Enhanced Protocols for Non-Visual Navigation of Smartphone Applications Screen Icons

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Abstract– *In this paper, loopholes of the existing protocols for navigating smart phone applications screen icons and requirements for the design and development of enhanced ones are identified. Enhanced protocols for non-visual smart phone applications screen icons navigation were developed. In the ongoing work, we are developing a Smartphone application using android Operating system that imbeds the developed protocols. After developing the application, we propose to deploy the developed smartphone application and navigate a given smartphones application screen icons and test the efficiency of the developed protocols.*

Keywords: *Visual impairment, Navigation protocols, smartphone, screen icons, enhanced protocols*

1 INTRODUCTION

The primary goal of this research was to develop enhanced protocols for non-Visual navigation of smart phone applications screen icons. This study was focused on developing enhanced protocols that consider how smart phone application services can be accessed by people with full vision as well as those with visual impairment. This research was also intended to identify the strengths, weaknesses, opportunities and threats (SWOT) that smart phone applications/services offer to visually impaired users.
In this research, Navigation is a field of study that focuses on the process of traversing from one part of an application to another forth or backwards. Smart phone is a cellular phone that performs many of the functions of a computer, typically having a touch screen interface, Internet access, and an operating system capable of running downloaded applications.

Visual impairment blindness is defined as the collective term - visual loss, which refers to either a loss of ability to see or vision reduction. The term low vision, partially sighted, or visual impairment, can be used for a person who has not lost the capacity to see, but whose vision is significantly reduced compared to normal vision. Sight impaired which is usually defined as having poor visual acuity (3/60 to 6/60) means that a normal person sees an object at a distance of 60m while a visually impaired one sees it in a distance between 3m to 6m but having a full field of vision, or having a combination of slightly reduced visual acuity (up to 6/24) and a reduced field of vision or having blurriness or cloudiness in the central vision. Severely sight impaired (blindness) is where a person is so blind that he/she cannot do any work for which eye sight is essential.

According to the study in [1], around 314 million people are visually impaired, of which approximately 45 million are visually impaired. Of the total number, 12 million are children, 82 percent are of age 50 or older. Developing countries (Uganda inclusive) have the largest representation of visually impaired people, with around 87 percent representation. Visually impaired people have a harder time finding their way around unfamiliar mobile menus, which in effect denies them the ability to explore mobile phone technologies.

Smartphones are considered to be marvelous potent tools for visually impaired people [2], [3] once designed and installed with applications that specifically favour the capability of these people. Mobile smart phones are installed with protocols which provide navigational assistance in such situations, obviating the need of visually impaired people.

However, visually impaired users still face challenges when operating their mobile smart phones. Current smartphones are fairly powerful computational devices, yet they are still designed without very appropriate features and tools for everyone, on a large extent they are impossible to use for visually impaired and elderly persons. Partially sighted users, for example, may complain about the size of the letters on the relatively small phone screens, while visually impaired users have difficulties finding items easily on touch screen phones [3].

This research intended to explore mobile accessibility system that addresses essential and practical needs of visually impaired users of mobile smart phones by designing and developing enhanced protocols for non-visual navigation of smartphone applications screen icons which enable atouch based human interface discoverable (easy to explore and to figure out how to perform desired tasks), each command icon assigned a single tap to announce its action, and a double tap to activate it. This enables participants to drag their finger around the screen until they land on an item of their choice. Then a double tap performs the intended action. Such a system aims at preventing accidental activations while making it intuitive and completely accessible.

2 *Related Work*

Visual impairment has a significant impact on the quality of life of the individual, the family, the community and the nation at large [4]. Advances in information technology (IT), and in particular mobile technology, are increasing the scope for IT-based assistive technologies to support a better quality of life for individuals with disabilities, including visual impairment. Assistive technology has the potential to enhance visually impaired individual ability to participate fully in societal activities and to live independently. Modern mobile assistive technologies are more discrete than traditional technologies and include (or are delivered via) a wide range of mobile computerized devices like mobile phones [5]. These assistive technologies include any product, instrument, equipment or technical system designed for or used by a person with disabilities, which prevents, compensates, supervise, alleviates or neutralize the effects of the disability.

One of the options available for the persons who are visually impaired in Uganda is using off-shelf phones that have speech output features incorporated directly into their system. Using a third party software is the other option available for people with visual impairment. Third party software can provide voice and/or Braille output to allow accessibility for most of phone features. However, phones with this software are more expensive and have compatibility restrictions to mobile networks. In Uganda, a third world country, many people with visual impairment still live under the poverty line, hence unable to purchase phones with sophisticated software to enable them access all phone functionalities. Therefore, there is a need to develop a mobile compatible application that can be used on low cost smart phones on the Ugandan network to access all phone features.

The findings of the study resulted into establishment of personalized navigation tools for different categories of visually impairment. Ultimately, the researcher developed a mobile phone application to enable visually impaired persons engage all smart phone features, hence eliminating social and economic inequities that cause widespread unemployment among them.

3 RESEARCH METHODOLOGY

Design research was used as the research method for the development of these protocols. We used prototyping approach with module based development. Then developed modules were put together to form test systems, effective prototypes on which various aspects testing functionality was tried out. Working components were maintained and improved upon, while non-functioning components were disabled and others ultimately dropped.

Basically a hybrid approach involving the use of module based development and prototyping led to the development of a shadow system which was later translated into the final working mobile phone application for non-visual navigation of smart phone application icons. At the heart of the entire process were coding with multiple alternative implementations of the procedures embodying the process and protocols developed for the research.

The image below describes the whole approach that was taken and to some degree, illustrating how the final system was developed.

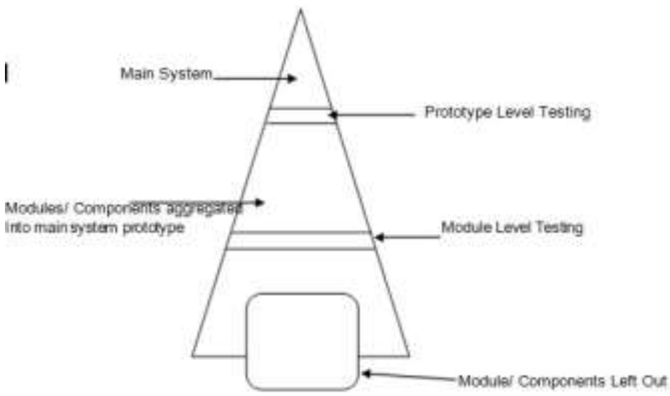

Figure 1: Approach used

Module based testing was done to ensure each component performed according to plan before integration into the shadow system (main prototype). This was done in order to quickly identify problems in a more isolated way and have them handled. Modules that passed module level testing were then transferred into a shadow system forming a visible skeleton of the final system and tested for unified operation.

4 FINDINGS AND DISCUSSIONS

One of the most common problems that visually impaired people experience is their day to-day coping with their impairment. With the advancement of technology, Android smartphones are equipped with specific applications that aid visually impaired in their daily functioning. Having the names of the application icons stored in an array format prays a big role in reducing swiping challenges.

The Structural design of these smartphones have many components which include input handler and Vision handler, the functions of these handlers keep changing depending on whether the device is running on server or client mode. The input handler captures both touch and sensor events respectively.

4.1 *Design Requirements*

The requirements for the system was elicited by conducting an analysis on reading problems and wanted functionality that would hinder a person to navigate content. This functionality, called Text to Speech already exists in smartphones and we intend to investigate the usability of the Text to Speech functionality by testing out the Android phone running android operating system version 4.0 and above.

The major problem with smartphones is the accessibility of the Text to Speech function; It's not easy for a visually impaired user to turn on this feature since it is placed inaccessibly under the Settings and Accessibility menus. Hence, an important design requirement is to make the existing smartphone features more accessible by letting users easily locate, turn on and turn off the features.

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A set of general requirements was developed to assist in coming up with enhanced Protocols for the smartphones to be used by visually impaired people 1. Keep everything simple with large text sizes and spaced buttons, 2. Choose simple layouts like linear layouts or relative layouts and avoid scroll layouts as the visually impaired find it difficult to control scroll speed,

3. Keep texts large and fonts simple. Texts and backgrounds should use contrasting colours like black and white respectively,

4. Eliminate toggle buttons and make use of two buttons for options like YES and NO with a minimal spacing of an average index finger between them. Toggle buttons are confusing and difficult to use for people with vision impairments. Keeping the width of the YES and NO buttons and the spacing between them slightly larger will make it easier to use,

5. Having the texts and button descriptions bold will ease the reading process. Moreover, having clear alert dialogs are important whenever necessary especially when toggling on or off features and services.

6. Design two different layouts one for portrait mode and one for landscape mode to avoid display issues when the user switches orientation from landscape to portrait and vice versa.

7. Use bright notification icons for users with vision impairment.

8. Embedding the icons names into a forward and backward arrow with a middle but forselection (ok).

5 *The Enhanced Protocols*

The enhanced protocols were designed with the following features to overcome the loopholes in navigation of smartphone applications screen icons by visually impaired users: 1. Having the names of the application icons stored in an array format so as to reduce on the swiping.

2. Having the Forward and Backward navigation arrows to aide navigation from one screen to another so as to counter the fast speeds exist during swiping.

3. Having the upward and downward navigation arrows to act as a shortcut for the user to easily access the notification panel and opens the texts of interest.

4. Having the biggest button in the middle of screen for fingerprint recognition to ensure effective securing of information within the smart phone through authentication and authorization access.

5. Accepting and rejecting icons displayed separately on the screen i.e. the accepting icon on the right side and the rejecting icon on the left hand side, requiring the user to only tap and hold on each icon to perform the intended activity.

6. Notification application designed in such way that for incoming messages of different categories possess different sound notifications by announcing their categories. I.e. Email, social media, texts messages announce themselves differently. This assists non-visual users to automatically tell the message category received.

7. Smartphones designed in such way that as the users consume the battery to a certain point of getting notifications about the low capacity, the remaining percentage displays as well as announces itself on the screen to keep the user certain about the remaining time of phone usage, hence avoiding abrupt blackouts.

