



Mobile Application Design to Improve Accessibility for People with Visual Impairment

Alexi Delgado¹, Juan Pacherras Alor²

¹Mining Engineering Section, Pontificia Universidad Católica del Perú, Lima-Peru, kdelgadov@pucp.edu.pe

²Systems Engineering Program, Universidad de Ciencias y Humanidades, Lima-Peru, juapacherras@uch.pe

ABSTRACT

Vision difficulties are problems that confront the population and can occur for a variety of reasons. Therefore, this project seeks to design a mobile application that will benefit the visually impaired in the district of Puente Piedra by providing them with a platform that allows them to interact without obstacles. Therefore, for the present, the basic functions that allow a fluid communication through the mobile have been considered, such as editing contacts, the possibility of calling, writing messages and programming alarms through a voice command. This can be used to develop mobile applications for people with disabilities by providing innovative tools that enable social inclusion in the technological field.

Key words : Balsamiq Mockups, Mobile application, Visual impairment.

1. INTRODUCTION

Nowadays, millions of people live with some kind of visual impairment [1]. Visual impairment and blindness are the first and second most prevalent types of human disability in the world [2]. To better understand this, it must be established that blind people are those who lack the sense of sight, while people who have a visual impairment that cannot be corrected either by operation or with glasses are referred to as people with low vision [3]. On the other hand, disability is a set of physical and mental disorders; for every 1.2 thousand children, there is some form of visual impairment [4] according to [5]. As a result, the development of these persons is hindered, since they perceive information about reality differently from those persons who do not have visual difficulties [6]. Over the last 25 years, visual rehabilitation for adults with visual impairment has increased [7]. In this regard, according to WHO, 285 million people suffer from visual impairment, with an average of 39 million who are blind and 216 million who have vision problems with treatment.

Although mobile devices are increasingly being improved for human activities, people with visual impairment are often not prioritized, leaving aside the needs they present [8]. However, this is necessary to consider as their needs differ and need to be addressed in the simplest way. Therefore, and recognizing that visually impaired people are at a disadvantage in the

world, we seek to solve this problem with a mobile application so that they can carry out their activities as normally as possible [9], as the purpose of technological advances is to improve the quality of life of people by promoting social inclusion through a commitment to collective development [10].

The methodology to be used will be a compilation in software design parts. For this purpose, the possibility of working with the MarvelApp tool was evaluated, which is classified as a very useful tool for creating functional prototypes of applications from the design of sketches, which has a web page where the entire prototype can be made [11]. Also, NinjaMock was evaluated, an intermediate level tool for the creation of sketches for mobiles such as iOS, Android and Windows Phone, and also for web design, where the interaction of its prototypes does not go beyond links between screens and displays [12]. On the other hand, another possible tool for the study was RUP, a tool focused on design having a strong role in meeting the needs of the client [13]. Finally, Balsamiq Mockups was considered, a tool that assists in the design of user interfaces with a simple and friendly interface [14]. Once the different possibilities were evaluated, it was established that the design of the mobile application will be more focused on the design parts, architecture in design standards in order to be user friendly [15]. Therefore, this paper will use the Balsamiq software to make the corresponding sketches and analyze each component of the interfaces, being this very useful and easy to use [16].

For the present study, it was considered to analyze the functions and needs of the mobile application in order to achieve the necessary requirements of the application and achieve the desired functionality of the design [17]. The design for visually impaired people is proposed for their daily assistance, providing the user with a better access and condition for their communication [18], with answers that allow understanding the interfaces and results according to the requirements of the users.

The main objective is the design of a mobile application for people suffering from lack of vision in the district of Puente Piedra - Peru, through which the communication of the mentioned target group will be benefited, particularly focused through calls, messages, among others.

The present paper is divided into the following sections: In the second section the methodology will be explained along with the tools to be used and the expected functions according to the pointed interfaces. In the third section, the application of

the design is made in conjunction with the methodology. In the fourth stage, the recommendations of the case study will be discussed. Finally, in the fifth section, the conclusions of the present project are outlined.

