NEW PERSPECTIVES FOR THE BLIND WITH UPCOMING TABLET AND SMARTPHONE BASED SOLUTIONS

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Several initiatives in the last few decades have been launched aiming at additional tactile feedback for the people who are blind. Most of those relied on special hardware which could stimulate either the hands, the tongue or other parts of the body to let the visually impaired absorb some additional environmental information, thus enhancing their life quality. The recent development of powerful personal programmable appliances, like new tablets and smartphones, opens a wider range of opportunities for the deployment of affordable solutions for persons who bear disabilities as vision loss. This work includes initially a review showing some of the landmarks in the development of haptic equipments and then presents a set of recent tactile innovations, as well as the proposition of a project designed to offer an accessibility application based on the Android platform for adaptability performance testing by visually impaired users.

Keywords: Accessibility, Blindness, Haptics, Android.

Várias iniciativas nas últimas décadas foram lançadas visando um feedback tátil adicional para as pessoas cegas. A maioria das pessoas dependia de hardware especial que poderia estimular as mãos, a língua ou outras partes do corpo para permitir que os deficientes visuais absorver algumas informações ambientais adicionais, aumentando assim a sua qualidade de vida. O recente desenvolvimento de poderosos aparelhos pessoais programáveis, como novos tablets e smartphones, abre uma ampla gama de oportunidades para a implantação de soluções acessíveis para pessoas portadoras de deficiência como perda de visão. Este trabalho inclui inicialmente uma revisão mostrando alguns dos marcos no desenvolvimento de equipamentos hápticos e, em seguida, apresenta um conjunto de inovações táteis recentes, bem como a proposição de um projeto projetado para oferecer uma aplicação de acessibilidade baseada na plataforma Android para testes de desempenho de adaptabilidade Por deficientes visuais.

Palavras-chave: Acessibilidade, Cegueira, Haptico, Android.

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1 INTRODUCTION

For centuries, social inclusion of people who are disabled or show some sort of limitation (when compared to the majority of the population) has been a challenging endeavor. Due to social exclusion or limitation to a restricted interaction space, blindness has been considered one of the hardest conditions a person can face. Throughout the years, many experiments were conducted to reduce capability gaps, but few periods allowed the opportunity of a leap on life quality for the disabled and blind.

In this work we review some of the more relevant innovation initiatives for the visually impaired and identify recent technological developments which may contribute to the release of a new breed of computer-based haptic solutions. In this regard, we propose the ICA3 Android-based project. It is planned for implementation in three stages starting with a basic and affordable application using standard tablet and smartphone hardware.

1.1 Methodology

A bibliographic review from multiple sources of assistive technology information (including IEEE and ACM Digital Libraries e.g.) was performed with focus on exposing a representative picture of assistive solutions along the years.

A research for potentially valuable new technologies was carried out based on company profiles, US patents and assistive technology conferences and papers. The search criteria focused on solutions based on tablet and smartphone platforms using (or not) additional sensory resources.

1.2 Objectives

In this work we provide a review of haptic solutions developed in the last decades, and recent hardware and software improvements recently identified. Those can potentially leverage the development of further applications. We expect this new set of tools to translate into practical and affordable solutions for those who need better social interactions based on enhanced visual information feedback. The ICA3 project plan is proposed as an example of possible developments for testing the effectiveness of those new solutions.

2 HISTORICAL LANDMARKS

Since the early developments associated with Braille language, many tools were proposed aimed at improving the quality of communications and interactions of blind and low-vision people. Paul Bach-y-Rita, in the 60s (BACH-Y-RITA, 1969), proposed and developed a tactile solution that became a benchmark in its time for the use of electronic support systems to aid the visually impaired. His device, called “Tactile Vision Substitution System (TVSS)” included a camera controlled by the user, which had its optical-electrical signals converted for stimuli using tactile devices connected to the user's skin.

Many other equipments developed in similar experiments focused their improvements on system resolution, portability and mobility, but still facing problems related to their maintenance and robustness. Among other systems, a tongue unit has been investigated (BACH-Y-RITA, 2003) and later became a product. In those cases where tactile interfaces were proposed, they used several different actuator types, including piezo-electrical actuator for mechanical movement or lateral movements perception by fingers (LEVESQUE, 2009).

A broad review by Benali and Khoudja (BENALI, 2004) details most of those sensory substitution devices.

The difficulties for massive adoption of those devices were discussed by Charles Lenay (LENAY, 2003). The main concern was that those systems don't reach to substitute a sense by another, while demanding substantial learning effort to reach positive results. Another aspect was related to the expectations around a general-purpose "sensory substitution" for visual perception. Instead, researchers should focus on specific-purpose uses for those haptic devices, as stated by Jack LOOMIS (LOOMIS, 2010). In this work we follow that approach as well.

Additionally, the cost and robustness of those solutions has been a common concern.

3 NEW TECHNOLOGIES

Breakthrough technologies started to unveil new development opportunities recently. While the majority of former initiatives during the last 40-50 years involved hardware developments along with new processes and methodologies, current ubiquity of tablets and smartphones can potentially become the basis for the new touch-sensitive applications.

