Production of Low Cost Assistive Technology

Erik Schüler
Instituto Federal de Educação, Ciência e Tecnologia
Rio G. do Sul - Farroupilha
Av. São Vicente, 785
+55 (54) 3260-2400
erik.schuler@farroupilha.ifrs.edu.br

Bruna P. Salton
Instituto Federal de Educação, Ciência e Tecnologia
Rio G. do Sul - Bento Gonçalves.
Av. Osvaldo Aranha, 540
+55 (54) 3455-3200
bruna.salton@bento.ifrs.edu.br

Andréa P. Sonza
Instituto Federal de Educação, Ciência e Tecnologia
Rio G. do Sul - Reitoria
R. General Osório, 348
+55 (54) 3449-3300
andrea.sonza@ifrs.edu.br

Agebson R. Façanha
Instituto Federal de Educação, Ciência e Tecnologia
Ceará - Fortaleza
Av. Treze de Maio, 2081
+55 (85) 3401-2300
agebson@ifce.edu.br

Rodrigo Cainelli
Instituto Federal de Educação, Ciência e Tecnologia
Rio G. do Sul - Reitoria
R. General Osório, 348
+55 (54) 3449-3300
rodrigo.cainelli@ifrs.edu.br

Juliano Gatto
Instituto Federal de Educação, Ciência e Tecnologia
Rio G. do Sul - Bento Gonçalves.
Av. Osvaldo Aranha, 540
+55 (54) 3455-3200
juliano.gatto@bento.ifrs.edu.br

Luan Kunzler
Instituto Federal de Educação, Ciência e Tecnologia
Rio G. do Sul - Farroupilha
Av. São Vicente, 785
+55 (54) 3260-2400
bolsista_ta@farroupilha.ifrs.edu.br

Maria da C. C. Araújo
Instituto Federal de Educação, Ciência e Tecnologia
Ceará - Fortaleza
Av. Treze de Maio, 2081
+55 (85) 3401-2300
mariacarneiro@ifce.edu.br

ABSTRACT

The Assistive Technology Centers of Instituto Federal de Educação, Ciência e Tecnologia of Rio Grande do Sul and Ceará in Brazil have been developing a range of low cost assistive technology (AT) products. These products are developed to have exactly the same functionality and performance as commercial ones, but with much lower price. Some examples of low cost AT products developed include: Braille display, thermoforming tool for production of tactile materials, cane tip that detects puddles, digital game that helps the visually impaired in rehabilitation involving mobility and orientation using 3D sound effects, Android application for blind people to access Twitter, different types of switches that use balls to perform computer mouse functions (small ball to be used by hand and big ball to be used by foot), sip-and-puff switch, capacitive touch switch, a type of mouse that uses a set of buttons to perform regular mouse functions and movements, another type of mouse that uses buttons and rolling bars for moving around the screen, computer keyboard key-guard, home automation system with web interface, augmentative and alternative communication devices, and a proposition for digitally creating video audio description. The range of technologies developed continues to grow due to increasing demand.

Categories and Subject Descriptors

Accessibility and inclusion.

General Terms

Design.

Keywords

Assistive technology, adaptive technology, disability.

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1. ASSISTIVE TECHNOLOGY

Assistive products are a direct consequence of applications already established. Their main goal is to make possible, for people with disabilities, to have their functional abilities augmented in order to, as much as possible, have a normal life.

Assistive technology was first defined in the United States where a legal definition was first published in the Technology-Related Assistance for Individuals with Disabilities Act of 1988 (The Tech Act). This act was later replaced by the Assistive Technology Act of 1998, defining assistive technology as technology designed to be utilized in an assistive technology device or assistive technology service. The term assistive technology device means any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities while assistive technology service refers to any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device [1].

In Brazil, assistive technology is defined as an area of knowledge, with interdisciplinary characteristic, which encompasses products, resources, methodologies, strategies, practices and services that aim to promote the functionality and participation of people with disabilities, aiming towards their autonomy, independence, quality of life and social inclusion [2].