2. METHODOLOGY

This research will develop the design of a mobile application for the use of people with total or partial visual impairment, which will be accessed by voice command to access a social interaction through commands such as calls, messages and main tasks such as adding, deleting and editing contacts. It will also show the design developed and adapted for full accessibility and a menu that is easy to use, interactive and fun to use [19].

2.1 Design Structure

It will be focused on the respective needs of the client by performing the main tasks through voice command. The software will be developed by assembling several study techniques and solving some problems that may arise to the clients and rebuilding the mechanism, with the aim of improving the basis of development for a correct final result. Also, this mobile application will be of great help for their development of communication through technology, in which it will provide them with several options of use. The functions of the application development are shown in Table 1.

Table 1: Application development description

Function	Description
Contacts	In this section the user will be allowed to add, edit and delete contacts by voice command.
Phone Calls	In this module it will be allowed to make a call by voice command.
Messages	In this division it is allowed to send messages composed by voice command or to delete them if necessary.
Alarms	This option facilitates the creation, edition and removal of alarms through voice command.

2.2 Balsamiq Mockups Analysis

This is a significant factor in the first phase of your prototype application development. Balsamiq is a tool that will allow us to make the prototype to obtain a quick visualization of the interface, helping us to create and modify the application. Likewise, Balsamiq contributes with the ability to simulate what would be a view of the application both mobile and web, as it has several tools not available in other softwares, as well as achieve screenshots of interactive presentations [20]. Likewise, the tools Android Studio, Visual Studio and the special use of Voice SDK will be used as they play a crucial role in the development of the mobile application.

A. Android Studio

An IDE development environment for Android operating systems, it has an emulator to visualize the projects created. It contains C++ language and NDK tools that allow us to develop in native code [21].

B. Visual Studio

A development software for web applications in an IDE environment, which presents tools to facilitate and solve programming languages that use the .NET Framework [22].

C. Voice SDK

Voice software development kit that provides us with benefits for using voice components such as voice-to-text access, voice translation, intention recognition, among others [23].

3. APPLICATION

3.1 Design Structure

The application “HelpVoice” is created for the specific use of people with total or partial visual disability in the district of Puente Piedra, Lima; with the purpose of contributing in an active communication through their mobile device. Figure 1 shows the design of the home screen of the mobile application, which at the same time will be dictated by audio so that the person can recognize it through hearing, feature shown in Figure 2.

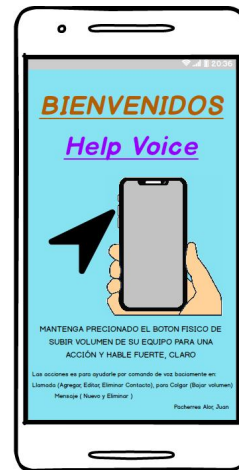


Figure 1: Home Screen

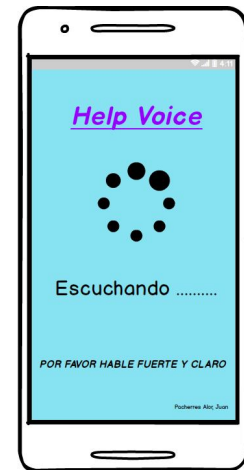


Figure 2: Main Screen

3.2 Balsamiq Mockups Analysis

It should be noted that the Balsamiq Mockups tool will be used for the design of the prototypes, helping us to solve important aspects for the creation of the prototype. Also, this prototype will be composed by 4 parts according to the main functions (Contacts, Phone calls, Messages, Alarms), in which the features to be found for the application will be detailed.

A. Contacts

The interface development of Contacts in the application is shown in Table 2.

Table 2: Contacts development description

Contacts	
Add	It is used to add contacts through voice command by pressing and holding the external volume up button.
Edit	Its purpose is to edit the contact by pressing the external button to increase the volume, using the voice command.
Delete	It assists in removing contacts via audio by pressing the external volume up button with the help of the voice command.

