not always able to read plain text, we choose to display SLs on screen to give them access to every piece of information. We could use videos of people signing isolated signs to make complete utterances. However, such a method lacks flexibility because of image rights and absence of modularity. Moreover, SLs are natural languages and not just a transcription of a spoken language. They have a proper syntax and a proper lexicon and though are not simply a code like braille would be. We choose to generate animation for a dedicated humanoid called virtual signer (VS).

There are, at the moment, existing sign generation systems such as the European project eSIGN [4] or the Greek ILSP system [7]. These systems are generally relying on parametric models such as HamNoSys [12]. Parametric models describe the signs as tuples of values taken in finite sets. Studies [5] show that parametric models are insufficient to describe the whole majority of signs in French Sign Language (LSF). Based on a geometric and temporal approach [6], our team is working on a new generation systems covering the whole LSF lexicon. However, generation from geometric models often leads to perfect movement in the mathematical sense. And thus, the animation generated is very often mechanical and robotic.
Improving the quality of the animation will lead to a more understandable VS, and thus, to a better efficiency in communicating with deaf people.

My work as a PhD student is to improve the overall quality of the animation by making them more realistic. This is done by studying and modelling the skeleton of the VS in human-like ways. The study is oriented along two main axes:

- Firstly by studying the anatomy of the human skeleton and by applying biomechanical and kinesthetic constraints on the VS. For instance by preventing the wrist of the VS to be bent more than 90°.
- Secondly, by studying motion capture corpora and extracting statistical models. From these two separate studies, I will build a general model of the skeleton allowing a more realistic management of movements. The model will then be applied to the current animation system and be evaluated.

The next section deals with realistic modelling of the skeleton, the approaches covered in the litterature and the way I am doing my studies. The third section deals with the later parts of the PhD work: implementation and evaluation. The last section is a brief conclusion and what, in my sense, I will gain from the doctoral consortium.

2. REALISTIC MODELS OF THE SKELETON

The human skeleton as been deeply studied in the medical field. Lately, these studies have been extended to the domain of computer science for many purposes. The field of computer graphics have seen a particular interest in these researches with the increasing demands of realism in special effects and animation films. On one hand, the modelling of the skeleton including exclusively bones and joints has been extensively studied by many teams and have been successfully summarized up until 1993 by Badler and al. [1]. On the other hand researches on the biomechanical functioning of the skeleton have been made quasi-exclusively for medical purposes and not for computer animation, leading to very costly solutions. This is mainly because computer animation is actually ruled by data-driven approaches such as motion capture [9]. These approaches are cheaper in terms of computation time and provide good results as far as a professional animator checks the result of the process. We then need to find an intermediate between the very realistic models of biomechanical simulation and data centered approaches which lack of modularity.

The skeleton we consider is a simple sequence of joints (elbow, shoulder, wrist, etc.) connected by bones (upper arm, forearm, etc.). The first step of the study is the statistical analysis of a motion capture database [3]. Because of the large range of motions included in the database, we assume that the motion capture data studied is representative of the motions of a human. Then I extract, for each joint of the upper body, the limit values on each axis of rotation: for instance, to what extent the wrist can be bent. Aside from the limits, I also compute contribution of each joint in composed sequences. For instance if we want to bend forward the back of the VS about 80°, how much should we rotate each joint of the spine to make the posture realistic ? The upper-body of the skeleton has been modelled this way, from the spine to the wrists.

The second step of the study is to integrate various biological data to our model to complete the gaps such as the absence of wrists/hands information on the MoCap database. These data are comprised of biomechanical and clinical data [2], anthropometry data [11],
biomechanical modelling [8] and anatomical data [10]. The integration of the two previous studies will lead me to build a single final model for the skeleton of the VS.

![Density of probability for the twisting of the strong (right) elbow.](image)

**Figure 1.** Density of probability for the twisting of the strong (right) elbow.

### 3. IMPLEMENTATION & EVALUATION

The model will next be integrated to the animation generation system to calibrate the skeleton. The system is currently taking sign descriptions as input. Each of these description gives us sets of constraints on the joints of the skeleton through time. For instance, the sign WARDROBE in LSF is made as shown on figure 2. We can see for each arm three key-postures (dots), and between them, two transitions (arrows). The key-postures are straight-forward constraints on the body ("place your wrist here"), ie transitions are interpolation from a set of constraints to the next.

![Description of the sign WARDROBE in LSF.](image)

**Figure 2.** Description of the sign WARDROBE in LSF.

Currently, the system takes these constraints and applies basic CSP/optimization methods to solve them (Inverse Kinematics). Since constraint solving problems are underspecified problems (i.e. from a constraint set we can find an infinity of solution), the solutions given by the methods are generally very far from a natural posture.

The statistical model I build will be used as a selection system for generated postures of the skeleton. The system will generate, for each constraints set, a number of solutions. Each of these solutions will be assigned a score depending on how likely they are to be found in the
MoCap database. The final posture will be the one with the highest score, assuming that it will be the most natural. On the other hand, every unconstrained degree of freedom of the hands will be managed by the biomechanical models. Since the hands are the most constrained parts of the body in sign language synthesis we think that we can greatly improve realism by modelling inter-fingers reactions.

Once the model will be completely integrated to the animation generation system, I intend to evaluate and validate it by confronting the signs to users. The users should be both deaf and hearing persons, as well as signers or not. The first step will be to show animations build with and without the model, and to ask for a measure of "naturalness" in the generated motion. Then I will show to deaf signing people results of the generation with and without the model and ask for a measure of understandability.

Another clue on evaluation I would like to study is the possibility to feed generated animations to a sign language recognition system and see whether the signs are recognized as LSF signs. However, we the recognition systems to be developed and also evaluated before doing so.

4. CONCLUSION & PROSPECTS

The work I intend to do during my PhD will aim to build a model of the skeleton for VS. This model will be sufficiently realistic to palliate the robotic motion problems but also quick to compute to allow quasi-real time generation of animation.

The overall statistical study has been completed and is currently being implemented to be tested. The biomechanical parts of the model are still being studied but we expect finishing this study before the end of the implementation of the statistical scoring system.

The implementation phase will be followed by a calibration process that will more than probably take us some time. We don't know yet how we are going to proceed to calibrate the various parameters (such as the number of posture to generate for the scoring system).

In the end of my PhD, I want to release a set of tools for easily manipulating and animating the skeleton of the signing avatar. Hopefully, this work will be the first step into more and more realistic tools for the signing avatars, but also for general purpose animation.

5. ACKNOWLEDGEMENTS

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6. REFERENCES


AudioNav: A Mixed Reality Navigation System for Individuals Who Are Visually Impaired

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ABSTRACT

This research is to design a novel indoor navigation tool called AudioNav for users with visual impairment. Current navigation systems rely upon expensive physical augmentation of the environment or expensive sensing equipment. The proposed system is infrastructure-free and low cost as it uses only a virtual representation of a building to be navigated.

Our proposed system: 1) extracts a floor-plan and recognizes landmarks in the three-dimensional model of a building, 2) locates and tracks the user inside the building while there is no GPS reception, 3) finds the most suitable path based on the user’s special needs, and provides step-by-step direction to the destination using voice, speech, or haptic feedback.

General Terms
Assistive Technology, Visually Impaired, Path Planning, Localization.

1. PROJECT SUMMARY

1.1 Problem
The ability to navigate effectively and safely in unfamiliar environments relies upon being able to build a cognitive map of the environment [5]. Whereas sighted people primarily rely upon vision to create such a map, individuals with vision impairment (VI) have to rely upon their remaining senses such as touch, hearing or proprioceptive cues. Cognitive mapping as such is a relatively slow process leading to lower mobility of individuals with VI.

1.2 Motivation
To increase the mobility of users with VI, a number of indoor and outdoor wayfinding techniques have been developed. Whereas outdoor systems rely upon GPS to locate the user [2, 10], indoor systems typically rely upon expensive physical augmentation of the environment such as infrared (IR) [9, 8], ultrasound [7], or radio frequency identitier (RFID) tags [1, 4, 3] or expensive sensing equipment such as the systems based on computer vision [6]. Since these techniques are expensive, no indoor navigation system has been implemented on a large scale. Most of these techniques require that the user carries extra equipment which is not desirable as individual with VI already carry additional equipment such as cane or Braille-reader.

