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Tracking System Proposal of Walking Sticks Aiming the Orientation and Mobility of the Visually Impaired

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Abstract: This article aims to partially present the proposal of developing a system for tracking electronic walking sticks, applied in orientation and mobility of the visually impaired. The embedded walking stick system sends information from the macro and micro navigation to a server of application integrated with a database. The back-end will allow the access to the setting operations of the system and available features and the front-end will be available to you or your family. The system should allow you to add and remove features or services, according to accessibility and usability requirements for each application scenario. The project is part of a case study of a doctoral work that has been developed in the postgraduate studies in Electrical Engineering from the Federal University of Rio Grande do Sul.

Keywords: Accessibility, electronic walking sticks, orientation and mobility, server, visually impaired..

1. INTRODUCTION

Assistive Technology (AT) is any item, device or system, commercially available, modified or customized that is used to increase, maintain or improve functional capabilities of individuals with disabilities. The definition, although quite extensive, is used in its own context to refer to tools used to improve or increase the functionality of technologies based on software or hardware. Among the resources used by the visually impaired for locomotion, the white stick is presented as one of the cheapest and safest when its handled correctly Section508 (2014).

The traditional white sticks are useful mechanisms only to help to detect obstacles within an immediate environment surrounding the blind (micro navigation) and cannot predict obstacles in advance located above or below the waist line and does not inform the location or global position (macro navigation). Due to the technological advancements, a great deal of tasks executed by humans is being aided by computers. The technology makes things easier for the application with those without disabilities, and for those with some sort of disability, technology makes things possible. On that basis, embedded computer systems are present in various activities; they are dedicated systems that have a restricted functionality to meet a specific task in larger systems in which they are inserted. These systems are naturally heterogeneous, because they are made up of hardware and software components based on different architectures.

The internet is a tool that is constantly evolving and that allows to develop numerous applications. Currently, technologies such as Global System module for Mobile Communications (GSM), the most popular standard for cellular systems and personal communications equipment throughout the world using GPRS data networks (which use the structure of the GSM mobile operators), it is possible to execute several applications and provide access to any remote equipment, either fixed or mobile. Thereby, you can get information and control equipment in a short period of time, anywhere you want. With global positioning system (GPS) technology, its possible to determine the location of any point on the Earths surface by providing the information related to global positioning, such as latitude, longitude, altitude and speed. Considering the markets interests, it grows the need to monitor, track and control terrestrial objects. And taking into account the assistive technologys interests, we can use the tracking technology to assist people with special needs. Often, it is important that monitoring and decision making are performed in real time, whether for security or management applications Guimares et al. (2012).

This article describes proposals, methodologies and partial tools used for the development of an application server to support the macro and micro navigation of the visually impaired, with an embedded system on a stick to replace the vision by sound and touch. The project is being developed in PPGEE (Graduate Program in Electrical Engineering) and is as part of a doctoral work, the project is a prototype applied in assistive technology in order to aid in orientation and mobility of the visually impaired for short and long distances. Stages of systems development in real time are modular and structured, however, like in any automation project, tools and methodologies are available to assist in the development of projects, regardless of the methodology, and they must provide the breakdown of the project in parts, in order to facilitate their understanding and complexity. These parts may be represented as abstract

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models that describe the essential aspects of the system da Silva (2009).

2. ASSISTIVE TECHNOLOGY

Visually impaired people have been using, for several years, many types of devices to help them in daily life, the most common features and services are dogs used as guides, however, they are often expensive and prohibitive in some places, and traditional white sticks provide clues about the environment, but they are not capable of identifying obstacles more than one meter above or below the waist line. Both belong to the categoryOrientation and Mobility in AT.

2.1 Visual Impairment and White Stick

In general, the sight can be considered as the most important sense of the human species, because it is responsible for capturing stimuli and spatial projections, thus facilitating the individuals relationship to their social environment. Approximately half of the physical area of the brain is devoted to vision and almost 70% of its capacity of processing sensory information is used to treat the visual stimuli. According to recent studies, men tend to give greater attention to visual stimuli.

