*FUDMA Journal of Sciences (FJS)*
*Maiden Edition*
*Vol. 1 No. 1, November, 2017, pp 128-138*

# DESIGN OF A PROTOTYPE MOBILE PHONE FOR VISUAL IMPAIRED PEOPLE

**[1]Usman U., [2]Abdulwahab, L.**
*[*1] Department of Computer Science,*
*Faculty of Computer Science and Information Technology,*
*Bayero University, Kano, Nigeria.*
*[2] Department of Information Technology,*
*Faculty of Computer Science and Information Technology,*
*Bayero University, Kano, Nigeria.*
*Email of corresponding author: *abd_wahhb@yahoo.com*

***Abstract***
Available mobile phone devices in the market have failed to be easily accessible by people with visual challenge; efforts made to create special and accessible mobile phones for this class of people have not yielded much advantage especially to those of them that have no form of western education or could not understand communications in English language. Through interview and previous publications the research investigated the level of mobile phone usage among Hausa-speaking people with visual disabilities. Findings revealed low level of access to mobile phone for communications, and reasons ranging from complexity of usage to costly nature of specially made phones for their class; hence creating a digital divide to access and use of mobile phones among them. To alleviate the challenges for visual impaired, the researcher proposed a mobile phone prototype program, to pave way for bridging the digital divide between people that are visually challenged and those that are not. The prototype has been developed to speak to its users in guiding them during usage and the spoken words are customised in Hausa and Pidgin English languages which are believed to be among popular languages spoken in the West African countries and by the target population, especially those that do not have access to western form of education. The design was implemented using Microsoft Visual Studio 2010 in conjunction with Microsoft Access 2010. The developed system has undergone series of tests and appeared to be a stepping stone for bridging digital divide among this group of people with special needs.

***Keywords:*** *Visual Impairment, Mobile Phone, Hausa, Pidgin-English, Prototype, Digital divide.*

## Introduction

Mobile telecommunication service popularly referred to as Global System for Mobile Communication (GSM) operation started in Nigeria in February 2001, a good number of Nigerians have been enjoying the services being provided by the telecom service providers in the country (Baez, Kechiche, & Boguszewska, 2010). Basharu (2009) reported that at the inception of mobile telecommunication in Nigeria, it was possible for the visually challenged people to access their account balance information and other vital information through audio sound in some of the networks like Zain (now Airtel) network through dialling 147. Today, all those services have elapsed, indirectly denying people with visual challenge the previledge to communicate with their mobile phones. The most challenging aspect of mobile phone services and usage in Nigeria today, is some group of Nigerians living with disabilities are almost completely left out. This group of people include those that tend to have problems, e.g.; visually impaired and blind people and those with mental retardation etc. (Lenegnen & Kayode, 2014). Accessibility to the information and communication technology (ICT) world is a necessity for every one today, whether able bodied or people with disability. In fact, persons with disabilities stand to benefit more from access to ICT than most people without such disabilities, because ICT presents the person with disability one great opportunity, i.e., independence (Basharu, 2009; Balarabe et al., 2014).

Mobile phone usage has advanced from the time when Nigerians can only use their phones to make calls and send Short Messages (SMS) to the present day that smart mobile phones are used for virtually all forms of daily activities ranging from using phones to surf the internet, check Bank account balances-transaction, watch live television programmes etc. (Omowale Adelabu, Sanusi, & Esiri, 2015)

Although in advanced countries efforts were made by experts to create technological tools including mobile phones to help the visually challenged people; making information access easier for them (Lucky & Achebe, 2013). These tools include phones with screen readers, navigational tools to guide them through their footpaths, braille keybords etc. A good number of them are now available in Nigeria and are being used by some few opportuned visually challenged citizens; the major problem lies in the fact that most assistive technology products required advanced knowledge to operate which is lacking in the case of millions of disadvantage visually challenged citizens; another difficulty is that most of these assistive technology equipmemts are programmed to read the screen contents in English and other foreign languages which are alien to many Nigerians in this group. Many people with special need in Nigeria lack access to quality education. Lenegnen and Kayode (2014), stated that "Special education is costly to the extent that many of the parents cannot afford the school fees".