While planning the path is a key for successful navigation, few navigation systems [7, 8, 3] provide some form of specialized path planning. The objective of this proposal is to develop a navigation system that addresses these issues.

1.3 Solution
AudioNav is a navigation system that is infrastructure free, low cost, and considers special requirements of individuals with VI. The three unique characteristics of this system are that it augments reality, uses the user as a sensor, and applies probabilistic techniques to reduce uncertainty.

Our aim is to localize the user using a 3D model of the building and a dead-reckoning approach achieved with low cost sensing provided by a portable device, such as a cell phone with an internal or external accelerometer and magnetometer. The disadvantage of using dead-reckoning is un-bounded accumulation of errors over time. During indoor navigation, the user is constrained by physical infrastructure such as doors and walls which reduce the chance of veering from a straight path. Therefore, localization with the same precision as outdoor navigation may not be required.

Nevertheless, dead reckoning can maintain accuracy through periodic calibration. At the same time, since individuals with VI have a good sense of touch, the identification of spatial landmarks plays an important role in navigation of these spaces. This project uses probabilistic localization schemes that incorporate the feedback provided by the user via confirming the presence of landmarks along their path.

Safe paths with minimum uncertainty will be planned by adapting techniques from the fields of robotics and artificial intelligence. Such techniques model and mitigate the uncertainty associated with localization as well as user's varying ability to positively confirm landmarks encountered along their path.

AudioNav provides information and direction to the user using augmented reality. While augmented reality is typically associated with visualization, in this proposal we seek using audio or haptic feedback.

From a user point of view the proposed system offers multiple advantages. It is affordable, since it has minimal hardware requirements and can run on a cellphone. Required sensing can be achieved through inexpensive motion sensing controller technology. It is ubiquitous since it relies only upon a 3D model of the building, which allows for large scale implementation due to recent advances in the technology for creating such models. 3D models are available on the free virtual globe application Google Earth which can be used with AudioNav. Also, new models can be created using 3D modeling programs such as SketchUp and added to the Google Earth.

The proposed system can be also used by users with cognitive disabilities and sighted people, the anticipation is that it will be possible to have community-based efforts for the annotation of large scale model creation for public spaces such as train stations, airports, libraries etc. The proposed system also offers an information service, which will answer spatial queries that can be solved by analyzing an augmented model of the building. For example models can be augmented with information which may be useful to a user with VI, such as the location of washrooms, the spatial layout of rooms or the nearest fire exit.

This research seeks to answer three main questions:

1. Can we accurately localize the user using dead-reckoning and user feedback?
2. Can we find a safe path and provide directions to the user with VI so the user may arrive safely at their destination?
3. What is the best way to interact with the user?
1.4 Stage

We have implemented AudioNav for an Android phone. The tool extracts the oor-plan and landmarks from the 3D model of a building such as doors and windows. We have implemented a pedometer using the accelerometer built into the phone and using the pedometer and compass the system tracks the user and estimates user's location. The current implementation plans the shortest path and provides speech instructions.

Future research includes implementing probabilistic localization and dead-reckoning, improving path planning to minimize uncertainty, improving the object recognition to extract more complicated landmarks such as staircases and toilets, implementing voice recognition to receive user's feedback, and investigating machine learning and information collection from the user to improve accuracy. As part of future work, we need to do user studies to answer our research questions and modify our system to improve usability.

1.5 Contributions

The proposed system can increase the mobility of millions of visually impaired users around the world, which will allow them to enjoy a more independent lifestyle and improve their quality of life. Increased mobility allows access to higher education as well as broaden their employment opportunities as visually impaired suffer from high unemployment rates. This contribution will be particularly important in low-income regions, as well as in developing and third world countries where the use of portable and wireless devices is emerging, due to its lack of physical infrastructure dependence.

1.6 Gain

By attending the ASSETS 2009 Doctoral Consortium, I hope to receive feedback from researchers with experience in variety of related fields. This can help me to improve my research goals and plans, discover new ideas to consider in my research, and find new problems that need to be answered.

REFERENCES


Using Interactive Objects for Speech Intervention

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ABSTRACT

Technological advances in physical computing and automatic speech recognition (ASR) have made the development of novel solutions for speech intervention possible. I plan to combine an ASR engine with programmable microcontrollers to develop exercises and activities based on interaction with smart objects for helping with speech therapy intervention for children.

Keywords
Physical Computing, Speech Recognition, Speech Therapy

1. THESIS RESEARCH SUMMARY

The key component of speech therapy intervention is one-on-one practice with a speech therapist. This is typically conducted in a private session where the therapist involves the client in speech activities, such as games, and provides them with feedback. The client is then encouraged to practice speech on his or her own before meeting with the therapist again. Frequent private lessons are expensive and might not be available to a lot of children. While it is impossible to replace the work of a speech therapist with a computer application, recent technological advances in automatic speech recognition (ASR) and physical computing hold great promise for the development of tools to supplement professional intervention with exercises and activities that make them more effective and efficient.

2. BACKGROUND RESEARCH

The shortage of speech training resources for people who need speech therapy is widely recognized [3]. This need is especially pressing for children since intervention works best if started at an early age. Previous research has recognized the potential of ASR for speech training [8]. Additionally, the importance of games and engaging exercises and activities for children is emphasized in previous research and used successfully in various areas of assistive technology [7, 11]. Various computer-based speech training (CBST) systems such as ARTUR [4], Box of Tricks [14] and Speech Training, Assessment and Remediation system (STAR) [6] exist that rely on ASR to implement a speech training system for children. While most of these approaches use games to engage children in speech training exercises, they still utilize the computer screen and speaker to provide feedback to the user. Furthermore, the feedback is in the form of wave-form visualizations, tongue and vocal tract animations or recorded voices. Figure 1 shows a screenshot of the feedback that is provided by the ARTUR application [4]. I believe that as the video of the speech therapist that we propose to provide as feedback is more helpful to children than these forms of feedback. In other research, the Nintendo game console is used as an alternative interactive device for training games and communication tool by children [12].
3. SPEECH AND INTERACTIVE OBJECTS

In this research, I use tools developed in the area of physical computing to develop games that utilize novel physical interfaces, (i.e. interactive objects), that transcend the computer screen, mouse and keyboard interaction paradigm. There are several benefits for using this approach. Firstly, interacting with tangible objects emphasizes the element of play and makes the experience more immersive. Secondly, playing with these objects resembles the actual speech therapy sessions where a large number of varied toys such as dolls and drawings are used to elicit speech. Finally, these interfaces are more customizable for the specific needs of children with disabilities and their design is not confined to the limits of the desktop computer interface. For example, one possibility is to customize the object for blind users by implementing movement detection and vibration feedback in them.

For the implementation of the interactive objects, I use the Arduino microcontroller, an open-source embedded programmable controller that is used in physical interfaces [1, 10]. Recent research has demonstrated the flexibility and great potential of this controller for the development of smart textiles and interactive objects [5]. The controller is embedded in dolls and building blocks that are used in the intervention to afford speech interaction with the child. The speech is received by embedded microphones and sent over a wireless network to a computer. The actuators on the toys are activated based on the received voice; thereby implementing a dynamic interaction between the child and the toy via the computer. I use the CMU-SPHINX open-source speech recognition engine to process the input signal from the microphone [2].

An essential part of my solution is developing an interface that allows the speech therapist to configure the program to suit the need of each child. As recommended in the literature, I recognize that actively involving the speech therapist is essential for the success of the system [8]. To this end, I have developed an easy to use interface to customize the activities and feedback of the system. Figure 2 shows a screenshot of the video feedback configuration component of the interface. The therapist specifies what words or phrases are to be practiced over a practice period and records video clips demonstrating the correct pronunciation of each phrase. While the feedback provided to the child is mainly through various behaviors displayed by the interactive object (e.g., vibrations, sounds, lights), the video recorded by the therapist is also played on the computer screen if the child
repeatedly fails to pronounce a word and needs help with the pronunciation.

![Word Configuration](image)

**Figure 2.** Video configuration interface allows the SLP to review and record video clips for each word

The speech therapist can configure the difficulty of the exercises by specifying how closely the child’s pronunciations should match correct pronunciations stored in the system. The system keeps track of the interactions of the child and provides the therapist with a report at the end of the exercise period that is used to assess which tasks and games are completed and which words and sounds are problematic.