8. Application icons displayed on the screen in their alphabetical orders to reduce on navigational time consuming by non-visual users while turning different screen pages in search for certain icons of intended purposes.

9. Enhanced system designed with audio communication of a specific object by one tap action. This enables users most especially visually impaired to quickly understand/tell the real item that is being dealt with. E.g. as the user scrolls along the list of specific item he/she finds it easy to select the item of interest.

10. The smartphone designed in such a way that as the user i.e. visually impaired types a message, each letter/figure that is touched on, keeps announcing itself to enable the user easily understand the name of the letter/figure and then generates the text of interest.

6 CONCLUSION

The developed enhanced protocols for non-visual navigation of smartphone applications screen icons are very necessary as they favour the functional capability of non-visual users. In our next phase of research, we propose to develop a smartphone application using android Operating system that imbeds the developed protocols and then deploy the developed smartphone application and navigate a given smartphones application screen icons and test the efficiency of the developed protocols. With current level of our research, it is more promising that the developed enhanced protocols will pray a big role in easing the lives ofnon-visual smartphone users and enable them to perform to the level of sighted people.

Comparison of existing smart phone protocols on both visually impaired and sighted users

Existing protocols	Visually impaired Person	Vision Person
screen layout	Current smart phones are designed with smooth platform screens. This becomes complicated in identifying icons when it comes to non-visual user hence minimizing the effectiveness of communication	Reduces the time taken to perform certain actions whether calling, saving or searching for any application/ number on the smart phone.
Speed	Smartphone applications are designed with high level of sensitivity in that they require quick navigation of icons which doesn`t favour non-visual persons who require working at slow pace	A person with vision finds it very easy to coup up with smart phone sensitivity since whatever step is taken as well as icon displayed on the screen, are seen at the same time.
Swiping	When it comes to receiving/ rejecting calls, or performing any action that require swiping, more confusion arise to visually impaired users as they find it hard to identify the required direction to perform the necessary action.	cheap and easier since doesn`t involve button typing method
Text Noti-Fication	The sounds of different texts received on smart phones sound almost the same and without sight to see and ability to read and differentiate them, cause confusion to the recipient i.e. email messages, social media, text messages, etc. sound the same when arrive on phone.	The system with smart phones works it very well for sighted users since different messages are displayed with different icon symbols and therefore becomes easy for users to tell the type of message received even before opening it.
Arrow Di-Rection	In case of incoming calls, accepting icon (green) and rejecting icon (red) are designed in such a way that their arrows point in opposite directions requiring the user to swipe in the same directions for any of the arrows to perform the action of interest. This is definitely a challenge for visual impaired users to identify and maintain the specific directions.	Identifying and moving in the same line of specific arrow direction during incoming calls i.e. accepting or rejecting a call is very possible for sighted users as they are able to see and understand the necessary action to take.

Icon Ar-rangement	For different smart phones, different icons are just displayed randomly without being arranged in their alphabetical orders.This cost much time to allocate a specific icon most especially when it comes to a non-visual user who has to rotate in search for certain icon for a certain activity.	With or without alphabetical arrangement of icons on the screen, sighted users find no challenge in allocating what they want, since it is just a matter of seeing the icon and placing on it to perform the needed function.
Input Han-Dling	Addition of data i.e. music, contacts, airtime loading, new applications, games among others, to smart phones is very complicated to visually impaired users since identifying an item/ number basically requires someone to visualize, upload and save them.	Generally data addition to smartphones is even more simplified and quickened when a user is able to see, read and type.

Table 1: showing properties of existing protocols for visually impaired

Comparison of existing smart phone protocols on both visually impaired and sighted users

Privacy	The system that favours visually impaired users is always guided by audio, therefore whatever is being typed, read, uploaded is heard by everyone within the vicinity, hence no privacy in usage.	Privacy is very effective for sighted users as audio application is not necessary. A user types, reads, uploads every information without attracting anyone's attention.
Information Retrieval	Retrieving/ deleting the uploaded information within the smart phone still bears complications as users without sight, find it hard to tell or identify the real information of their interests e.g. identifying a certain music track from music album confuses them.	Since it only requires opening, scrolling, reading and then activating/ de-activating the item of interest, life remains softer to sighted smartphone user when it comes to retrieving the information.
Security	The only favourable way for non-visual smartphone users to secure information within their phones, is application of face/ voice recognition methods to open phones screens.However the methods are still ineffective since the screen can still open in case the user has other people that resemble him/her	Sighted users have variety of security methods that favour their usage of smart phones which are very effective like pattern, password, among others to lock and unlock their phone screens or applications.
Battery	With smart phones, as battery become low to about 20 percentages, within the course of the phone functioning, the alerting alarms start notifying the user. However understand the remaining percentage is not possible for non-visual users as the alarming sound doesn`t change for different stages of battery usage.	Battery usage warnings go hand in hand with display of remaining percentage in form of figures. Thus the sighted user gets helped to be reminded about connecting the phone to the charger as well as knowing the remaining amount of phone battery. This protects users from abrupt phone blackouts.

Table 2: showing properties of existing protocols for visually impaired

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