It is considered disabled a person who, by the reason of congenital or acquired loss or abnormality in functions of body structures, including psychological functions, may present particular difficulties in conjunction with environmental factors that limit or hinder the activity and participation on an equal basis with others [3] [4].

It is known that the use of assistive technologies helps people with special needs to participate in their daily activities, giving them a maximum level of independence. On the other hand, it is also known that most of the products developed as assistive technologies can be extremely expensive, what can preclude their acquisition on the market.

With this in mind, this document aims to briefly explain about the development and concept of social assistive technology, as well as to demonstrate some products built with low cost material, aiming

to provide technologies similar to the commercial ones, but with a price reduction of up to 70%.

This paper is a report of technological products available by our research groups. Many of them do not have great technological advances. On the contrary, some of them use commercial parts to be done, but the goal here is to present the results achieved by now by the two Brazilian groups and make, when possible, a comparison regarding cost and performance of our products and the commercial ones.

In section 2, some of our low cost technologies are demonstrated, where price and performance are compared. Conclusions are depicted in section 3.

2. LOW COST TECHNOLOGIES

Social Assistive Technology (SAT) is a term that is not widely used yet, and can be defined as everything developed and/or adapted to promote autonomy and improvement in Activities of Daily Living (ADL).

They can be developed and/or idealized by the society through Non Governmental Organizations, Public or Private Institutions, Community Associations, Social Movements, Cooperatives, Universities, Research Centers and Sponsors [5].

In many low-income and middle-income countries, only 5%-15% of people who require assistive devices and technologies have access to them. Production is low and often of limited quality. In many settings where access might be possible, costs are prohibitive [6].

Knowing that access to assistive technology can be difficult, especially because of the high cost, it is important to be creative in using existing resources in new ways.

About thirty different solutions are currently being produced or in phase of development at two Brazilian states, Rio Grande do Sul and Ceará, in the Assistive Technology Centers inside the Federal Institutes for Education, Science and Technology installed on them, although many other centers exist. Most of these products are hardware based solutions (about twenty), while the others are software based solutions. Following, eight of these products are presented.

2.1 Braille Display

A Braille Display, or a Refreshable Braille Device [7], is to be used by blind-deaf people, who are unable to read texts from, for example, a computer or hear it from a voice synthesizer [8].

The apparatus is capable of capturing the text through a special software and send it to the device to be read by the user. In Brazil, this assistive device can reach up to U$4,000.00, due to import fees and, of course, the manufacturer's profit.

By achieving a commercial Braille module, a U$1,000.00 Braille Line has been developed, with the same functionality of the imported one. A free or paid software reads the text from the computer and transforms it into a bit stream, that is sent through the USB port. A microcontroller receives, treats and sends the data to the Braille module in order to translate the text into a sequence of points characters, as depicted in figure 1.

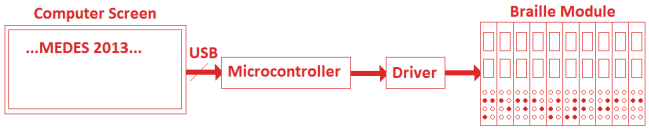


Figure 1. Braille line scheme.]

Once one line of the text is read, the user jumps to the next line and the device refreshes itself. Also, many other features were added to the product, such as a clock, a voice decoder, able to transform into Braille what is been said, an interface to the capacitive driver described in subsection 2.3, or any other driver available, and more. For blind-deaf people, such tool can become the only communication way with other people.

2.2 Button Mouse

People who have motion limitations are often unable to use common mouses, mainly due to its small size. Thus, special mouses are adapted to work through the use large buttons, as shown in figure 2.

As one can see, instead of moving the mouse itself, only buttons are pressed to displace the cursor on the screen. A five times cheaper mouse has been developed with the same functionality of commercial ones, and a first version ten times cheaper mouse has been produced with recycled parts.

Beyond the regular mouse functions (up, down, right, left, right click and left click) held by the buttons, one can connect eight different drivers to performance different functions through drivers controlling (see section 2.3 for an example).

Through the use of these drivers, the buttons functions are displaced to the drivers themselves, thus facilitating the use of the computer by people with severe limitations.

Figure 2. Button mouse.

A commercial device costs about U$300.00, but the one herein presented can be fabricated for no more than U$20.00, with exactly the same functionality of the first.

2.3 Capacitive Driver

The capacitive driver, based on capacitance variation due to the touch (finger, hand, foot, etc) is indicated for people who, for different reasons, present limited movements.

It can be connected to electrically conductive surfaces, such as fruits or any metallic or semi-metallic object, and allows one to control other devices connected to the capacitive driver.

For example, in figure 3 it is shown the driver connected to an apple. Once the user touches the fruit, the capacitive driver detects and drives, for example, a lamp, a sound emitter or even a computer mouse.

Figure 3. Example of application for the capacitive driver.

When connected to the button mouse described in section 2.2, the set becomes a powerful tool for people with movement and/or speech limitations.

As far as the authors know, there is no similar devices commercially available and the final price for the presented device is reaches about U$20.00.

2.4 Audio Transmitter

The audio transmitter is a bluetooth based device to help students with Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD) at the class room [9], [10]. The device uses a bluetooth connection to send audio data from a server device (teacher's cell phone, for example) to the connected users (students' cell phones, for example).

Since there is a signal treatment to eliminate external noise, only the teacher voice is transmitted, thus reducing the negative effects of any possible environmental disturbance to the student with ADD or ADHD.

Figure 4(a) outlines the transmission scheme, where a teacher transmits the class to four students through bluetooth connection.

A commercial apparatus will cost about U$1,700.00, while this one, which is essentially software based and can be used in any Android based device, can be distributed for free through internet.

Once the teacher and the student downloads the application, there is no other adjustment to be done. After turning on the equipment, they will connect themselves with each other, and transmission may begin. Since connection will be between the teacher's transmitter and student's receiver, no crosstalk occurs.

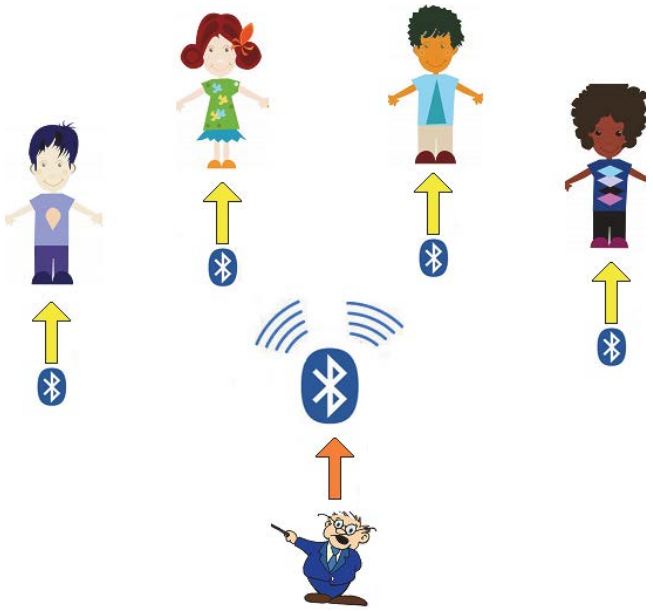


Figure 4. Transmission scheme for ADD/ADHD assistance.

2.5 Cane Tip for Water Detection

Blind or even visually impaired people commonly use a cane as a mobility tool. One of the several problems faced by these people is to soak their shoes in puddles, causing discomforts that can last for hours.

In order to solve this problem, a special tip that vibrates when in contact with puddles was created. Actually, any walking stick can be used, since only the pointer of the stick is adapted to it by the user itself.

The system is based on a simple driver circuit, which is performed by a Darlington pair [11] that triggers a small vibrating engine when water closes the contact on the pair base.

Once more, no commercial equivalent is known, but the final cost of the presented solution can be estimated on about U$20.00.