B. Phone Calls

Pressing the volume up button will activate the voice command (as shown in Figure 2), in which the user will be prompted to call the person "x" while keeping the external button pressed (as shown in Figure 3). Then, when you finish speaking, the volume key will be released, sending an audio depending on the function you want to perform. Also, if you wish to cancel the call, an audio confirmation of the cancelled call will be transmitted (as shown in Figure 4). On the other hand, if the call cannot be completed due to external reasons such as the recipient being in another call, an audio notification of the busy call will be sent. Similarly, if the mobile of the destination is disconnected, an audio notification of the cancelled call will be sent. Finally, if the call has been answered, no audio will be emitted but the communication with the recipient will be connected, and in order to hang up the call it will be finished pressing the external volume down button. Once the call is finished, the screen will appear waiting for a new command in order to be easily accessed (Figure 2).

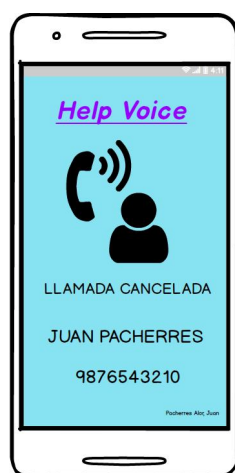
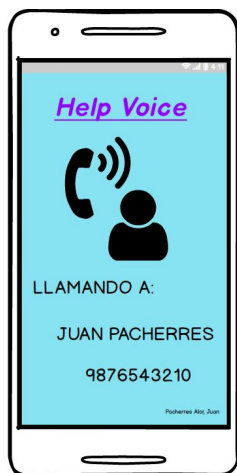


Figure 3: Calling Screen **Figure 4:** Cancelled Call Screen

C. Messages

In this section users can write messages to their contacts by holding down the volume up button, or delete messages if necessary. By pressing the external volume up button the voice command will be activated (as shown in Figure 2) in which the user request to send a message to a certain contact,

the resulting interface is shown in Figure 5. After that, the volume button will be released so that another screen appears in which the user can submit an audio that dictates the message in a concise way, keeping the volume key pressed; in case the message will be submitted, the button will be pressed saying to send the message to the person "x" and a confirmation audio will be sent notifying if the message was sent correctly (see Figure 6) or not (see Figure 7).

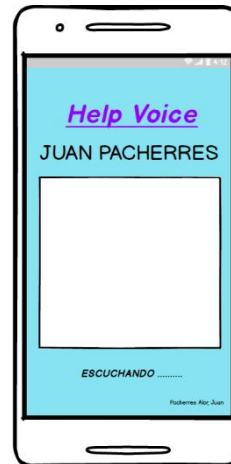


Figure 5: Message Dictation Screen

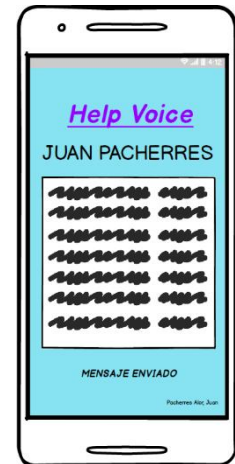


Figure 6: SentMessage Screen

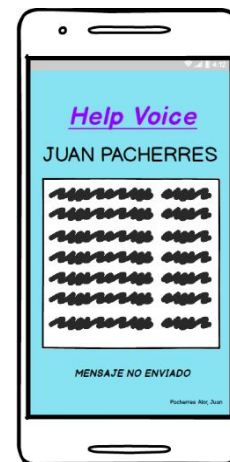


Figure 7: Unsent Message Screen

D. Alarms

Pressing the volume up button will activate the voice command, which will be specified to set the alarm at a certain time on a given date. Then when the button is released, an audio will be transmitted confirming that the alarm has been activated. Once the alarm is turned on, you will need to press the physical volume down button on the mobile phone to turn it off. On the other hand, in case the alarm needs to be deleted, the same procedure is repeated with the difference of activating the voice command to delete the alarm from the determined time and date.