The new technological approaches may vary, and some of them require adding special hardware modules for the new haptic products, but some applications can be deployed in most of current tablets as they are shipped nowadays. Some examples are shown below:

Northwestern University professors Joe Mullenbach, Craig Shultz, Anne Marie Piper, Michael Peshkin, Suhong Jin, and J. Edward Colgate developed the TPad tablet and a series of prototypes showing a tactile feedback screen. The developed solution uses variable friction via an additional surface on top of the original tablet (or smartphone) screen (JIN, 2014).

The TPad has been tested using a Kindle Fire tablet and some Android applications, e.g.: Remote touch – where two remote users experiment touch sensations through the screens - and Haptic Sketching, where the user creates an effect based on direct drawings (MULLENBACH 2013). Following implementations used a Nexus tablet and also a Motorola smartphone, where new applications have been presented (MULLENBACH 2014).

Currently, the above solution is being formatted to become a product by Tanvas (formerly known as Tangible Haptics, LLC). A representative list of other solutions developed recently and close to become available to developers are mentioned below:

- Fujitsu's Haptic Sensor Tablet technology is based on the emission of ultrasonic sensible vibrations under the device screen. Friction of user finger against the surface is modified, so it causes user perception of touch. Such feature can be directed towards different areas of the screen by software with a variety of tactile sensations, from light pulses to stronger bumpy impacts. A prototype has been presented on Feb., 25th 2014 at Mobile World Congress event (FUJITSU, 2014).

- Google's Project Tango adds new sensors to mobile devices, thus allowing spatial perception for the Android platform. Motion tracking, depth perception and area learning are features included in the special Software Development Kit, which was made available for testing in the United States in May, 2015 (GOOGLE, 2015).

- Microsoft Research unveiled its Fingertip haptics technology on august 5, 2014. Immersion Corporation (IMMERSION,2015), and Senseg are other providers offering alternative haptic solutions. Finnish company Senseg has developed its Tixel technology in which eletrostactic pulses generates touch sensation on the screen (SENSEG, 2013). A Software Development Kit was made available for a period in 2014.

4 PROPOSED DEVELOPMENT PLAN

In order to contribute to the development of new and affordable solutions for the visually impaired, the ICA3 application (phonetically read as *I see a 'tree')* software is proposed. Its development (currently in requirements analysis phase) targets android-based platforms for smartphones and tablets. The application in its first stage will provide feedback based on commonly found resources (as back camera and vibration motor). Its haptic feedback will be generated when the finger is over the image of an *object* on the screen, while no sensation will be provided when the finger is on another section of the screen.

In order to allow the application to differentiate between which parts of the screen to provide feedback and which not, an image processing feature is included which transforms the camera inputs into black-and-white high contrast continuous images by amplifying the opposition between those parts of the image which shows the contours of an object (which will become 'white') and the other surrounding parts (that will remain dark), as images are processed. This way the system will distinguish, for any points on the screen, which ones are going to bear tactic feedback (thus providing sensible movement on the user's hand) and which will not produce any vibrations. This basic solution principle has been already partially described in the literature before (MULLEMBACH, 2013).

The ICA3 application in its first *basic* stage "1" will allow investigations on the potentialities and limitations of an extremely affordable tool. Its software includes: - an image processing module; - a positioning module to identify which part of the screen is pointed by the user's finger, - the motor vibration actuator module and - the correlation module that corresponds the pointed position with the 'white' or 'dark' condition of the screen in that point, so the sensible feedback can be generated based on system vibration. In stage '2', we will use Android's Accessibility Services and the Tanvas platform features. The application will allow enhanced feedback, thus users will have a more complex tactile experience for investigations. All software elements are designed for implementation in Java using Android Studio environment and tools.

Table1 – Project phases

Stages	Main implementations
1	STANDARD TABLET HARDWARE; TACTILE FEEDBACK WITH A SINGLE TOUCH POINT
2	ADDED: TANVAS TPAD HW USING ICA3 APP WITH ENHANCED FEEDBACK
3	ADDITIONAL HW & SW (GOOGLE TANGO'S "DEPTH SENSE" FEATURES)

Source: Project team

The main intention for those implementations is to allow blinded users (initially from local associations) to test and provide feedback to those applications. As already mentioned (LENNAY, 2009), some educational efforts must be endeavored so that users may take the most out of the applications. One of the aspects is related to the capacity of using touch sensations for decoding visual images. A special learning program is proposed with exercises for practicing the recognition of basic forms (squares, rectangles, triangles and circles) as well as 3-D volumes and more complex shapes. In special, investigation related to the projected *in perspective* view of distant objects (which seem small but are not really small) is of special interest using those devices.

The future stage '3' application aims the integration with the Google Tango Platform, adding 'depth perception' features which will provide complementary information to help users deal with perspective views and moving images.

Along with the tests by visually impaired persons, one future option being considered is the selection of specific sounds which can be added to provide additional feedback information based on the pointed image properties, as proposed by Jack Loomis (LOOMIS, 2010).

5 CONCLUSIONS

We found during the investigation various new technological resources presenting early achievements and potential for a broader adoption in the future as the new solutions for the blinded show efficacy. The proposed implementation project aims at following that new path, test users adaptability and stimulating other developments in the same direction in benefit of those who need additional visual information.

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