In 1950, after studies linked to the problem of blindness and the mechanics of the gear, the first lieutenant and ophthalmologist of Valley Forge Hospital, Dr. Richard Hoover created a stick which was longer and lighter than the traditional ones of support, to be used as an extension of the index finger, to probe through tactile-kinesthetic perception the space ahead, detecting the nature and the marching conditions, existence of obstacles, locating landmarks and protecting the lower body from collisions. The traditional white stick, used by visually impaired, is mainly characterized by its lightness and its more elongated sizes, regarding the bats, which were shorter and heavier and commonly used before Hoovers proposal. The traditional white cane is basically configured in three different parts: 1 handle that allows the user, from the correct grip, the handling of the equipment; 2 - rod that functions as a users body extension and helps him in reading the space around, through tactile signals transmitted by it when touching the ground; 3 tip that is responsible for direct contact with the ground.

The running speed and stick movement depends on the blind, however, one of the most common ways to move it is the technique known by the two beats. This is to describe an arc in front of the body, covering approximately the shoulder width and hitting with the tip of his stick the floor just on the limits of the oscillation. The side where the stick touches the ground should be the opposite of the foot that is ahead, so that you always put the foot in the position previously hit with the tip of the stick. Thus, the blind can detect objects that are in front of him, as well as irregularities on the floor. Moreover, the oscillation of the stick also has the purpose of directing the blind, so that he can walk straight. Currently, among the resources used by the blind for locomotion, the white stick is presented as one of the cheapest and safest when its handled properly. Figure 1 shows the characteristic

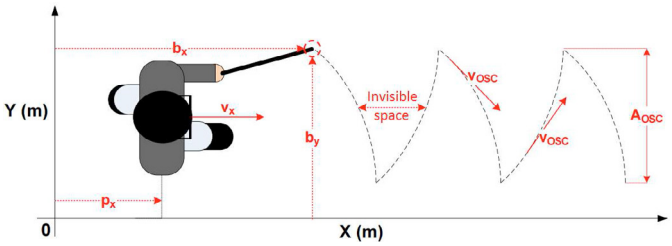

Fig. 1. Illustration of the characteristic movement of a white stick. Source: Rosa (2009)

movement of a white stick and, as you can see, this leaves a wide space for probing in front of the user. In red, it is shown the parameters that can be measured and calculated from the tests carried out in Rosa, (2009).

In Rosa (2009), the needed data were recorded to calculate the desired parameters for the calculation of the driving speed, v_x. Having done the filming at 25fps (*frames per second*), it follows that:

$$v_x = \frac{p_{xend} - p_{xinitial}}{\frac{frame_{end} - frame_{initial}}{25}} \tag{1}$$

where p_x is the position of the visually impaired in the axis X. Measurements of b_x and b_y refer to the stick when the tip position of the touch on the ground. With these measures, it is possible to calculate the amplitude and stick oscillation rate (A_{OSC} and v_{OSC}), respectively), as well as the invisible space for the same. The oscillation speed using the user as a reference is the average speed, tangentially to the arc described by the cane. As the length of the arc described by the stick is given by:

$$a = 2.r.arcsin(A_{OSC}/2) \tag{2}$$

and if it is measured (the stick turning radius) is about $1m$, we have that:

$$v_{OSC} = \frac{2.arcsin(A_{OSC}/2).(n^{o}\text{of rings} - 1)}{\frac{frame_{end} - frame_{initial}}{25}} \tag{3}$$

where the number of touches represents the number of times that the stick hits the ground, on both sides

By the results obtained in Regalado (2009), we reached an important conclusion; there is an approximately constant ratio v_x and v_{OSC}. This is due to the fact that the pace of the stick has to keep pace with the step, in order to always be on the opposite side to the front foot. Concerning the amplitude of oscillation, it was found that there is a greater tendency to further enlarge the motion by increasing the running speed which rather impairs the invisible area.

In this case, and only for quantification, it is considered that the invisible area is the distance that goes from the point where the tip of the stick passes in front of the user to the next pass in the opposite direction (illustrated in Figure 1). Assuming v_{OSC} is constant along the entire path, it follows that: