Analysis and Proposed Improvements in the Support for the Visually Impaired in the Use of Public Transportation

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***Abstract* - This paper proposes an improvement in an already existing service in Recife, Brazil that notifies the visually impaired of the time a bus arrives at a bus stop and the time they should get off a bus. Statistics on the number of visually impaired people around the world as well as some information about the main challenges they face in urban areas will be presented. This paper will also present the concept of SmartCity and some solutions designed around it. Finally, a solution is proposed in order to mitigate problems visually impaired people face when using public transportation. It is expected that this application will benefit not only blind people, but also any person who has a mobility impairment.**

Keywords-Blind person; visual impairment; physical disabilities; cittamobi; smart city; smartphone.

I. INTRODUCTION

Nowadays, moving around in Brazilian big city is not a smooth task. The streets are always overcrowded by cars and pedestrians are rarely prioritized. Sidewalks are commonly broken, and lack both good places to sit and shelter from the weather. Given the fact that the obstacles are big for common people, it is not difficult to understand how these problems may affect a person with a mobility impairment.

Among the various physical disabilities, blindness or visual impairment is the concern of this paper. It is estimated that an amount of 285 million people worldwide are visually impaired: 39 million are blind and 246 million have low vision [1]. In Brazil, more than 35 million (18.8% of the population) claims to have visual impairment. Part of this total, 29 million have some permanent difficulty, more than 6 million have great permanent difficulty for seeing and 528,624 are unable to see, according to an IBGE research [2].

According to Castro [3], one of the great difficulties for the visually impaired is moving around urban areas, from walking to a particular bus stop to knowing the right place to get off a bus when reaching the final destination. In recent years, accessibility has improved, but it is still hard for many people with disabilities to use public transportation. In many situations, passengers need to ask people for help at bus stops to know what bus is passing by. When there is no one else at the bus stop, a passenger needs to stop all buses in order to be able to identify which one they need to take.

The development of new technologies has increased the accessibility on smartphones. Both iOS (iPhone Operating System) and Android have features focused specifically for the visually impaired.

As a result, it is believed that smartphones have a big potential to help people with several kinds of impairment and can make this group more confident and independent in their daily activities. This paper proposes an improvement for an already existing application which help visually impaired to take buses.

This paper is presented as follows: Introduction, describes the problem; Section II depicts about smart cities, their concepts and visually impaired people; Section III is presenting the methodology of the our work; Section IV describes two good existing solutions; Section V explains the proposed solution; Section VI provides a conclusion and next steps.

II. ABOUT SMART CITIES AND VISUALLY IMPAIRED PEOPLE

This section presents a study about smart cities and people with visual impairment.

A. Smart Cities

The interest in Smart Cities is motivated by great challenges, such as climate change, economy, mobility, among other problems. The European Union (EU) has committed to constantly developing strategies that enable the "smart" urban growth in their cities. Arup (Arup Group Limited) estimates that the global market for smart urban services will be 400 million dollars a year by 2020. According to Su *et al.* [7], the concept of Smart City is defined as the use of communication and information technology to measure, analyze and integrate key data from small systems to a centralized system. Thereby, smart cities bring intelligent responses to different types of needs, including everyday needs, environmental concerns, public safety, trade activities and city services. In smart cities, buildings and smart buildings are highlighted with sensors, actuators, controllers, central programming units, several kinds of interfaces, communication networks and smart meters are installed to ensure better energy performance of the building [8].

Smart Cities tend to evolve, creating an integration of the "intelligences" within a city. Some of these intelligences stand out like Baloon *et al.* [4] and Deakin [5] defines:

- Creativity and inventiveness some citizens from a certain practice, such as scientists, artists, and entrepreneurs, which impact greatly on how work is organized;
- The collective intelligence of a population, which results in the human capacity to evolve based on the institutions of the city related to cooperation, integration and collaboration;

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- Artificial intelligence that is integrated into the physical environment and is available to the public, such as communication infrastructure, digital spaces or online problem solving tools.

The intelligent cities can create more efficient urban systems and are able to face contemporary challenges and urban problems. More innovative and competitive cities are created where mobility is improved, public spaces are more secure, and there is a better management of environmental resources.

B. Visually Impaired People

Blindness is understood as the lack of visual perception.

The International Council of Ophthalmology [9] describes total blindness as the complete lack of visual perception of light and form. The World Health Organization [10] defines blindness and visual acuity to 20/400 less than (6/120) or a visual field loss to less than 10 degrees.

According to the World Blind Union (WBU) [11], the lack in proper training in mobility and the lack of access to public transportation are some of the major obstacles for the blind or partially sighted when they need access to education, employment, services in general, and full participation in their communities. Transportation itself presents different challenges within the local, regional, national and international levels.

A survey conducted by a group of students from Paraíba Valley University points out the main problems of the visually impaired in urban mobility [6]:

- Obstacles on sidewalks
- Few or non-existent proper signaling
- Very short time for the sound signal of traffic light
- Absence of technology in the public transportation
- Lack of maintenance and standardization of sidewalks
- Large flow of people in public places

According to this survey done by Fornaziero and Zulian [6], most visually impaired memorize the paths, either by walking or by bus. The survey also found out that one of the major difficulties this group has is to know the right time to get off a bus. Some have set up "checkpoints" to know the right time to leave it. Examples of "checkpoints" cited by respondents were amount of "sharp curves" and "speed bumps".

III. METHODOLOGY

First of all, we discussed some of the problems that the people with disabilities experience in the context of public transport. In some bus stations, more than one bus line can stop at the same time, forming a big queue of buses and making it difficult to get on the bus, if this one has stopped far away. We observed a few problems at the bus stop. For example, some buses stops far away from where people are, and for blind people this is a serious problem. Finally, the data were analyzed with focus on people with visual impairments.

Once the problem was identified, bibliographic research was performed in order to find previous works related to the issue.

A benchmarking was performed and it was aimed at finding other existing applications that help the visually impaired to move around cities with public transportation.

Finally, brainstorming sessions and user research showed that the best solution is to improve an already existing application, *CittaMobi* [13]. It already benefits users and they are happy with it.

IV. EXISTING SOLUTIONS

Two good solutions will be presented in this paper. The first one is from the UK, and the latter is from Brazil:

A. GeorgiePhone (UK)

"Much more than phoning, texting and keeping in touch, *GeorgiePhone* is like a friend who helps with everyday tasks and takes the stress out of travelling alone. *GeorgiePhone* confirms where you are and what is around, bus journey information, your ability to keep up with the web and YouTube, reading print and diary dates."[12]

According to its site, *GeorgiePhone* is a family of apps designed mainly for blind or low vision people and it has a variety of functions like camera, color detection, user finder, bus track, among other very useful options.

The most interesting function for this paper is the bus tracking system. It locates the nearest bus stop for the user and tells how to get there. Once the user is on the bus, the app says the names of the bus stops. This way, a user knows when they need to drop, reducing the stress of a bus journey. Internet connection and GPS (Global Positioning Satellite) are needed, and it works only on the Android platform.

B. CittaMobi Accessibility (Brazil)

The *CittaMobi* accessibility is an app designer specifically for users with visual impairment and provides a bus arrival schedule. The interaction design is simpler and all queries are made by VoiceOver, with the application automatically notifying the user of the desired bus proximity.

A user does not need to be at the bus stop to know what time the bus will pass by, and it is possible to verify in real time the bus RTA. In addition, it also presents the closest bus stops of the current user location. This app is only available for iOS.

V. PROPOSAL

The *CittaMobi* already has some features which improve the user experience of bus users. The main feature is the estimated time left for buses to arrive at a particular bus stop. Before and after taking the bus, a user can look bus routes up. Users can also mark on the map where they want to get off a bus. It is possible to bookmark bus lines and bus stops.

As noted by Fornaziero and Zulian [6], one of the greatest difficulties the visually impaired face is knowing whether their bus arrived. In Recife, there are stops for multiple bus

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lines, making it even harder for these users. *CittaMobi's* current service is presented in Figure 1.

Figure 1. *CittaMobi* application

CittaMobi's current service uses a Web Service module to get information about the buses and also to provide the information to application's users. Figure 2 presents the adjustments proposed for the *CittaMobi* application service.

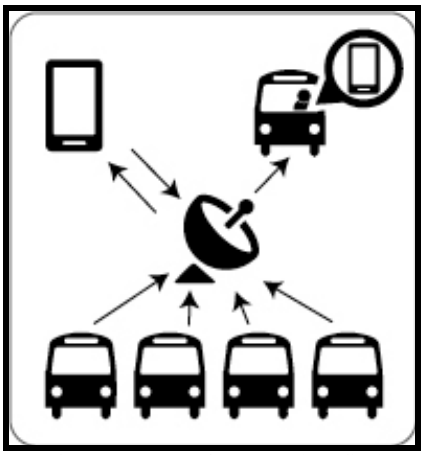

Figure 2. Enhancement proposed to *CittaMobi* application service

The enhancement proposed will be composed by Web Services to feed the mobile and web platforms. Based on *CittaMobi*, this paper proposes an enhancement to current service that includes an additional module to notify the presence of someone with mobility impairment at a bus stop. This module will provide to buses important information about passengers and other feedback like accidents, delays, etc. This will be useful to inform bus drivers of people with special needs at bus stops.

Currently the buses do not have a channel of communication with their passengers, especially those that require more attention, such as the visually impaired. The new proposal presented in Figure 3 presents the enhancement proposed to service, which comprises the interaction between users, services and applications. The new *CittaMobi* version will advise the bus driver that there is someone who needs special attention to get on the bus. The user that has a smartphone Android or iOS will select the bus line and then will press a button to send a message to the bus that has a smartphone fixed on the panel, connected to the service through the Internet aiming to show to bus driver that has someone at the specific bus stop who needs more attention to get on the bus.

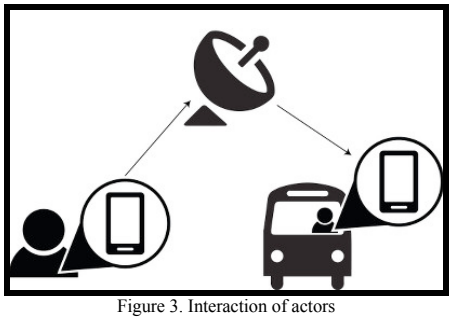

Figure 3. Interaction of actors

VI. CONCLUSION AND FUTURE WORK

The new service module will be useful for many people who have certain disabilities. Users will be able to choose bus lines through the mobile service and inform bus drivers when they need special attention when using public transportation services.

Many blind people live normal lives in their cities, but many cities do not invest the financial resources needed to make improve the well-being and quality of life of this group, especially in developing countries. Taking a bus should a simple routine task for everyone, not a challenging task. Thus, it is expected that the visually impaired have no great difficulty to take buses.

To the future work, we will create the actors map of the service to understand the actors involved in the whole process of mobility, from the application user to the other passengers of the bus.

Digital ethnography to finding out how the visually impaired people use smartphones.

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