4. RESULTS AND DISCUSSIONS

4.1 About the Case Study

Regarding the case study, the design of the mobile application was successfully achieved using Balsamiq Mockups to outline the application since it helped with the agile control of the creation of each layout. The aim was that the application could be used with voice control, to benefit users with total or partial visual difficulty when using a mobile, making them able to make a call, message or set an alarm independently thanks to the voice command [24].

There are some applications known as "Assistance Applications" which return data "in situ" to the visually impaired user, that is, the data is returned in real time when using a device to support the O&M [25]. Unlike [26], this study sought to adapt an application to the immediate needs of the user in an interactive way and without the need to use external devices that are not the mobile of the user.

4.2 About the Methodology

The advantages and disadvantages of Balsamiq Mockups are displayed in Table 3.

Table 3: Balsamiq Mockups Analysis

Balsamiq Mockups	
Advantages	<ul style="list-style-type: none"> • It is a user-friendly tool. • It provides a choice of pre-designed objects (such as menus, progress bar, status bars, etc.). • Allows to export the design in PNG and PDF format.
Disadvantages	<ul style="list-style-type: none"> • No minimum navigation is possible as it does not allow interactivity. • A precise setting system is needed when working with many components (by entering coordinates). • Some components lack options.

5. CONCLUSIONS

A mobile application was designed for people who partially or totally lack vision, through which some basic functions can be accessed to enable optimal communication without depending on a third person participating in the process, through a voice command.

The operation of this mobile application for people who lack vision will be done in the Android Studio and Visual Studio environment providing different effective tools for the development of the system, in particular the voice SDK.

Different enhancements can be included to the application depending on the needs of the users. For example, it is recommended that access to remote control of the home be included in a future study with the aim of decreasing the gap of technological social inclusion.

REFERENCES

- [1] S. Sanchez-Gordon, M. Mejía, and S. Luján-Mora, **Model for adjusting workplaces for employees with visual and hearing disabilities**, *2017 4th Int. Conf. eDemocracy eGovernment, ICEDEG 2017*, pp. 240–244, 2017.
<https://doi.org/10.1109/ICEDEG.2017.7962542>
- [2] A. López Delgado, E. Olmedo, P. Tadeu, and J. M. Fernández Batanero, **Propuesta de las condiciones de las Aplicaciones móviles, para la construcción de un Entorno de Accesibilidad Personal para usuarios con discapacidad visual en las Smart Cities**, *Aula Abierta*, vol. 48, no. 2, p. 193, 2019.
- [3] D. Zurc, M. Arias-Correa, J. Serrano-García, E. Valencia-Díaz, A. E. T. Hernández, and J. A. R. Rodríguez, **Autonomous navigation for visually impaired people in museographic spaces, based on mobile application**, vol. 16, no. 19, 2019.
- [4] C. Arter, *Children with Visual Impairment in Mainstream Settings*. 2013.
<https://doi.org/10.4324/9781315068350>
- [5] E. Soleimani-sefat, M. Rostami, S. Amani, and G. Movallali, **The Needs and Problems of Students with Visual Impairment**, *J. Soc. Sci. Humanit. Stud.*, vol. 2, no. 2, pp. 8–16, 2016.
- [6] A. R. Pratama, D. R. S. Saputro, and R. Riyadi, **Problem solving of student with visual impairment related to mathematical literacy problem**, *J. Phys. Conf. Ser.*, vol. 1008, no. 1, 2018.
- [7] A. T. Riddering, **Visual impairment and factors associated with difficulties with daily tasks**, *Diss. Abstr. Int. Sect. B Sci. Eng.*, vol. 78, no. 8-B(E), p. No-Specified, 2018.
- [8] M. C. Cuervo, **Mobile application as a tool for location and demarcation of routes for the blind**, no. April, 2015.
- [9] N. Carroll and I. Richardson, **Software-as-a-Medical Device: demystifying Connected Health regulations**, *J. Syst. Inf. Technol.*, vol. 18, no. 2, pp. 186–215, 2016.
- [10] F. B. Garrido, F. A. S. Herrera, P. E. C. Hernandez, and A. A. Porras, **A mobile application for the recognition of banknote: An alternative in the processing of images in people with visual disability**, *Iber. Conf. Inf. Syst. Technol. Cist.*, vol. 2018-June, pp. 1–7, 2018.
<https://doi.org/10.23919/CISTI.2018.8399417>
- [11] O. P. III. И.В.Иванов, О.В.Ковалишина, **Creación de una APP móvil para android capaz de detectar ultrasonidos**, *Вестник Росздравнадзора*, vol. 4, pp. 9–15, 2017.
- [12] J. R. Cajilima Alvarado, **Desarrollo de una aplicación, para dispositivos móviles que permita administrar pedidos y controlar rutas de los vendedores, aplicada a la empresa: ‘almacenes Juan Eljuri Cía. LTDA.’ División perfumería**, p. 117, 2015.
- [13] H. Mohd *et al.*, **A secured e-tendering model based on rational unified process (RUP) approach: Inception and elaboration phases**, *Int. J. Supply Chain Manag.*, vol. 5, no. 4, pp. 114–120, 2016.

- [14] E. Vacacela, J. Tenecota, J. Torres, and J. Celleri-pacheco, **Automation of Research Processes , Community Linkage and Pre-Professional Internships for Ecuadorian Universities**, pp. 35–44, 2018.
- [15] M. C. Fennema *et al.*, **Aplicaciones Móviles: arquitecturas, visualización, realidad aumentada, herramientas de medición, desarrollo híbrido**, pp. 539–543, 2016.
- [16] R. Goyena, **Prototype of system for the orientation of persons in condition of visual disability in the integrated system of public transport with mobile technology support**, *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2019.
- [17] M. R. Perez, T. Granollers, and i Saltiveri Juliol de, **Evaluación de herramientas para prototipado de sistemas interactivos**, 2010.
- [18] F. Garay, J. Camargo, L. Gonzalez, D. Segura, and N. Rincón, **Orientation Assistance for Visually Impaired Passengers within a Bus Rapid Transit System (Transmilenio), Using Satellite Geolocation**, *Ingeniería*, vol. 22, no. 2, pp. 283–297, 2017.
- [19] E. Larrea, **Análisis y diseño e implementación de una aplicación móvil para facilitar la comunicación alternativa de personas con TEA (trastorno con el espectro autista)**. 2016.
- [20] G. A. Cardona, F. N. Rendón, and R. Reyes, **Prototype for security identification in containers of alcoholic beverages**, *Actas Ing.*, vol. 2, pp. 334–343, 2016.
- [21] M. M. Fuad, D. Deb, and J. Etim, **An evidence based learning and teaching strategy for computer science classrooms and its extension into a mobile classroom response system**, *Proc. - IEEE 14th Int. Conf. Adv. Learn. Technol. ICALT 2014*, pp. 149–153, 2014.
- [22] D. P. Utomo *et al.*, **CLC (Cellular Lightweight Concrete) brick making process using neural network and extreme learning method based on microcontroller and Visual Studio.Net**, *2017 Int. Symp. Electron. Smart Devices, ISESD 2017*, vol. 2018-Janua, no. 1, pp. 79–84, 2018.
<https://doi.org/10.1109/ISESD.2017.8253309>
- [23] R. N. Rojas, E. Araya, and L. H. Vidal, **Diseño y desarrollo de prototipo de sistema de traducción instantánea del habla y transmisión en tiempo real, sobre el protocolo RTP utilizando tecnología de reconocimiento de voz**, *Síntesis tecnológica*, vol. 3, no. 1, pp. 15–25, 2006.
<https://doi.org/10.4206/sint.tecnol.2006.v3n1-02>
- [24] D. Valencia, V. Andrade, L. Navarro, and J. Benitez, **Diseño e implementación de una aplicación móvil de gestión de pedidos para restaurantes en Barranquilla**, pp. 1–5, 2015.
- [25] R. Goyena, **Apoyo móvil haciendo uso de realidad aumentada para personas con discapacidad visual: Aplicación y resultados**, *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2019.
- [26] R. Goyena, **Help for the blind using android phones**, *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2019.