Measuring Accessibility on Public Places using Ubiquitous Environments and MAS

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Abstract: This paper proposes the use of ubiquitous computing and multi-agent systems to obtain information related to the locomotion of people with visual impairments on public spaces; and use that information to evaluate the accessibility of such spaces.

1 INTRODUCTION

The present paper propose the use of ubiquitous computing as a tool aid in 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 (WHO, 2011) estimates that 15% of the world's population (approximately 1000 million people) has intellectual disabilities, physical or sensory impairment. Considering their families, wich 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.

1.1 Accessibility in Mexico

In México the National Commission of Human Rights has selected a sample from public buildings and elaborated a first evaluation - National Accessibility Assessment (Comisión Nacional de los Derechos Humanos, 2009), in an effort to collect objective and reliable information about the accessibility status of the Federal Administration buildings.

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.

The evaluation results (Comisión Nacional de los Derechos Humanos, 2009) 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 some times the facilities are not so comfortable to use.

Many accessibilities evaluations are carried out inspecting the buildings and verifying if they satisfy the construction regulations but we think it is possible to get more accurate results observing if people use them. That's the reason why we propose the use of ubiquitous computing to evaluate the

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accessibility of buildings, and public places, because many people can carry a cell phone or a small computing device, which can help us to collect information related to their locomotion and keep track if they used any accessible instalation.

1.2 Ubiquitous Computing

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 (Ito, T. et. al, 2010).

A key feature of ubiquitous computing systems is the ability to adapt their behaviour based on user activity and context (Privat, G., 2002). 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.

1.3 MAS and Ubiquitous Computing

A Multi-Agent System (MAS) is a distributed system consisting of autonomous entities called agents. These agents need to interact and cooperate to perform the task overall. One of the main properties of MAS is based on the distribution of cooperative algorithms. The decentralized and loosely coupled nature of the network makes it possible to design applications that are highly flexible, scalable and adaptive.

The multi-agent paradigm is well suited to ubiquitous computing environments from multiple perspectives. MAS provide a decentralized control based on distributed autonomous entities. MAS support complex interactions between entities. This feature seems essential for ubiquitous computing environments of diferent heterogeneous information seeking, physical sensors, services or user preferences. Integration of these data can only be at a higher level, where all kinds of information (service context) are expressed semantically. The Figure 1 represents all the typical elements that could be part of the user context in ubiquitous computing systems based on conventional agents.

The context awareness facet of a pervasive computing environment can encompass several diferent aspects, such as the physical position of an entity as well as its logical (sometimes physical) role, such as the type of service it represents (e.g. its a ramp, an elevator or a door access). We will build a awareness module to manage this kind of information, and entities will be represented by specific awareness agents. The (spatial, social, organizational) environments in which entities are situated will be modeled as awareness graphs, also called topological spaces, the agents are connected to their nodes, also called sites, accordingly.

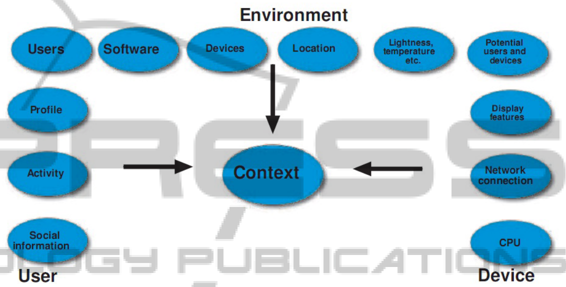

Figure 1: User context information in a ubiquitous environment.

However, diferent agents may have diferent perceptions of the same aspect (diferent notions of distance in a spatial arrangement) thus requiring a more precise definition of interaction on awareness graphs.

The awareness module will be designed according to the perception-reaction paradigm: the behavior of agents will be driven by the perception of signals, emitted by other agents and propagated across the awareness graph (to notify the presence in a specific site). The propagation of information will be mediated in intensity according to a graphic specific distance function evaluated between sites.

The closeness of some entities can be considered a fundamental awareness information: agents can have a sensitivity function based on intensity of the perceived presence field where a high threshold can be set to perceive entities in the close neighborhood while a lower threshold can be set to perceive also entities further apart. That information will be used to record when a person is aproaching to some facilities and more precisely register information about the use of accessible entities.

2 RELATED RESEARCHES

The project named GATHERING (Sociologyindex, 2011), 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 behaviour, which was repeated in the simulation. The program's ability to reproduce the collective behaviour observed in the field and in the experiment provides evidence of the usefulness of the theory of individual behaviour in which the program is based. The simulation proves the assumption that collective behaviour is the result of similar reference signals.

The project GATHERING allows 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 (Ali, W., Moulin, B., 2005) demonstrates that is possible to use multi-agent systems to model and simulate the behaviour 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 (Lee, J., Pinheiro dos Santos, W., 2010) 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 colour blindness and creating more accessible solutions.

The research project (Thriault, M., Des Rosiers, F., 2004) shows some advances related to modeling the accessibility perception by individuals, applying fuzzy logic to the microspatial 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 study case 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 Engineering and Chemistry Science Faculty 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 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 2).

We have taken a few measures of people walking on campus and observed that in most cases (approximately 45%) the regular people decreased their speed when they used the ramps and many people failed to answer the questions about the location of the nearest ramps.

Once it is evaluated the first study case 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 this museum we are planning to install sensors on different areas 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 at the same time we are planning to install video cameras to record it and complement the information regarding if these visitors used them easily or not.

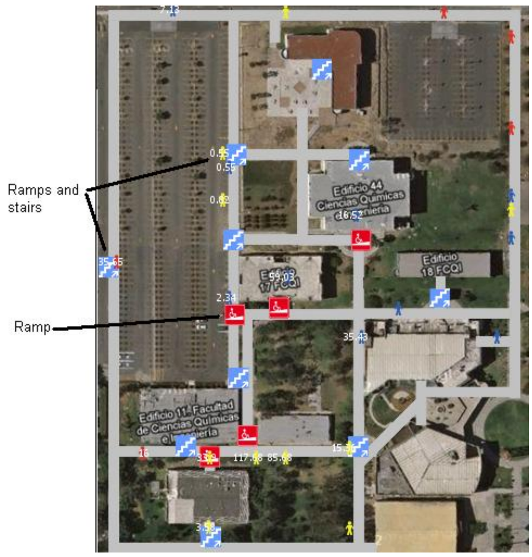

Figure 2: UABC campus map.

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, those are usually focused on very few types of facilities. It is required to analyze the behaviour of the individuals with disabilities from a systemic point of view, since they are part of society where we all live.

Ubiquitous computing, we help us to get closer to the scene, observe and measure the usefulness of the existing facilities and get relevant information about how they affect the movement of people. We also believe that information collected in this project will be useful to support disabled people through ubiquitous environments (e.g. aid them to find facilities), but also believe that the behaviour of users in the system is complex.

We believe that this behaviour 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.

5 FUTURE WORK

Collect more information on developments related to modelling human mobility, systems and technologies to assist people with disabilities in order to understand the previous work. Also review regulations and legislation, national and international accessibility and accommodations for public spaces. Finally gather information about the mobility needs of disabled people.

Propose a model to simulate real environments with obstacles and accessible facilities based on the knowledge acquired during the first two phases.

Create models of real scenes using the products of last stages. Build a database with information and make a compilation of results for further analysis.

Analyze the data collected on previous stages to formulate the conclusions of the research.

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