In the past, an attempt was made by Nokia phone Production Company in producing some set of cheap phones that has the three Nigerian major languages Hausa, Igbo and Yoruba as language options, choosing any of these language, the phone has the capability to speak out the time of the day in these respective languages (Proshare, 2006). These phones were not customized in an easy way enough to be used by the blind people who understand those languages, as the procedures of operating them were not simple, rather they were the same as every other phones used by the people who are not blind or visually challenged.

In a way to alleviate these problems and provide an opportunity to the Nigerian visually challenged to use of mobile phone that can be easily operated, this paper is intended to demonstrate (using a prototype) how a mobile phone customized to speak in two among most popular Nigerian languages of Hausa and Pidgin English. The mobile phone shall be designed with as little as possible number of buttons that shall allow even illiterate blind Nigerian who can understand these two (2) Languages to at-least make calls and also identify those that call their numbers through spoken words in these two languages. Usage of mobile phones by this group shall provide them with the ability to live an independent life, which is essential in attaining digital inclusion for people with special needs (Basharu, 2009; Balogun, 2013).

## Related works

Previous literatures related to this field of study exist both in prints and online today; all published in efforts to bridge the digital divide that exists between visually challenged people and their able bodied counterparts. While some researchers like Ghiani, Leporini and Paterno, (2008); Yatani and Truong (2009); Valente , Souza, and Feijo (2009) centred their work on creating supportive tools (usually tagged "Assistive devices"), some geared their efforts towards creating additive devices to be incorporated on existing devices and others concentrated their efforts on improving the services provided by the existing devices (through hardware design improvements of software production) to provide room for the disabled people to be carried along on the usage of these communication devices. Irie, Matsunaga, and Nagano (2005) described the steps taken to achieve universal design in the development of user-friendly and highly accessible, mobile phones called "Raku Raku Phone" with simple user-friendly interface and makes full use of speech synthesis and voice recognition technologies. The drawback was that the phone was customised in Chinese Language. (Irie, Matsunaga, & Nagano, 2005)

Ghiani, Leporini, and Paterno (2008) designed and developed an add on hardware with supporting software that can easily plugged on Personal Digital Assistants (PDAs) to assist in guiding blind people around their environment detecting available objects via RFID tags and a Reader plugged into the PDA (McGookin, Brewster, & Jiang, 2008)

Gelmuda and Kos (2012) present a vibrating bracelet using several vibrating motors and a vibrating signal modulation, with multipoint communication interface to ensure mobile safety system for blind people. The bracelet was designed to be carried on a wrist. Gollner, Bieling and Joost (2012) designed Mobile Lorm Glove; a mobile communication and translation device for the deaf-blind to enhance their independence. Priya, Indumathi, Kalaimagal, Suriya and Vasuki (2015) designed an SMS system (a modular device which is accessible by blind people) through interfacing of cell phone with Braille pad allowing dual impaired persons to have access to SMS system.

Although, hardware component of mobile phones studied are mostly design to fit into the palm of the users. It is in most cases produced with plastic casing comprising of buttons numbering about 12, most times with screen, a speaker and other features such as led light, cameras etc. interaction with this kind of devices usually requires visualization which further widens the gap of the digital divide between the blind people (Guerreiro, *et al,* 2009).

Previous literatures have suggested that there is digital divide in the area of mobile telecommunication tools available for use by some group of people with special needs. But, those devices produced are mainly developed with audio sounds in languages alien to those spoken by this group in Nigeria and other Sub Saharan countries especially, majority of whom are not opportune to undergo western education. This research is intended to fill this gap.

## Methodology

A prototype program was designed to bring mobile telecommunication service to accessible level for people with special needs especially the visually challenged Nigerians and implemented using a suitable design techniques and programming language.

## Data Collection

The primary source of data collection was used in the research work. The study used a group sample of blind people who are the potential target to benefit from the proposed mobile phone when developed. A group of three blind people were interviewed separately but, with the same type of questionnaire; the questions were read to them while their responses were written down at spaces provided.

To understand the level of knowledge and familiarity with the use of technological tools by the visually challenged three (3) research questions were developed and implemented.

***R1: Have you ever use a mobile phone by yourself?***

This question was to discover if the target users of the proposed mobile phone have ever make use of mobile phone before now. The responses to this question shall provide the fact about that shall help the designer to determine if proposed mobile phone can have any impact on the target users.

***R2: What other telecommunication devices have you use?***

This question is targeted at understanding the level of knowledge and usage of technological devices. Responses to this can provide a clue on likely features of technological devices already known to the target users, hence incorporate similar ones in the proposed mobile phone to ensure ease of usage and fast adaptation with the proposed mobile phone device.

***R3: If a mobile phone is to be provided to you how would you want it to be?***

This question was established to understanding the flavours and certain features the target users may likely want to have in a mobile phone (Pattison & Stedmon, 2006). Responses to this can provide a clue on likely features and flavours to incorporate into the proposed mobile phone, hence ensuring the effectiveness of the proposed mobile phone device to the target users. The summary of the responses is tabulated in table 1

**Table 1: Questions and Responses**

| No. | Question | Respondent 1 (18 years) | Respondent 2 (34 years) | Respondent 3 (64 Years) |
|---|---|---|---|---|
| 1 | Have you ever use a mobile phone by yourself | Yes, I can even dial numbers while listening to the keypad tunes | Yes But Only receive calls | No |
| 2 | What other telecommunication devices have you use? | Radio Set | Radio set | Radio Set |
| 3 | If a mobile phone is to be provided to you how would you want it to be? | Guiding me in my language, providing me the opportunity to have conversation with my people | To be easily operated like the radio set I am used to | Similar to other people's phone but should be guiding me on how to operate in my language |

From the responses of the visually challenged people interviewed the study discovered that the eldest do not have the opportunity of knowing how a mobile phone is. Also, the youngest one when given a mobile phone, can through the keypad tone dial numbers, but cannot locate names in the phonebook.

The Table 1. lso shows that all the respondents can slowly operate Radio sets conveniently without any need for assistance, this they do by listening to the sound that come out of the radio set while they tune the radio from one station to the other. In fact, respondents 2 and 3 were tested with their radio set to tune to Federal Radio Kaduna Hausa service individually and they did less than two minutes.

## Design

The research classified the design into two main components of a mobile phone, namely:

1. The Hardware component which describes the structure features that are external to the hardware of the proposed mobile phone, including controls and their positions on the phone, the screen size, the phone structure size in terms of width and height and also the lighting system of the proposed mobile phone.

2. The software component which includes the operating system provides a consistent and interactive interface for applications installed on the mobile phone as well as its users (Jindal & Jain, 2012) and other application software that allowed users to carry out one task or the other with the mobile phone. These tasks enable user to make and receive calls, and also search for already saved number in order to make call.

## Hardware Architectural Design

Considering the fact that in designing a hardware device for the visually challenged, the designer needs to focus on presenting the end user with a product that focused on overcoming their main disability. Hence, the research consider tactile sensitive component in the design.

In line with this, a good set of factors were considered in the effort to produce a mobile phone that is adaptable and can be easily used by these group of people whom the nature has in one way or the other limit their ability to act or interact in an equal manner as their fellow human beings without such disabilities.

Also, from the table the research discovered that some visually impaired people despite their level of illiteracy in western education, they can easily operate the common world receiver analogue Radio; hence, in this design the researchers incorporate the feature of analogue Radio Turning as a navigation medium to ease and simplify operation.

**The hardware of the proposed mobile phone was designed as illustrated by the Figure1:**

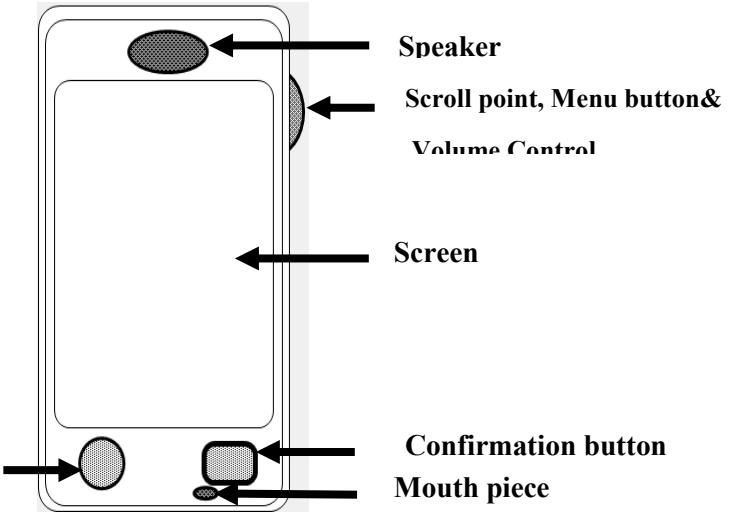


*Figure1: Proposed Mobile phone Structure*

**Features of the Propose Mobile Phone include:**

**Speaker:** It is a relatively loud audio output point through which operational instructions and calls conversations can heard by the phone operator.

**Scroll Point/Menu Button:** It is a round tuning point coupled with some tactile feel, similar to that obtainable in mouse scroll. It is also designed to have a button press capability to be used in accessing menu functions of the mobile phone. It is designed to be a multi-purpose and context sensitive navigational tool that allowed the mobile phone operator to explore the functions of the mobile phone as well as browsing through stored phone contacts in the phonebook.

**Screen:** Is a display unit for phone numbers and possibly Names of saved contacts. It is designed to have a black background colour to contrast the white text display function; this ensure that text displays are relatively clear for visually impaired users.

**Confirmation Button:** A square shaped rubber button with finger press tactile sensitivity; it is designed to be used to confirm a menu function or dialled calls to a particular receiver. Use to confirm a menu item selection after an audio announcement for the selection of the item.

**Mouth Piece:** The mouth piece (just as available in all phones) is the audio entry point for phone conversation.

**Selection Button:** A round shape rubber button also with finger press tactile sensitivity; to be used for selection of the current item on the screen. These may include a menu item, a contact name in the phonebook or a recent call contact name or phone number on the screen.

During the design the researchers paid kin attention to tactile sensitivity and differences in buttons shapes to provide an easier means for the phone user to be able to differentiate between buttons on the phone. Also, the mobile phone was designed with as little number of controls as possible for easier operation.

**Software Design**

The Software design encompasses the structure and interactions among different software modules that made up the operational software system for the proposed mobile phone. It has been depicted using diagrammatical tools in Figure 2.

**Interface Design**

Interface is a medium of interaction between the system user and the system. The interfaces for the prototype system are designed to be on screen display of the proposed mobile phone, showing the buttons, scrolling point and the display screen. User interaction with the program is designed to be done via the two mouse buttons and the scroll button.

The phone has a blank “Home Screen” display; through which all other functions can be accessed and used.

**The "Home Screen is shown in the diagrams in Figures 3 (A-D):**

**A** **B** **C** **D**

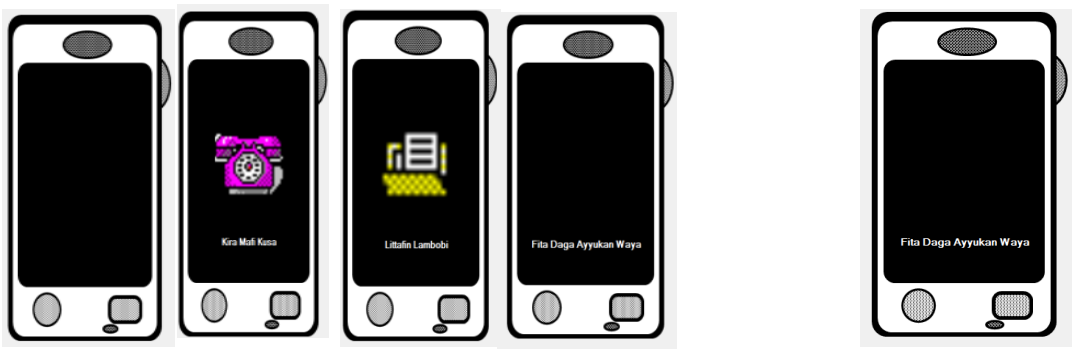


*Figure 2. Main Menus Screen Displays*

**Diagram A:** Home Screen Display

**Diagram B:** Recent Calls Menu Screen Display

**Diagram C:** PhoneBook Menu Screen Display

**Diagram D:** Exit Menu Screen Display

The menu is also designed with three main functions. The displays for each menu functions are depicted in the diagrams B, C and D above. When the Phone Book Function is accessed the mobile phone takes the user in another screen display, showing the names and corresponding phone numbers of saved contacts. The screen is designed also with dark backgroud and white text colour display, showing only one contact record at a time, this is to ensure clear view of the displayed items for convinience of visually impaired users.


*Figure 3. Phone contact Screen Display*

A **data structure** is a particular way of organizing data in a computer so that it can be used efficiently. It refers to as collection of data items whose organization is characterized by accessing process which can be used to store or retrieve individual element. The data structure for this application created to store phonebook record as well as the recent calls records each with fields (ID, Name and Phone Number).

**Implementation**

The Designed prototype was implanted using Visual Basic 2010programming language; The input design of the software is via the left, right and the scroll buttons mouse. Through these buttons the user can make selections, and navigate the menu items and using the mouse scroll button. The user is expected to listen to the voice announcements of options for an intending action/function which the user wants to perform with the prototyped phone system.

Also, the output from prototype phone software is on displayed screen and computer system speakers where the audio announcements and guide are spoken out to the hearing of the operator in two chosen languages (Hausa and pidgin English).

The screen display shall be immediately followed by an audio sound communicating and guiding the user on how to start using the phone. The mobile phone action functions for the circle shaped (left hand side button) is coded into the left mouse button click event, the action functions of the square shaped (right hand side button) was coded into the right button click event, while the expected functions of the scroll point click/scroll are built into the mouse scroll button click/scroll actions respectively.

The user shall be guided via audio sound to click the scroll button to start using the phone, and on doing this, shall be prompted with another audio sound for confirmation of same by pressing the scroll point again. When the confirmation is done, the user shall be presented with the screen below,

followed by audio announcement for entering the menu and also the announcement of the first menu item (Recent Calls) as shown in the diagram above.

Additionally audio sound guides options on selection, direct entry to recent calls list and scrolling to other menu items shall be sound out to the user's hearing. This option guide through audio is the same for all menu items. On selection of a menu item by pressing the left mouse, the user shall hear audio sound prompt to press the right hand side button for selection confirmation. And when this is done the menu item's action is carried out, that is, in the case of first menu item selection, a list of recent calls is displayed and read out in audio sound (one name or phone number at a time) with the most recent first and others (if they exist) shall be displayed and read out too when the user use the scroll point to reveal them as shown below.

***The mobile phone Keypad*** has been designed at the back of to be pulled out when phone numbers need to be keyed into the mobile phone; when pulled, the action is spoken out and any pressed button is also announced via an audio. The key pad display is shown in the Figure 4.


*Figure 4: Recent Calls List Screen Display*

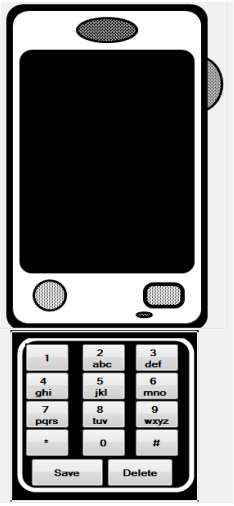


*Figure 5. Keypad Open Screen Display*

The keypad is designed to work the same way as the normal phones, it is designed to be used by people who are not visually challenged to key inn phone numbers and possibly saved them to phonebook. The keypad can be used by simply clicking on the key with the required number and when this is done the pressed key number is spoken out in audio. The delete/Share key can be used to delete the last key entry displayed on the phone's screen, while the Save / *Boye Lamba* key can be used to save entered phone number to the phonebook.

***Software System Algorithm***
***Algorithm for Home Screen to Menu Access***

*Start*

Display Home Screen

Allow Menu activation

If menu activation button pressed then

Announce menu entry selection

Prompt for selection Confirmation

If confirmation button press then

Enter Main Menu Module

End if

End if

Stop

**Algorithm for Main Menu**

Start

Announce Main Menu Entry

Display and Announce First Menu item

Audio Speak Selection option

Audio speak guide to navigate to other menu items

If selection button pressed then

Goto ***First Menu item (Recent Calls)***

Else if Scroll down then

Goto ***Second Menu item (Phonebook)***

Else if Scroll up then

Goto ***Third Menu item (Menu Exit)***

End if

***First Menu item (Recent Calls):***

Announce first menu item selection

Audio speak option for selection confirmation

Audio speak option to navigate to other menu items

If confirmation button pressed then

***Recent Calls Module***

Else if Scroll up then

Goto ***Third Menu item (Menu Exit)***

Else if Scroll down then

Goto ***Second Menu item (Phonebook)***

End if

***Second Menu item (Phonebook):***

Announce Second menu item selection

Audio speak option for selection confirmation

Audio speak option to navigate to other menu items

If confirmation button pressed then

***Phone Book Module***

Else if Scroll up then

Goto ***First Menu item (Recent Calls)***

Else if Scroll down then

Goto***Third Menu item (Exit Menu)***

End if

***Third Menu item (Menu Exit):***

Announce third menu item selection

Audio speak option for selection confirmation

Audio speak option to navigate to other menu items

If Scroll up then

Goto ***Second Menu item (Phonebook)***

Else if Scroll down then

Goto ***First Menu item (Recent Calls)***

Else if confirmation button pressed then

***Exit Menu module***

End if

Start

Displa**y** Home Screen

Allow Menu activation

If menu activation button pressed then

Announce menu entry selection

Prompt for selection Confirmation

If confirmation button press then

Enter Main Menu Module

End if

End if

Stop

**Algorithm for Main Menu**

Start

Announce Main Menu Entry

Display and Announce First Menu item

Audio Speak Selection option

Audio speak guide to navigate to other menu items

If selection button pressed then

Goto ***First Menu item (Recent Calls)***

Else if Scroll down then

Goto ***Second Menu item (Phonebook)***

Else if Scroll up then

Goto ***Third Menu item (Menu Exit)***

End if

***First Menu item (Recent Calls):***

Announce first menu item selection

Audio speak option for selection confirmation

Audio speak option to navigate to other menu items

If confirmation button pressed then

***Recent Calls Module***

Else if Scroll up then

Goto ***Third Menu item (Menu Exit)***

Else if Scroll down then

Goto ***Second Menu item (Phonebook)***

End if

***Second Menu item (Phonebook):***

Announce Second menu item selection

Audio speak option for selection confirmation

Audio speak option to navigate to other menu items

If confirmation button pressed then

***Phone Book Module***

Else if Scroll up then

Goto ***First Menu item (Recent Calls)***

Else if Scroll down then

Goto ***Third Menu item (Exit Menu)***

End if

***Third Menu item (Menu Exit):***

Announce third menu item selection

Audio speak option for selection confirmation

Audio speak option to navigate to other menu items

If Scroll up then

Goto ***Second Menu item (Phonebook)***

Else if Scroll down then

Goto ***First Menu item (Recent Calls)***

Else if confirmation button pressed then

***Exit Menu module***

End if

Stop.

Once the program is run, the language selection form containing radio buttons that allow a user select the required language is displayed as shown in Figure 5.


*Figure 5. Language selection Screen Display*

## Conclusion

In attempt to bridge the digital divide (in the area of mobile phone usage) among people with vision challenges; a mobile phone prototype software has been proposed, developed and customized to guide users in two popular African spoken languages of Hausa and Pidgin English. The designed was achieved using diagram tools to depict the architecture and interfaces of the system. The designed system was implemented using Microsoft Visual Studio 2010 in conjunction with Microsoft access 2010. These was achieved through the designing of the mobile phone interfaces by placing frames, labels, image boxes, shapes etc controls on a forms. All codes that respond to the users' inputs of clicking, right-clicking, scroll button click and scrolls were coded within the forms class modules except for command buttons for numeric entries and that of opening and closing of the mobile system keypad. The developed system was tested and all discovered errors corrected. Results and comments from different users of the system suggested the viability and the positive impact the new system shall offer if implemented on a mobile phone product.

## References

Akindele, O. O. (2011). *Study of the level of ICT Awareness among the Visually Impaired Students of the University of Jos.* Jos, Nigeria.

Baez, G., Kechiche, B., & Boguszewska, S. (2010, March). The Impact of Mobile Services In Nigeria. Pyramid Research.

Balarabe, A. H., Mahmoud, A. O., Omolase, C. O., & Nasiru, M. (2014). Exploring the option for alternative means of livelihood for blind street beggars in Sokoto, Nigeria. *Nigerian Journal of Clinical Practices , 17* (5), 637-640.

Balogun, T. A. (2013). In defense of Nigerian pidgin. *Jounal of Languages and Culture* , 90-98.

Basharu, D. (2009, November 4). ICT and Accessibility For Persons With Special Needs And The Elderly. *Peper presentation At Nigerian Communication Commission National Summit* . Abuja, FCT, Nigeria.

Gelmuda, W., & KOS, A. (2012). Vibrating Bracelet Interface for Blind People. *Proceedings of Electrotechnical Institute*, (pp. 199-206).

Ghiani, G., Leporini, B., & Paterno, F. (2008). Vibrotactile Feedback as an Orientation Aid for Blind users of Mobile Guides. *MobileHCI (ACM)* , 431-434.

Gollner, U., Bieling, T., & Joost, G. (2012). Mobile Lorm Glove: Introducing a Communication Device for Deaf-Blind People. *Association of Computer Machinery Inc.* , 127-130.

Guerreiro, T., Nicolau, H., Oliveira, J., Jorge, J., & Goncalves, D. (2009). Understanding Individual differences: Towards Effective Mobile Interface Design and Adaptation For the Blind.

Irie, T., Matsunaga, K., & Nagano, Y. (2005). Universal Design Activities for Mobile Phone: Ruku Ruku Phone. *FUJITSU Science Tech*, 78-85.

Jindal, G., & Jain, M. (2012). A Comparative Study of Mobile Phone's Operating Systems. *International Journal of Computer*

*Applications & Information Technology , Vol.I* (Issue III), 10-15.

Lenegnen, J. J., & Kayode, O. M. (2014). Promoting Access For Persons with Special Needs In Nigeria. *Research Journal in Organizational Psychology And Educational Studies* , 239-244.

Lucky, T. A., & Achebe, N. E. (2013). Information Service Delivery to the visually Impaired: A case study of Hope for the blind Foundation, Wusasa, Zaria (Nigeria). *Research Journal of Information Technology*, 18-23.

Mahmoud, A., Olatunji, F., & Ayanniyi, A. (2005). Ophthalmologists' Perception of The Rehabilitation Services For The Irreversible Blind In Nigeria. *Nigerian Journal of Ophthalmology* , 58-61.

McGookin, D., Brewster, S., & Jiang, W. (2008). Investigating Touchscreen Accessibility for People with Visual Impairments. *Nordi CHI: Using Bridges (ACM)* .

Oladejo, M. A., & Sofiyat, A. O. (2011). Educating StudentsImplications with Disabilities in Nigeria: Some Challenges and Policy. *European Journal of Humanities and Social Sciences* , 128-139.

Omowale Adelabu, P., Sanusi, B. O., & Esiri, M. (2015). Smartsphones And Communication Pattern Among Students In Higher Institutions. *Singaporean Journal Of Business Economics, And Management Studies , 3* (15), 56-63.

Pattison, M., & Stedmon, A. (2006). Inclusive design and human factors: designing mobile phones for older users. *PsychNology Journal* , 267-284.

Priya, G., N.Ndumathi, N.Kalaimagal, A.Suriya, & J.T.Vasuki. (2015). Hardware Based Braille Pad on Mobile Phone. *International Journal of Innovative Research in Computer and Communication Engineering* , 47-51.

Proshare. (2006, April 19). *Nigeria Spends N484 billion on mobile handsets-proshare*. Retrieved from Proshare Intelligent Investing: www.proshareng.com/news/1086

Southern, C., Clawson, J., Frey, B., Abowd, G. D., & Romero, M. (2012). An Evaluation of Braille Touch: Mobile Touchscreen Text Entry for The Visually Impaired. *MobileHCI (ACM)* .

Valente, L., Souza, C. S., & Feijo, B. (2009). Turn Off the Graphics: Designing non-visual interfaces for mobile phone games. *Journal of the Brazilian Computer Society* , 45-58.

Yatani, K., & Truong, K. N. (2009). SemFeel: A User Interface with Semantic Tactile Feedback for Mobile Touch-screen Devices. *User Interface Software and Technology (ACM)* .