Ubiquitous Computing to Measure the Accessibility of Public Places

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Abstract

This paper proposes the use of ubiquitous computing to obtain information related to the mobility of people with visual impairments on public spaces; and use that information to evaluate the accessibility of such spaces.

1. Introduction

In ubiquitous computing environments, the processing is done in different intercommunicated devices (most of them have wireless access links) such as mobile terminals (tablets, smart phones, laptops), networks of sensors and machines with which we interact in our daily lives (vending machines, refrigerators, microwaves, cars, traffic lights, televisions, computers). These environments, have a reduced availability of computing resources (application and network systems), so they must have to adapt to it, in order to operate efficiently [1].

A key feature of ubiquitous computing systems is the ability to adapt their behavior based on user activity and context [2]. The devices embedded in the environment can have computing and communication capabilities, which turns a network of intelligent devices and sensors in an global interface between users and facilities like ramps, elevators, light signals, etc.

The present paper propose the use of ubiquitous computing as a tool that facilitates the accessibility evaluation of public places, tracking people with visual impairments when they are moving in public places.

In order to estimate the magnitude of the population suffering disabilities have been carried out censuses and surveys in several countries. The World Health Organization [3] estimates that 15% of the world's population (approximately 1000 million people) has intellectual disabilities, physical or sensory impairment. Considering their families, which are also affected by disability, the number of people directly involved is around 2,000 million, which represents almost a third of world population.

Today society is striving to further integrate all people so it is trying to build different equipment and provide the accessibility for handicap people in order to facilitate their mobility; and help them to have a better quality of life; and as far as possible with a little more independence.

In the case of public places like schools, airport terminals, parks and government offices, we can see some effort to make them accessible. However, much remains to be done, because even with the necessary adjustments, many people with disabilities, like persons with visual impairments, require more elements that help them to discover these facilities; before they can use them. The lack of use of these facilities is because in most cases the signs that advertise them are visual and are placed right on the spot where the facilities are located and sometimes they are not so comfortable to use.

In Mexico we can see some effort to make accessible many public buildings like schools, airport terminals, parks and government offices. However, much remains to be done, because even with the necessary adjustments, many people with disabilities, like persons with visual impairments, require more elements that help them to discover the nearest facilities; before they can use them.

In relation to the mentioned in the previous paragraph, the Mexican National Commission of Human Rights has selected a sample from public buildings and elaborated a first evaluation - National Accessibility Assessment [4], in an effort to collect objective and reliable information about the accessibility status of the Federal Administration buildings.

The evaluation results from [4] showed that the greatest progress in this area has been related to the building's physical accessibility, which demonstrates that Mexican society continued equating accessibility for people with disabilities by building ramps for physically disabled people, not foreseeing the needs of people with other disabilities (e.g. visual impairments).

The contradictory results reflected that signaling is missing on the 100% of the sites evaluated in the sample; which help us explain the lack of use of these facilities, since in most cases the signs that advertise them are visual and are placed right on the spot where the facilities are located and sometimes the facilities are not so comfortable to use.

We are proposing the use of ubiquitous computing to evaluate the accessibility of buildings, and public places, because we believe that this evaluation will be more accurate if we observe

people walking on the buildings and not only the buildings alone.

2. Related works

The project named GATHERING [5], based on the principles of the theory of perception's control, is used to simulate, in a simplified way, the experiment of collective locomotion. The main conclusion of the experiment is the most common reference signals led to greater coordination of collective behavior, which was repeated in the simulation. The program's ability to reproduce the collective behavior observed in the field and in the experiment provides evidence of the usefulness of the theory of individual behavior in which the program is based. The simulation proves the assumption that collective behavior is the result of similar reference signals. This project allow us to make the following questions: How the collective locomotion affects the accessibility of places? And how collective locomotion affects the use of them by disabled people?

The work of [6] demonstrates that it is possible to use multi-agent systems to model and simulate the behavior of humans in a mall, where they focus on the distribution of physical spaces and the interests of each individual to navigate through mall, they also solved the issue of collecting information about the routes followed by visitors through surveys.