By limiting the words that are recognized by the system to a small number I simplify the recognition task and increase the accuracy of the engine as recommended in previous research [9]. This approach also allows the system to work well without training which is especially important for children and users with disabilities because successful training requires considerable effort and patience. To address concerns about the performance of the system for use by children and users with dysarthric speech I have conducted preliminary tests with both groups and have observed that the system performs satisfactorily without training. The application is designed primarily for training children but adults can also use it. The exercises can be configured to accommodate a wide range of users with various cognitive and literacy abilities.

By bringing together the fields of assistive technology and physical computing, this research paves the way for a new generation of applications that do not depend on the computer screen, mouse and keyboard as input and output devices. This approach is valuable because it can address the wide variety of the needs of people with disabilities.

I have been working with speech recognition and in particular the CMU-SPHINX engine for more than three years and have used it to implement a speech-interface for web navigation [13] So far in this project, I have created a prototype that incorporates speech recognition with the microcontroller. The next step is to develop prototypes of the interactive objects followed by user tests. The results of these tests will be used to refine the design. Finally, the refined system will be formally evaluated using a longitudinal study with actual users to assess its effectiveness.

### 4. ACKNOWLEDGMENTS
I would like to thank the panelists of the Eleventh International ACM SIGACCESS Conference on Computers & Accessibility (ASSETS 2009) Doctoral Consortium, where this work was first presented, for their helpful feedback and advice. I would like to thank Dr. Melanie Baljko and Dr. Nigel Livingston for their advice and support.

5. REFERENCES


ABSTRACT

Autism and dyslexia are both developmental disorders of neural origin. As we still do not understand the neural basis of these disorders fully, technology can take two approaches in helping those affected. The first is to compensate externally for a known difficulty and the other is to achieve the same function using a completely different means. To demonstrate the first option, we are developing a system to compensate for the auditory processing difficulties in case of dyslexia and to demonstrate the second option we propose a system for autism where we remove the need for traditional languages and instead use pictures for communication.

Categories and Subject Descriptors
K.4.2 [Computers and Society]: Social Issues | Assistive technologies for persons with disabilities

General Terms
Design, Human Factors

Keywords
Dyslexia, Clear Speech, Autism, Alternative and Augmentative Communication

1. INTRODUCTION

In our work we consider two developmental disorders that affect the faculty of language - autism and dyslexia. In dyslexia only reading is affected whereas in autism multiple aspects of development such as language, social communication are affected. For dyslexia, based on the hypothesis that auditory processing deficits could lead to reading difficulty we propose a system that could perform speech modification and hence compensate for those deficits. For Autism, we propose an Alternative and Augmentative Communication (AAC) device where two way communication can be achieved by using pictures instead of language.

2. DYSLEXIA AND AUDITORY PROCESSING

Developmental dyslexia is an unexpected difficulty in reading in children and adults who otherwise possess adequate intelligence and motivation. The prevalence rate is estimated to be between 5% to 10% in school age children. Dyslexia can be comorbid with language difficulties, writing and mathematics disorders. Though the exact cause of dyslexia is still a matter of debate [8] there is consensus that a significant proportion of these children have difficulties in auditory perception and these auditory difficulties might be causal to their reading difficulties.
The problems in auditory perception include difficulties in backward masking, temporal order judgment, and perceiving amplitude and frequency modulations [10, 11]. This creates difficulty in discriminating speech sounds, for instance the difference between two acoustically close phonemes like /ba/ and /da/ and hence leads to a poor representation of phonemes. Since reading is a grapheme to phoneme correspondence task, this poor representation translates to difficulties in reading.

2.1 Speech modification for dyslexia

The above points lead us to the following fundamental research question: can we modify speech in such a way that it improves intelligibility for children with dyslexia? A closely related subquestion is will this modification vary across languages which becomes more relevant in the Indian context as an Indian child is typically exposed to at least two to three languages and the language spoken at the school and home are different.

2.2 Clear speech and other related work

There exists some evidence [2, 5] that speech modification could aid children with dyslexia. Fast ForWord [5] uses speech modification as intervention for children with language learning impairments. Recent psychoacoustic studies show that a particular style of speech known as clear speech enhances intelligibility for children with dyslexia [2] and more generally for those who have difficulties in hearing [6]. Clear Speech is defined as the style of speech that results when one attempts to make his/her speech more intelligible. Speakers resort to clear speech when they think listeners do not have the knowledge of language or have some hearing impairments or the background is noisy. There is no clear consensus on the right set of features that differentiate clear speech from conversational speech. Some of the proposed features are increased consonant-vowel ratio, increased vowel space, slower rate of speaking, increased pitch range, lesser coarticulation and salient stop releases [3, 7].

Though the effectiveness of clear speech in general is known, there are no studies on dyslexic children which would inform us quantitatively about the intelligibility advantage that each of the above features offer. Studies on clear speech production in Indian languages is also absent. Hence, we propose to determine the relative merits of features of clear speech in the dyslexic context and their variability across multiple Indian languages. Specifically, we propose to study this problem, via auditory discrimination studies, for three Indian languages (Hindi, Tamil, Telugu). The goal is to identify the right features which offer most intelligibility advantage for children with dyslexia.

2.3 Proposed Solution

Once the appropriate feature set is identified, we propose to develop a system to generate clear speech from normal speech in real-time that can be utilised in different applications. Two exemplar applications are: (i) an assistive listening device and (ii) a tool to create audio books. An assistive listening device as shown in Fig. 1 would help students to gain better auditory discrimination in the class room environment. A system with text to speech capabilities on the other hand would allow teachers to create audio books with clear speech, for their students. Our hypothesis is that both these systems would help children acquire better phonemic representations and hence better reading skills.

3. AUTISM AND COMMUNICATION

A second problem that we are investigating is an assistive system for children with autism. Autism affects 1 in 1000 children. The language and communication skills of children with autism (CWA) vary widely. Some children have no functional communication, some are echolalic with ex-
tremely limited comprehension and some children do develop language but cannot understand abstractions such as idioms, metaphors and stories [9]. They also have difficulty in abstraction and generalization but are excellent visual thinkers.

3.1 Picture based communication system for autism

Language is an abstract symbol system. Therefore a fundamental question that arises is, will a lesser abstract system such as pictures aid in improving communication for children with autism. Such a system would take advantage of their visual thinking abilities as well. A related issue is identification of the most appropriate set of pictures for this system.

![Figure 1: Assistive listening device in a classroom for children with dyslexia.](image1)

![Figure 2: Receptive communication. The child's handheld performs a text to picture conversion.](image2)

3.2 Related Work

Augmentative and Alternative Communication (AAC) devices such as PECS and VOCA have been used with children with autism [4] where children can choose pictures to construct sentences. Historically, these devices were developed for children with severe speech and motor impairments (SSMI), who had difficulty with speaking and signing (expressive communication) but not with understanding other’s speech (receptive communication). However in the case of autism there are difficulties with both expressive and receptive communication [1]. Thus, the current devices do not offer a complete solution to the communication problem as they assist only in expressive communication but not in receptive communication. The input modality in these devices is not visual as a result of which the autistic child has to comprehend the language of the care giver to communicate with her/him. In our work, we propose to develop an AAC that addresses this lacuna.

3.3 Proposed Solution

The features of the assistive communication device we propose are
**Two way communication:** The AAC should aid in both expressive and receptive communication. Hence, we aim to build a device that could convert language to pictures and pictures to language and thus complete the communication loop.

The communication chain is as shown in Fig.2 and 3. At the care giver’s end a device enables sending text messages to the child. At the child’s end, a second device receives this message and converts the text into pictures. To enable expressive communication, this device would present the child with a set of pictures. They can choose the pictures that would describe their needs. An appropriate sentence would be constructed and would be synthesized using a text to speech system and spoken back to the care giver.

The device with the child consists of the following components

- a set of pictures that are intuitive to the child and helps them express their ideas in a day to day communication scenario
- a text to picture converter that converts the incoming text to appropriate pictures
- a picture to text converter, that constructs an appropriate sentence from the pictures chosen by the child and
- a text to speech converter that speaks out the above sentence to the care giver.

**Figure 3: Expressive communication. Here, the child’s handheld performs a picture to speech conversion.**

**Intuitive symbol set:** Historically AAC systems were developed for children who had severe speech and motor impairments. In this case, the pictures served as an alternative way to express a concept. These children can easily understand the relation between the picture and the concept. So even a weak visual relationship between the objects and pictures might suffice. However, in case of a child with autism, due to their difficulty with abstraction and generalization, the pictures need to have a strong resemblance to their referents. The more relevant these pictures are to the child’s culture and environment, the easier it is for them to use the system.

Current AACs use pictures derived from sources such as Picture Communication Symbols (PCS) which were designed for western culture. These pictures might not be intuitive to a child in the Indian context. Also, the existing symbol sets were initially conceived to be used in static cards. So, the representation for actions (e.g., go, come etc.) is abstract. In our work, we plan to use a symbol set that suits the Indian culture. Also, since this system will reside in a handheld device, we propose to use animations to represent actions.
4. EVALUATION

The AAC would be evaluated in a child-care giver scenario. The parameters for evaluation would be based on the improvement in number of times the child initiates the communication, the increase in comprehension. To be specific, we will measure if the vocabulary of the child improves when using the device and their mean utterance length (average length of sentence) improves.

5. STATUS OF RESEARCH

We have evaluated the intelligibility advantage of reduced rate of speaking on four children with reading difficulties. They were chosen from a local school and had been assessed by a clinical psychologist. These children were played some sample words in both normal and slowed down form (50% reduction in rate of speaking) and asked to spell these words. The results indicated an improvement in their performance. A controlled study with a larger population is being planned.

6. ABOUT THE AUTHOR

I am a second year Ph.D. student in Center for IT in Education, International Institute of Information Technology, Hyderabad, India. My research interests are the neuroscience underpinning developmental disorders and assistive system design. In particular, I am working on assistive systems for children with autism and dyslexia for my thesis.

REFERENCES

MobileAccessibility: Camera Focalization for Blind and Low-Vision Users On the Go

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ABSTRACT

There is a significant need for access to low-cost assistive mobile services through standard devices. Many special purpose devices that provide services are specialized for few functions, are usually not networked, and are expensive and difficult to sustain. Mobile devices and their sensors, along with audio or tactile output, show immense promise for improved daily accessibility to the world for blind people on the go. Particularly, the camera has the potential to expand environmental knowledge using context and computer vision. This research will investigate general camera interaction techniques, mobile device and camera accessibility for blind users, and computer vision techniques for recognition given mobile phone limitations. These studies along with formative studies and focus groups with users will inform the design, implementation, and evaluation of future lab and field studies for semi-autonomous focalization with the camera for blind users.

Categories and Subject Descriptors
K.4.2 [Social Issues]: Assistive technologies for persons with disabilities; H.5.2 [Information Interfaces and Presentation]: User Interfaces; I.2.10 [Vision and Scene Understanding]: Video Analysis; I.4.8 [Scene Analysis]: Object Recognition

General Terms
Design, Experimentation, Human Factors

Keywords
Mobile, camera, blind, low-vision, web services, focalization.

1. INTRODUCTION

Mobile devices present people with disabilities with new opportunities to act independently in the world. The World Health Organization estimates that there are more than 37 million blind and 124 million low-vision people in the world [2006]. For most of these people, common everyday activities, such as transportation, shopping, eating out, and simply taking a walk, can be major challenges. Most of these blind and low-vision people have not realized the full potential of the mobile revolution due to lack of sustainability and adoption of specialized devices which aid in some of these activities, partly due to the expense and proprietary nature of the companies which provide them, and the lack of accessible mainstream devices. The proposed platform leverages the sensors that modern cell phones have to keep devices cheap, and uses remote web services to process requests. Both human-powered and fully-automated web services are used to balance cost, accuracy, and timeliness of the services available. Being able to effectively use the camera to send essential data to these services is a huge challenge for blind people, and motivates this particular research.
1.1 Background and Motivation

There is scant computer science research on blind and low-vision users’ interaction with mobile devices and general computing practices, not to mention interaction with cameras. There is work on the design of auditory user interfaces for blind users but not in the context of activities on the go. Watanabe et al. [7] surveyed the present state of mobile phone usage by blind and low-vision people in Japan, finding that users felt that current applications with speech output were insufficient for supporting their needs. Through interviews and diary studies with 20 visually and motor impaired users, Kane, Jayant, et. al. [5] ran a formative study that examined how people with visual and motor impairments select, adapt, and use mobile devices on the go.

Very few mainstream phones are completely accessible off the shelf. The iPhone and Google Android-enabled phones now provide free screen readers. While this is promising, this only makes accessible certain functions of the phone. Many specialized portable devices fill a specific need of blind and low-vision users and are prohibitively expensive. The kNFBReaderMobile provides optical character recognition (OCR) for documents, but is very expensive and is particular to just one phone. Other examples are portable navigation devices, like Access Ingenuity’s GPS Trekker, barcode readers such as the ID Mate OMNI talking scanner, and talking book readers like the Victor Stream.

There is barely any literature on blind people’s interactions with the camera. There have been a few exciting camera prototypes developed recently (e.g. TouchSight and Haidary’s Camera for the Blind) using audio notes and tactile screens, but these have not investigated the actual interaction while taking a photo. A currency reader has been made for a mainstream Windows Mobile phone which works very well as currency is very distinct in its pattern [6]. Motivating scenarios that should propel more research in this area include recognizing faces, creating art, taking well-framed photos for family members, reading signs on office doors, reading street signs, perusing a menu with a non-standard font, locating a bus stop number, matching a pair of socks, and differentiating the women’s from the men’s bathroom. These recognition techniques themselves are not trivial, but for them to work at all necessitates blind people taking the “right” pictures to send to services to reach their goals.

2. PROPOSED SOLUTION

MobileAccessibility will provide a mixed-initiative user interface for blind and low-vision people which will be integrated with remote automated and human-powered services (Figure 1). The user-centered design of the MobileAccessibility platform will involve blind and low-vision people throughout its development as both evaluators and researchers. One of the main HCI challenges is the development of intelligent, multi-modal user interfaces to the cell phone that choose how and when to interrupt and present information to users. The research for my thesis will start to tackle this challenge, in the realm of camera focalization.

I will work on gathering the appropriate camera data and feedback for the mixed-initiative mobile user interface. With contextual information from the phone and the user, this can be a semiautonomous procedure, as in the Blind Driver Challenge [4]. The goal is to provide environmental information without object modeling or tagging. I will design, implement, and evaluate interactive procedures for blind users to point the camera in the right direction, which I call focalization. Two main areas that need to be researched to reach this goal are interaction and vision.
Camera Interaction: Some issues to be investigated are the combined use of tonal, verbal, and tactile output modalities and what input to get from the users about their environment (e.g., when should this be task oriented or location oriented?) How does panning the scene with the camera with real-time feedback fare versus taking single photographs and getting more discrete feedback? How do we know we’ve taken the picture we needed?

How do blind users perform with feedback about absolute distances to move the camera? What about relative distances?

Computer Vision: Though mobile phones boast cameras with higher resolution these days (5 megapixels and up), there are still many hardware limitations with them compared to expensive high-end cameras. Issues such as lower resolution, motion blur, lighting, and perspective must be investigated. Also, OCR is currently only reliable with standard text documents. Finding text in a scene and then using OCR is an open problem which people have researched for awhile but have not found a sufficient solution for, so this must be carefully taken into account.

Eventually, we will conduct lab and field studies to verify usability for the user interfaces, preceded by research into experience sampling for blind and low-vision users.

3. RESEARCH GOALS AND STATUS

I have conducted a preliminary formative study about mobile technology adoption and accessibility with Kane et. al. [5]. We have already begun work on creating prototype applications on the Google G1 phone using the Android platform. So far these prototypes include an accessible barcode reader, a color recognizer, and a bus navigation system. We will also use existing OCR applications such as the kNFBreaderMobile and TextScout. These prototypes will span different sensors and different remote services, both automated and human. After building initial prototypes, we will conduct focus groups and iterate on designs. Next we will conduct lab studies studying the interaction of our work with the provider web interfaces studied by other members of our team to test out latency, cost, and quality of results. Examples of services we will test out include OCR (using human services and also automated services with human verification), and specific object recognition of already defined objects.

Richard Ladner, my advisor, has extensive research experience on access technology for blind people since the 1980s. Our team has a close relationship with the National Federation of the Blind, Jernigan Institute, Google, Seattle Lighthouse for the Blind, and the Accessibility Group at IBM Tokyo Research Lab. Jeffrey Bigham, a professor at U. Rochester who has worked on WebInsight and WebAnywhere [2,3], will be a consultant and researcher on the MobileAccessibility platform.

Figure 1. MobileAccessibility platform showing the user, the phone interface, and the remote services. (a) Sensor (camera) and user input from the phone via user interface (b) automated web services (c) human web services (d) Accessibility Commons (shared data repository).
4. ENVISIONED CONTRIBUTIONS TO THE ACCESSIBILITY FIELD

An accessible cell phone that can accomplish multiple tasks has the potential to provide blind and low-vision people with more independence than they have currently. Furthermore, the MobileAccessibility solution has the potential to be inexpensive and more sustainable than current accessibility solutions. Being able to harness the power of the camera and leverage the potential power of human and automated web services are two major components for making this framework succeed. Blind students will be recruited for the project giving them a chance to participate in work directly affecting them. Lessons learned from these studies can extend to users with different disabilities or situational impairments, and push towards more universal design.

5. REFERENCES


Modeling Animations of American Sign Language Verbs through Motion-Capture of Native ASL Signers

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ABSTRACT
Software to generate American Sign Language (ASL) automatically can provide benefits for deaf people with low English literacy. However, modern computational linguistic software cannot produce important aspects of ASL signs and verbs. Better models of spatially complex signs are needed. Our goals are: to create a linguistic resource of ASL signs via motion-capture data collection; to model the movement paths of inflecting/indicating verbs using machine learning and computational techniques; and to produce grammatical, natural looking and understandable animations of ASL. Our methods include linguistic annotation of the data and evaluation by native ASL signers. This summary also describes our research progress.

Keywords
Animation, American Sign Language, Accessibility Technology, Machine Learning, Motion Capture, Inflecting Verb, Indicating Verb.

1. MOTIVATIONS AND BACKGROUND
There are several accessibility motivations for generating ASL animations for people who are deaf. However, generating ASL software is quite challenging for several reasons:

1. There is no standard written form for ASL, thus an ASL system cannot produce text output. Our software must produce an animation displaying a human character’s signing. This lack of a writing system makes it difficult and expensive to collect a large corpus of ASL with sufficient details for computational research purposes.

2. Movement data is needed for animation research. Previous researchers have collected some video corpora of ASL that are annotated by ASL linguists [1]. However, it is challenging to record the signer’s complex body joint movements, handshapes, facial expression, head tilt, and eye gaze from a video. Motion-capture technology is more reliable for this level of detail.

3. When signers use ASL, they use the space around them. The linguistic use of space is discussed below.

1.1 Linguistic Use of Space
Signers arrange invisible placeholders in the signing space to represent entities in the conversation [1] [2]. We shall refer to these placeholders as “tokens” [3]. Signers assign objects and persons under discussion to token locations, and they later refer to these entities by
pointing to the token locations. The personal, possessive, and reflexive pronouns in ASL involve pointing to token locations.

Many verbs change their motion paths to indicate subject, object, or both. These verbs have been referred to as “inflecting verbs” [4], “indicating verbs” [3], and “agreeing verbs” [5]. We shall compromise by calling them “inflecting/indicating verbs.” Generally, the motion paths of inflecting/indicating verbs change so that their direction goes from the subject to the object. However, their paths are more complex than that. Each verb has a standard motion path that is affected by the subject and object locations in space around the signer. In Figure 1(a), three images are shown of the beginning, middle, and end of the movement of the ASL verb sign “blame”; the subject of the verb has been set up on the left side, and the object, on the right. In Figure 1(b), three images of the performance of the verb “blame” are shown again, but this time, the position of the subject and the object are reversed.

(a) Mary(token location on the left) blames John(token location on the right).

(b) John(token location on the right) blames Mary(token location on the left).

Figure 1. Subject and object location information incorporated into the movement path of an ASL inflecting/indicating verb, “blame.”

There are also other verb classes in ASL we are not focusing on in this research: plain verbs and classifier predicates. The motion paths of plain verbs do not change based on the locations in space established for their subject/object. Other ASL signs are produced using handshapes that indicate certain semantic features of entities being depicted in a 3D scene under discussion. The handshapes are called classifiers [6] and the signs containing them are called classifier predicates [7]. The motion of classifier predicates change in a 3D representative way and relate to where and how the real-world entity being discussed actually moves. Researchers have modeled and generated some animations of ASL classifier predicates [8] [9], but they are not the focus of our current work.

1.2 Prior Work
It has been experimentally determined that native ASL signers achieve better comprehension scores when viewing ASL animations in which the virtual human character uses token locations [10]. To generate such animations, researchers could benefit from studying token location data in collections of ASL sentences performed by human signers. Unfortunately, researchers building collections of ASL sentences for research purposes have not recorded 3D coordinates...
of token locations. Current ASL generation technology cannot predict how to dynamically modify the movement of signs based on these spatial associations.

There have been several research projects studying sign languages animations. The European eSIGN project [11] and ViSiCAST project [12] generate some British Sign Language (BSL) verb performances by a virtual human. BSL is a distinct language from ASL but shares some linguistic properties. However the European eSIGN and ViSiCAST projects cannot produce the complex inflecting/indicating verb performances discussed above. They only model a few verbs that move in a line from one location in space to another. SignSmith Studio is a commercial sign language animation program by VCom3D, Inc. [13]. This product provides users a dictionary of signs, a fingerspelling generator, and limited control of eye-gaze and facial expression. The product can replace each word of a scripted English sentence with a corresponding ASL sign without morphological modifications added to the animation, which must be later added by a human editor. Using Sign Smith Studio, usually only people that are fluent in ASL can manually create content that incorporates the signs, facial expressions, mouthing, and eye gaze of real ASL signing.

2. RESEARCH GOALS

The goal of our research is three-fold:

1. To create a permanent linguistic research data resource of digital 3D movement information of ASL body movement and handshapes collected from native signers that can be studied by future linguists.
2. To analyze the 3D spatial motion paths of the signer’s hand and to uncover patterns of inflecting/indicating verbs in how those paths relate to the content of the sentences using computational techniques.
3. To produce animation of a character performing ASL based on our data analysis and to ask native ASL signers to evaluate the quality of animation during the development.

To achieve the goals, the first stage of our research is to accurately and efficiently record 3D motion-capture data from ASL signers. We are using a customized configuration of commercial motion-capture devices: Animazoo IGS-190 (spandex bodysuit with inertial magnetic sensors), Intersense IS-900 (microphone sensors using acoustic triangulation for head tracking), Applied Science Labs H6 eye-tracker (a near-eye camera), and a pair of Immersion CyberGloves. By collecting movement data from native ASL signers, we will build more accurate computer models for ASL synthesis.

We want to learn how the token locations affect sign movement and how inflecting/indicating verbs change their movements based on how tokens have been set up. We are collecting a multi-sentence corpus in which signers set up tokens as they sign and also collect repetitions of some ASL inflecting/indicating verb performances. We are designing experiments to record different performances of some inflecting/indicating verb performances with different given arrangements of tokens in the signing space. We plan to record the shapes of each hand, 3D orientation of the palm, and 3D coordinates of hands. Based on our collected data, we will design algorithms to calculate realistic movements for a signer.

We will experiment with machine learning techniques to learn and build the mathematical models of inflecting/indicating verbs of when tokens are set up and where they are placed.
We are considering using some of the motion-capture learning techniques like those of [14] [15] [16] to learn the verb performances. These models will be encoded in our ASL generation software to produce animations.

Native ASL signers will evaluate the animations we produce using our mathematical models. We will make use of earlier experiences [10] with recruiting and conducting experiments with native ASL signers. In past studies, we have asked participants to view the animations; then, we asked them 10-point Likert-scale subjective questions. Signers were asked to rate the grammaticality, naturalness, and understandability of the animations on these scales. We have also asked signers comprehension questions about the content of the animation – presenting answer choices in form of images to be circled. A native ASL signer had conducted our evaluations of ASL animations to ensure that a conversational ASL experimental environment is maintained during the study.