Some important advances has been done in order to improve the accessibility to some services, like [7] where they studied the chromatic abnormalities of the human visual system and develop computational tools for adaptability of human-machine interfaces, providing the inclusion of individuals with color blindness and creating more accessible solutions.

The research project [8] shows some advances related to modeling the accessibility perception by individuals, applying fuzzy logic to the micro-spatial analysis of individual trip patterns and duration, while taking into account various types of households and a large set of activity nodes, allows measuring the actual willingness-to-travel of urban dwellers, thereby building more subtle and comprehensive accessibility indexes.

3. Study case

As a case study it must be carried out some evaluations for public spaces that may represent a real example, both the variety of its physical facilities as the various situations that can emerge due to the presence of people.

In the first instance due to the extent of its facilities and the dynamic that presents product of the daily activities, the installations of the School of Chemical Sciences and Engineering at the Autonomous University of Baja California, are a magnificent stage for the case study. We already selected the different areas and made some tests with sensors detecting people using ramps and stairs but we are planning to install cameras to record more information related to people walking on the campus (see Figure 1).

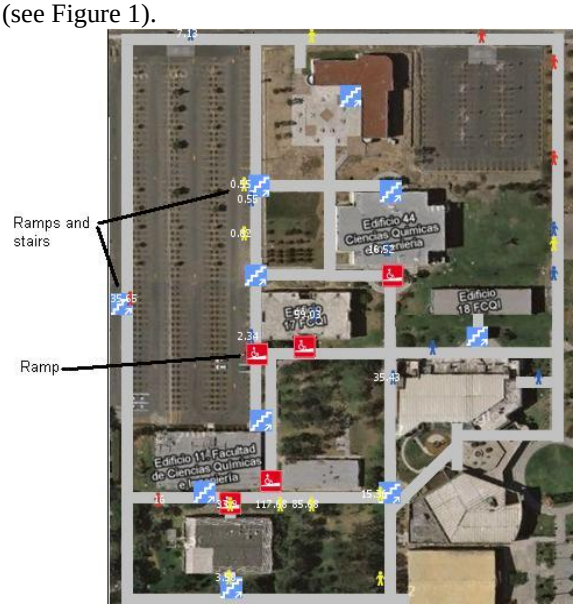

Figure 1.Aerial picture of the School of Chemical Sciences showing some facilities

To perform the first measurements were selected certain routes within the campus, some of which had ramps and other did not have ramps or obstacles. The first tests were carried out with students who had no difficulty getting around. They were asked to scour walking routes and proceeded to measure their travel times.

Until now we have preliminary results from the first study case, where we observed that some accessible installations adversely affect the time it takes a person to travel a route.

We are currently preparing the experiments for measurements with people with visual impairments.

Once it is evaluated the first case of study and have made the appropriate adjustments, is intended bring it to another stage where can be seen a greater presence of people with disabilities and has the facilities to their displacement, as is the case of the local museum named El Trompo.

In El Trompo museum we are planning to install sensors on different accessible installations like ramps, elevator, restrooms, exhibition halls, stands, etc; and will implement a badge with sensors that can be carried by visitors with some disability, so we can register where they are, if they used some facilities and also we are planning to install video cameras to record and complement the information regarding if these visitors could move inside the museum independently and safely.

The Figure 2 shows a museum's level layout as an example of the sensors deployment.

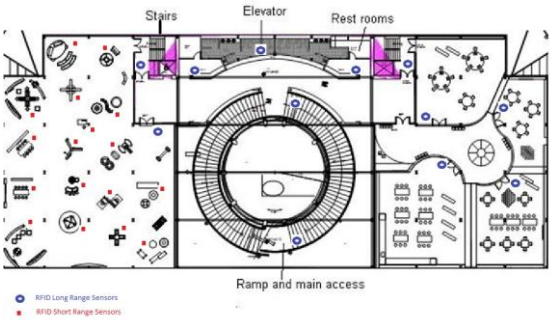

Figure 2. El Trompo museum layout showing sensors deployment

In the museum we are planning to install two kinds of sensors the first one are short range sensors (marked with a small red square), which will be located on stands, we will use them to detect and identify when a person with a badge reach a stand. The second kind of sensors are the long range sensors (marked with a blue square), they will be located on access points, like the ramp, elevators, restrooms, etc; such sensors will allow us to detect when a person reach any facility, like the rest room or elevator; or when a person walks on a ramp (see Figure 2.

In Figure 3 we present a model where we represent a broader view of how we carry out the events capture in order to subsequently measure the accessibility of various physical facilities. As can be seen in Figure 3, at the lowest level are sensors located on access points, which register when a person approaches them.

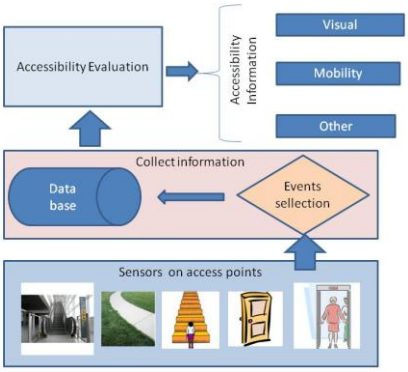

Figure 3. Accessibility evaluation model

In the second level of the model you can see the data collection module which consists of a component that evaluates the events and passes them to a database where they are registered for later evaluation, which is done in the module known as accessibility evaluation which threw relevant information about the accessibility of spaces monitored with sensors.

4. Conclusions

People with different disabilities present challenges that are difficult to understand for most people. Although many countries have regulations about facilities for disabled people, are usually focused on very few types of facilities. It is required to analyze the behavior of the individuals with disabilities from a systemic point of view, since they are part of society where we all live. From a standpoint of ubiquitous computing, we can get closer to observe and measure the usefulness of the existing facilities and get relevant information about how they affect the movement of people. We believe that disabled people can be supported through a ubiquitous environments, but also believe that the behavior of users in the system is complex.

We believe that this behavior must be understood first, then propose new designs that improve the social environment and user support. In the future we observe that we can use all the information collected in this project and use it to create models that can help us to evaluate accessibility of places in a virtual environment.

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6. References

[1] T. Ito, H. Takahashi, T. Suganuma, T. Kinoshita and N. Shiratori, “Design of adaptive communication mechanism for ubiquitous multiagent systems,” Journal of Information Processing, vol. 18, pp.175-189. 2010.

[2] G. Privat. “Des objets communicants a la communication ambiante.” Les Cahiers du Num erique, 3(4):2344, 2002..

[3] The World Health Organization (WHO), 2011, Disability and health, [online]. Available at: http://www.who.int/mediacentre/factsheets/fs352/es/index.html

[4] Comisión Nacional de los Derechos Humanos, México, 2009, Muestra – Diagnóstico Nacional De Accesibilidad en Inmuebles de la Administración Pública Federal. [online]. Available at: http://www.cndh.org.mx/index.htm

[5] Sociologyindex, “Collective behavior, social move-mints and activism.” Sociologyindex. 2011. [Online]. Available:

http://sociologyindex.com/collective_behavior.htm
[Accesed: march 2011].

[6] W. Ali y B. Moulin, "2D-3D Multi-agent GeoSimulation with knowledge-based agents of customer's shopping behavior in a shopping mall," Springer-Verlag Berlin Heidelberg, 2005.

[7] J. Lee and W. Pinheiro dos Santos, "An adaptative fuzzy-based system to evaluate color blindness, IWSSIP 2010 - 17th International Conference on Systems, Signals and Image Processing, Brazil, 2010.

[8] M. Thriault and F. Des Rosiers, "Modelling perceived accessibility to urban amenities using fuzzy logic, transportation GIS and origin-destination surveys," 7th AGILE Conference on Geographic Information Science, Greece, 2004.