3. CURRENT PROGRESS

In the past year, we have set up the motion-capture equipment (with a body suit, cybergloves, overhead acoustic sensors for head tracking, high-definition cameras, eye-tracker). We have created manuals and protocols for equipment and annotation. We have also designed and evaluated a new calibration protocol for motion-capture gloves, which is designed to make the process more efficient and to be accessible for participants who are deaf and use ASL [17]. We have started recording ASL multi-sentence passages from subjects. Deaf ASL signers have been asked to perform ASL sentences at the lab while wearing the motion-capture equipment discussed in section 2 and while being videotaped. We have begun to linguistically annotate the data collected and use it to animate virtual human characters. Currently, we are planning how to mathematically analyze the data to build models of signs.

4. CONTRIBUTIONS

There are societal benefits from this research for the one half million deaf people in United States for whom ASL is their primary means of communication. Our research addresses challenges in creating computer-generated ASL animation. This technology can be used to make more information and accessible to deaf Americans. Our future goal is for content developers using our software to be able to script fluent sentences of ASL. This technology could also be used in software for automatically translating from English to ASL.

The corpus we create will include digitally recorded 3D movement data from signers using the motion-capture equipment, the video recording of signers performing ASL while wearing the motion capture equipment, and the linguistic annotation added by native ASL signers. This ASL data will be retained after our project and studied by the future researchers. Learning how to generate ASL signs whose movements are affected by the arrangement of entities in space will be a significant advancement for ASL linguistic understanding and animation generation.

REFERENCES


An Online Multimedia Language Assistant for People with Aphasia and Other Language Barriers

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ABSTRACT
Individuals with aphasia, a language disorder, are seldom able to utilize the Internet as a source of information, because their disability makes many written words incomprehensible. A similar situation exists for individuals who read and speak a second language but do not possess a vocabulary as extensive as in their native language. Pictures have been demonstrated to help in both cases. However, few existing paper or electronic picture dictionaries provide efficient, scalable, and adaptable support for looking up unknown terms encountered when browsing the web. For my thesis research, I am designing and developing an Online Multimedia Language Assistant, which allows a reader to click on an unknown word and receive interpretations of the word in as many as five different multimedia representations. The system provides a popup dictionary, images, animations and audio, where applicable. It is also adaptable (by user) and adaptive (system).

Keywords: Multimedia language, visual communication, aphasia, second language, medical care, cooking.

1. INTRODUCTION
The Internet is a rich source of information today, and yet, most of its information is given in written form. For individuals with aphasia, an inability to comprehend text, as a result of a stroke, brain tumor, or brain trauma, the Internet becomes inaccessible. Their language disorder makes it difficult for them to read complex words and associate them with meaningful concepts. Even if an aphasic can recognize individual words, he or she may have problems understanding a more complex phrase.

Guidelines exist for creating aphasia friendly websites by increasing the readability of the web (font size, spacing, etc.). The use of pictures as an aid has been recommended since people with aphasia tend to retain their ability to comprehend images and animations [6]. However, little research has actually been done on improving individuals with aphasics’ understanding of web content. Systems have been built using pictorial or auditory materials to support an aphasic in building communications, such as Augmentative and Alternative Communication (AAC) devices (e.g. Lingraphica [2] and ESI-Planner II [1]), but none support web use.

For my dissertation research, I am building an Online Multimedia Language Assistant system that helps users (people with aphasia) to instantly look up multimedia representations of words by clicking on the unfamiliar word and/or to select concepts represented by images in an adaptively organized dictionary that translates the user’s intent into written or spoken communication. Users can also add their own pictures, videos, and audio clips, and thus, personalize the language assistant to fit their needs. The system’s media organization is adaptive and based on usage updates and user profiles. The focus of the Online Multimedia Language Assistant system is to provide multimedia cues as a supplement to verbal texts to
enhance comprehension of words in context, and how to enlarge the white space and font size in a webpage to make it aphasia-friendly is not part of the work.

The Online Multimedia Language Assistant differs from other communication/language support systems in three main aspects. First, vocabularies of most systems (i.e., Lingraphica) contain mainly images, icons, and speech audio (pronunciations of the words). Other visual and audio stimuli are under-exploited. The system I am building also incorporates videos and environmental sounds to support concept illustration and communication. Second, few AAC devices target the enhancement of an aphasic's comprehension of online information. Pictorial Internet dictionaries (e.g., [4] and [5]), which are designed for cross-language translation, are implemented as separate websites and require switching between web pages when people look up an unknown word. This presents two problems, one of context switching in opening a new web site, and second, the loss of the context in which the word is being used. The multimedia language assistant uses a browser extension which avoids the context switching and additional manipulation. Third, current pictorial dictionaries are typically created by designers. They provide one or two efficacy-untested pictures to demonstrate a concept. This form of image generation does not scale well, that is, adding additional domains of interest and multiple variations of images is time consuming and expensive. The multimedia language assistant provides mechanisms for user contribution of new multimedia data to expand and personalize the vocabulary.

The ultimate goal of my research is to help people who have aphasia. Our target group is those who still maintain a small vocabulary of simple words but have trouble understand more complex information in context. However, it is very difficult to conduct studies with the target population during the development stage of the system. First, it is challenging to communicate with individuals who have considerable language disabilities. Any portion of the participatory design, such as explaining system operations, conducting user studies, and gathering user feedback can introduce errors as a result of miscommunications. Second, it is inappropriate to load some of the problems that occur with the early development stages of a system on this set of people who already have considerable struggles with daily life. Third, systems designed for aphasic individuals have to be aphasia-friendly. With early prototypes, it is hard to differentiate problems that arise as a comprehension failure or an interface design flaw.

Therefore for many of our studies, we take the aphorism that “everyone is disabled in some situation” and applied the language disability issue that aphasics face to a second population, those people who use English as a second language. For people who live, work, or study in a second language environment, the language barrier can be frustrating and similar to the problems people with aphasia encounter in daily life. Even with the global access of the Internet and its abundant information, non-native speakers seeking domain specific information may incur difficulties. I will therefore first test the system on individuals for whom English is a second-language.

There are some issues with using non-native English speakers. In particular, they have such high verbal abilities that multimedia representations of concepts might be a hindrance rather than a help for them. This has to be tested before we can readily conclude that these people make good substitutes on which to evaluate our multimedia translation system. We propose to get around their ability to look up words in English to native language dictionary by selecting cooking and medical care as test scenarios. These are common domains in which non-native speakers run into problems, and in which the terminologies in the source language may not have direct translations to their own language. Even if they do, people may not know the words
in their own language. If the multimedia language assistant turns out to be useful for this type of user support, it also increases the marketability of the system, making it a less expensive choice for people with aphasia.

2. THE ASSISTANT’S WEB INTERFACE

Different web interfaces have been designed for the different functions provided by the Online Multimedia Language Assistant. For the main function, an instant multimedia dictionary, a web browser extension has been implemented, in which a small pop-up window presents the assigned multimedia representation when a word is selected by the pointer on a web page. Other web services provided include a search engine into the backend library, a viewer of the taxonomy of the vocabulary organization, and a platform for users to upload and share new multimedia data for concepts, as well as rate existing data. Having all the data and services online means that people can access the language assistant from any device with an Internet connection. Thus, problems with AAC devices such as portability, storage limitations, and synchronization constraints are removed.

3. RESEARCH PROBLEM AND EXPERIMENT DESCRIPTIONS

The multimedia language assistant is being built on the premise that multimedia enhanced web content is easier to comprehend than pure text enhancement. This premise has not yet been verified although we have tested the efficacy of different multimedia stimuli in conveying concepts using individual words and in the context of building short commonly used phrases.

To test out this premise, two experiments are being run, one in the cooking domain and the other in medical care. Each study is designed to target different visual representations according to the characteristics of the domain with the hypothesis that pictorial representations can enhance language comprehension for people using English as a second language, and by extrapolation, people with aphasia. Realistic photos are used for cooking, while iconic illustrations and animations are used for medical care which often needs animation for comprehension and also a consideration of the sensitivity of the subject matter in different cultures. In the food experiment, subjects are asked to select a named dish from a set of pictures. In the medical experiment, subjects must select over the counter medicines to fix a medical problem. Text only descriptions are compared to text supplemented with pictures to determine if the pictures enhance the comprehension.

4. RESEARCH STATUS

The Online Multimedia Language Assistant system has been implemented, and the initial vocabulary for the system installed. It is based on the vocabulary used in Lingraphica [2] and statistics on word usage frequency in daily conversations. Data collection, assignment and evaluation of web images, icons, animations, videos and non-speech audios have been completed. The web interface as a FireFox extension is available at http://soundnet.cs.princeton.edu/OMLA/dict/firefox/download/.

Experiments on the food and medication domains to evaluate the power of pictorial representations in web content comprehension for English as a second language individuals have been designed, piloted and are ready to be run.

Another aspect to explore is the balance between that static content of the OMLA database and the dynamic changes introduced by the adaptive features of the system. People with aphasia have already had difficulty in learning a new technology. The automatic change of the vocabulary organization and selection of effective multimedia representations which aims
to promote the efficiency of the system may simply introduce confusion. Thus, in the initial testing stage, the adaptive features are disabled. Later, once the system is modified and proved to be accessible to people with aphasia, an option will be provided to the users whenever there is an automatic adjustment in the system asking if they would like to accept the update or keep the current setting.

Ongoing and future work includes: 1) conducting the efficacy experiments with non-native English speakers; 2) testing the integrated multimedia language assistant system with non-native English Speakers; 3) modifying the system accordingly and evaluating the final system with people with aphasia; 4) analyzing and writing up the results.

5. ENVISIONED CONTRIBUTION

The Online Multimedia Language Assistant will be the first adaptive system that supports individuals in need of multimedia to understand and use written language available through commonly used browsers. It can support people with aphasia in more easily retrieving information from the Internet and in communicating via the Internet. In a broader scope, people with language barrier problems are also likely to benefit from this system.

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Haptic/Audio based exergaming for visually impaired individuals

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ABSTRACT
Exergames are video games that use physical activity as input and which have potential to change sedentary lifestyles and improve associated health problems such as obesity. However, exergames are generally difficult for the visually impaired to play. In this research, we describe a method of interacting with exergames for visually impaired players.

Categories and Subject Descriptors
J.0 [Computer Applications]: GENERAL

General Terms
Accessibility

Keywords
Exergames, Visually Impaired, Wii, Audio, Haptic

1. PROBLEM
There are 7.8 million people living with visual impairments (VI) in the United States alone [1]. It has been shown that people with VI perform lower than sighted people on standardized physical fitness tests [2]. People with VI also have a lower average monthly income when compared to their sighted counterparts [1]. Social barriers are also present as the visually impaired might not have a partner or sighted guide to exercise with [3]. Safety concerns of the parents, teachers, and the visually impaired themselves are also important [4]. Self imposed barriers, such as not knowing what to do or the fear of being made fun of also restrict the amount of physical activities some people with VI are willing to do [5]. We propose a cost effective system of encouraging physical activity with enhancements for people with VI.

2. MOTIVATION
Traditionally, video games have done very little to increase activity amongst the players. In fact, studies have shown that traditional video games promote unhealthy behavior even more so than watching television [8]. Only 27% of children and 25% of adults engage in moderate-intensity physical activity each week [12].

A recent trend in video games is a genre called exergames [9]. These are video games that require exercise by the player in order to get the enjoyment from the entertainment of the game. Exergames require more input from the player other than the traditional button pressing. Games such as Dance Dance Revolution require the player to position his feet in such a way to match patterns displayed on the screen in time with the music. The release of the Nintendo Wii has strongly promoted the popularity of exergames. Games such as tennis and baseball can be played by actually swinging a controller (WiiMote) at the appropriate time based on the graphics displayed on the screen.
Although these games are fun and create exercise, they strongly rely on graphics and hand eye coordination in order to play them. This is difficult and essentially impossible for visually impaired players. Audio and haptic have been successfully used as alternative forms of feedback that allow users with VI to play games.

Additional audio cues can give the player an idea of what exactly is happening on the screen [10]. Currently speech is used as an addition to graphics, but it can be enhanced to be more descriptive to those who have difficulties seeing the screen. Sound effects also currently supplement the graphics, but they can be enhanced to provide more detailed spatial audio to assist those with VI. Using the left/right/front/back speakers can enhance the virtual representation such that a person with visual impairment can picture the state of the game. In addition to spatial cues, visual game state cues can be represented as additional audio cues as shown in a Battleship game modified for visual impaired players. And finally, an audio technique called sonification, uses earcons or sound radar to assist those with VI as demonstrated in the game Audio Quake.

Another cue that can be enhanced is haptic [11]. Haptic refers to the sense of touch. A common haptic cue used in video games is the rumble. The controller will rumble when something is happening. This is usually done to give a sighted player a more accurate representation of the virtual world being shown on the screen. For example when an explosion occurs, the controller will shake making the player feel as though he is actually a part of the virtual world. Traditionally haptic has been used as a tertiary form of cue in video games (visuals and audio first), but for games that are enhanced for visually impaired players it can be more of a primary cue. For example, when a rumble occurs, a player knows that it is time to do something. A version of Guitar Hero, which is primarily a pattern matching hand/eye coordination game, was modified to rely mainly on haptic cues due to the fact audio cues would interfere with the musical context of the game [6]. This showed very promising results indicating that haptic can be used as a substitute when the visual cues are not available.

3. SOLUTION

In order to promote exercise for people with VI in an environment where they can feel safe and not need others to help them, we propose creating exergames with enhancements for VI. Based on the previous studies we will enhance the audio and haptic cues to give the player the ability to formulate a correct representation of the virtual environment based on those cues.

Cost will also be a consideration. We think this can be done relatively cheaply with off the shelf components. The technology packaged with the Nintendo Wii is very available and extremely cost effective while also being accurate and useful. With the built in accelerometers, speaker, and rumble we can detect the necessary information to determine the motion of the player. We can also provide enhanced non visual cues such as haptic and audio which have proven to make the games more accessible. With the popularity of exergames and the benefits they bring, we think making them accessible to people with visual impairments will provide an entertaining, safe, healthy and rewarding experience.

4. STAGE

We have created a software title "VITennis", or Visual Impaired Tennis where a basic tennis game utilizing the WiiMote has been modified with enhancements for visually impaired players. We have added spatial audio such that the player can tell whether the ball is going to the left or right of the screen. We have also added haptic feedback through the WiiMote's
rumble capability which indicates when to swing and can give some status on the current state of the game.

We have had 1 preliminary trial with the game being played by 13 completely blind students. We monitored energy expenditure using wearable accelerometers and found levels of energy expenditure higher than regular video game playing. The energy expenditure was also high enough to contribute to the daily recommended dose of exercise for children. We plan to perform a long term study and analyze the long term benefits of exergaming for people with VI.

Our VI Tennis game only exercised the player’s dominate arm, and with that we seek to explore how we can engage the visually impaired player in a whole body exercise using a haptic/audio based approach. We seek to construct a vibrotactile/audio exercise suit that also has basic motion capturing technology. Along with this suit we plan to develop several exergames that entertain the player while providing exercise in a manor that is accessible to people with VI.

Some research questions we seek to investigate are:

(1) How can we engage users with VI in whole body exercise?
(2) How can we provide a technique for motor learning that allows users with VI to correctly perform their exercises? This would include a method for motion capturing as well as providing whole body multi-modal feedback.

5. CONTRIBUTIONS

We hope to expand the very popular and healthy exergames genre to include those with VI. We also expect to promote exercise to a group who performs lower than average on standardized fitness tests.

6. GAIN

I have spent the last 10 years developing software for a gaming company. Participating in this conference will really help me understand what is needed to succeed in a research environment. The area of assistive technologies is very interesting to me, and I would like to learn what others are researching as well as receive feedback on my project from those who are experts in this field.

7. REFERENCES

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Improving Vocabulary Organization in Assistive Communication Tools: a Mixed-Initiative Approach

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ABSTRACT
Navigating a vocabulary consisting of thousands of entries in order to select appropriate words for building communication is challenging for individuals with lexical access impairments like those caused by aphasia. Ineffective vocabulary organization and navigation hurt the usability and adoption of assistive communication tools and ultimately fail to help users engage in practical communication. We have developed a multi-modal visual vocabulary that enables improved navigation and effective word finding by modeling a speaker’s “mental lexicon”, where words are stored and organized in ways that allow efficient access and retrieval. Due to impaired links in their mental lexicon, people with aphasia have persistent difficulties accessing and retrieving words that express intended concepts. The Visual Vocabulary for Aphasia (ViVA) attempts to compensate for some of these missing or impaired semantic connections by organizing words in a dynamic semantic network where links between words reflect word association measures based on WordNet, human judgments of semantic similarity, and past vocabulary usage.

Keywords: Assistive Communication, Aphasia, Semantic Networks, Adaptive Tools, Visual Vocabularies

1. INTRODUCTION
Aphasia, an acquired disorder that impacts an individual’s language abilities, affects close to one million people in the United States alone [15]. It is often acquired as a result of stroke, brain tumor, or other brain injuries. The resulting impairments to the ability to understand and produce language vary in severity and can affect an individual in any combination. Even though rehabilitation can alleviate the level of impairment, a significant number of people with aphasia are left with a life-long chronic disability that impacts a wide range of activities and prevents full re-engagement in life.

Technological tools can assist communication for people with language impairments, but current solutions share a key disadvantage: vocabulary organization and navigation impair effective word finding and phrase construction due to deep hierarchies or extensive flat word collections. We have developed a prototype for a multi-modal visual vocabulary communication tool that implements a novel approach to word organization which enables the user to browse for words efficiently. The visual vocabulary for aphasia (ViVA) organizes words in a context-sensitive network enhanced with semantic measures and tailored to a user profile. ViVA is designed to reorganize and update the vocabulary structure automatically according to user preferences and system usage statistics. This paper describes the design of the vocabulary, presents experimental results from an initial evaluation, and outlines plans for further research.
2. BACKGROUND

Designing technological tools to assist people with aphasia is particularly challenging due to the variability of resulting impairments. Thus, some researchers have advocated addressing the heterogeneous needs of the user population by providing flexible and customizable solutions [5, 16]. There has been consistent effort in designing adaptive assistive tools for people with cognitive impairments, but none have proven to be usable by aphasic individuals. Such tools mainly include scheduling and prompting systems that aim to reduce the burden of caregivers (e.g., [8] and [13]). There have been relatively few systems for non-therapeutic purposes for less severely affected individuals, such as systems that support daily activities like cooking, photo management and social interactions [2, 6, 14].

In an attempt to fill some of this void, Boyd-Graber et al. developed a hybrid communication system where a desktop computer is used for compositional tasks such as appointment scheduling and a personal digital assistant is used as a portable extension to assist communication outside of the home [5]. The interface combines images, text and speech audio and provides some support for customization. The findings from the system’s evaluation confirmed the need for better customization capabilities and revealed that limitations specific to vocabulary breadth and depth, and word retrieval are a fundamental problem. Although initial vocabulary sets can be formed from words frequently needed by the target population, no packaged system has the depth or breadth to meet the requirements of every individual. Furthermore, most existing assistive communication vocabularies have a lexical organization scheme based on a simple list of words. Some word collections are organized in hierarchies which often leads to deep and confusing searches; others are simply a list of arbitrary categories which causes excessive scrolling and a sense of disorganization. To address these issues, it is important to build a well-structured computerized vocabulary that can be easily maintained and enhanced, and that offers improved navigation and word retrieval.

3. DESIGNING ViVA

We have designed a visual vocabulary for aphasia (ViVA) that is both adaptable, able to be customized by the user, and adaptive, able to dynamically change to better suit the user’s past actions and future needs. This mixed-initiative approach enables the user to feel in control by making changes and anticipating ones that have been initiated by the tool while still allowing adaptive methods to help determine where and when changes are required. The vocabulary’s adaptable component allows the user to add and remove vocabulary items, group them in personalized categories, enhance words with images and sounds, and associate existing phrases with a concept. The adaptive component updates the vocabulary organization based on vocabulary usage statistics, user preferences and a number of semantic association measures (see Fig. 1). For example, if the user wishes to compose the phrase “I need an appointment with my doctor” and she searches for doctor first, the words medication and appointment may surface (see Fig. 1), because they have been linked to doctor due to past usage, while hospital and doctor could be linked due to prediction based on known semantic measures. In addition, the user may be able to find the phrase “Need appointment with my doctor” right away if it has been composed in the past. Thus, the vocabulary tailors the word organization according to both user-specific information and general knowledge of human semantic memory.
People with aphasia, especially those impaired by anomic aphasia, experience persistent difficulties accessing and retrieving words that express intended concepts. To help these users find the words they need, we appeal to the psychological literature on speakers' "mental lexicon", where words are stored and organized in ways that allow efficient access and retrieval. Currently, ViVA compensates for some of the missing semantic connections in a user’s mental lexicon by incorporating links between words based on evocation. Evocation is a word association measure that indicates how much one concept brings to mind another one. It is particularly valuable for vocabulary navigation because it encodes cross-part-of-speech associations which most existing assistive vocabularies lack. We compiled our own dataset of evocation through an online experiment posted on Amazon Mechanical Turk (AMT) [3]. Using machine learning techniques, the structure of WordNet (a large-scale lexical database) [10], and an initial collection of evocation ratings [4], we generated a list of word pairs with predicted high evocation ratings. These pairs were then rated for evocation by AMT workers. During a period of three months, we collected ratings for 107,550 word pairs. The ratings from untrained online annotators correlated well (0.60) with those collected by Boyd-Graber et al. [4] from trained annotators.

![Diagram of components of proposed vocabulary](image)

**Figure 1. Schematic of components of proposed vocabulary.**

4. **INITIAL EVALUATION**

As a first step to evaluating ViVA, we assessed how it adapts to a user’s profile by using simulated usage data in the form of sentences gathered from blogs of elderly people from the Ageless Project [1]. We investigated how ViVA performs in connecting words to construct a sentence compared to the vocabulary hierarchy of Lingraphica [9], a popular assistive device for people with aphasia. We first trained ViVA with simulated usage data extracted from one blogger’s profile. We then examined how it constructs new sentences from that same profile.
The links in ViVA’s vocabulary network which reflected evocation and simulated usage shortened the browsing paths between approximately 44% of the words that appeared next to each other in a sentence from the usage sets (the rest of the paths were the same length as in Lingraphica). Using logistic regression, we predicted additional links between words which improved the results by extra 7.6% on average. On average, 22% of the paths became shorter by two or more steps due to ViVA’s vocabulary organization. A naïve baseline test showed that our improvement in shortening the distances between related words cannot be achieved simply with a random increase in the density of the vocabulary network [11].

We also ran a pilot study with able users in which participants were asked to find the missing words in a number of phrases using one of two vocabulary conditions – VIVA and Lingraphica. The results revealed that it took significantly longer to find the missing words in ViVA than in Lingraphica. Significantly more words were skipped with Lingraphica. Finally, significantly fewer clicks were required to connect words in ViVA than in Lingraphica and users agreed that navigating the vocabulary through related words helps them find the target word faster [12].

5. FUTURE WORK

The preliminary evaluation of ViVA’s prototype shows the potential of our alternative vocabulary organization to adapt and suggest useful words based on semantic measures and usage statistics. Next, we plan to investigate how people with aphasia respond to the proposed adaptive vocabulary. We will run evaluation studies with aphasic participants which will compare sentence construction using ViVA’s vocabulary organization and the hierarchical vocabulary organization found in Lingraphica [9]. Previous research suggests that adaptive approaches are likely to benefit users with impairments even more than able users. This is due to evidence that user acceptance of adaptive interfaces is partially dependent on how much time and effort the user could save by using adaptation [7]. Thus, we will be looking to answer questions such as what the effect of adaption on user’s cognitive load is, what the tradeoff between improved navigation and changing vocabulary structure is, and whether ViVA facilitates or impedes vocabulary exploration and learning.

6. CONCLUSION

We presented the design of the visual vocabulary for aphasia (ViVA) which addresses vocabulary organization and navigation problems prevalent in existing assistive communication tools. ViVA implements adaptable techniques in order to allow the user to customize the tool and adaptive techniques to be able to tailor the vocabulary organization to better fit usage patterns and user needs. To assist people with aphasia in finding words efficiently, we exploit theories of human semantic memory and create a dynamic semantic network reflecting known word association measures and human judgment of semantic similarity. Results from an initial evaluation of the adaptive capabilities of ViVA demonstrate the potential of the proposed approach to vocabulary organization which we plan to investigate further involving users with aphasia.

7. ACKNOWLEDGMENTS

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8. REFERENCES


The ASSETS conference explores the use of computing and information technologies to help persons with disabilities and older adults. ASSETS is the premier forum for presenting innovative research on the design and use of both mainstream and specialized assistive technologies. This includes the use of technology by and in support of:

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