2.6 Virtual Audio Description

This project enables blind people to access video productions, by using audio description. The technique uses a software that combines and synchronizes a text file containing descriptions of a certain movie, for example, with voice synthesis, making easier the movie comprehension when no dialogue is available between the movie characters.

Differently of the available commercial software, this one allows user to chose the most pleasant voice he/she wants to hear. The user also has the possibility to count on the support of virtual communities to describe different titles, making such movies, for example, quickly more accessible.

2.7 Digital Way

The project aims to develop a system including localization tags, sensor devices with bluetooth communication, smartphones and an online management system with a database that allows, together with a tactile floor, the orientation and information about points surroundings blind people.

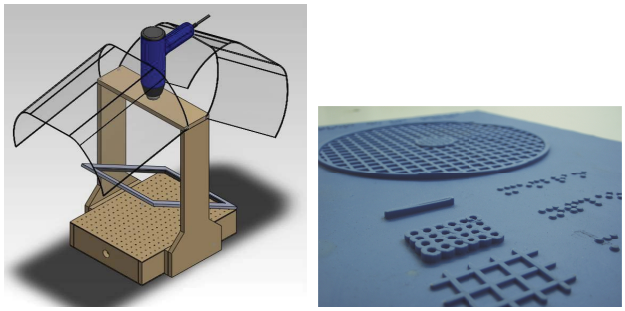
The implantation of such system in an indoor environment, makes possible, for blind people, to walk around with independence and autonomy, only by using a walking stick (cane tip) and an Android compatible application, properly installed on the user smartphone.

2.8 Thermoforming Tool

A thermoforming tool allows the production of different tactile study materials from prefabricated patterns containing the desired images or reliefs.

The apparatus consists of a perforated box to create vacuum through a heater. Once a plastic pellicle is placed between the box and the predefined pattern, this pellicle will mold itself. Figure 5 depicts the tool scheme and an example of a tactile material.

The cost of a commercial thermoforming tool is about U$4,000.00. However, the presented product has a final fabrication cost of no more than U$135.00.



(a) (b)

Figure 5. (a) Thermoforming tool and (b) tactile material example.

2.9 Other accessibility solutions

As mentioned, many other products are in fabrication or development phase. In the hardware portion, one can cites different kinds of drivers to be used by people with different limitations, home made computer keyboard key-guard, blow triggered drivers, spacial orientation through ultrasound sensors, tactile floor, etc.

In software branch, some of the solutions are a web controlled home automation system, 3D sound effects games, educational games, Quick Response Code (QR-code) readers through smartphone and others.

There is also a team specialized in web accessibility, responsible for identifying and solving accessibility issues in governmental websites. Web accessibility basically means that people with disabilities can perceive, understand, navigate, and interact with the web. The main goal of the web accessibility team is to provide solutions to ensure accessibility on Brazilian government websites and systems. This team participated in the development of the Brazilian government web accessibility guidelines, called e-MAG, and has created a web based system for manual accessibility evaluation that involves real users and generates a report with both quantitative and qualitative results. The latest project of the web accessibility team is the development of a content management system that generates accessible content and is accessible itself to users with disabilities. The team manages to keep an accessible website, where any person can find information about web accessibility, assistive technology, and special education. The website code, which was built following accessibility guidelines, is available for download.

3. FINAL REMARKS

A huge number of assistive technologies is possible, depending mostly on the disability one is dealing with. For example, for blind people, can tips, spatial orientation (through different methods) and Braille writing are essential while, for deaf people, visual effects are a key point. In other words, there is not one single solution for all kinds of special needs people can present.

As consequence, since demand is not that large, the price can become an important limiting factor for life improvement, regarding people with these special needs.

At the Assistive Technology Centers of Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Sul and Ceará in Brazil, different solutions, having low cost as the bottom line, have been developed in the last five years, culminating in almost thirty products, although many others are being currently studied.

Many of these solutions have already been distributed to other government and/or private associations, and the main goal for the next years is to equip about 400 centers for people with disabilities in Brazil. The goal of this paper was to present some of solutions developed and compare, as much as possible, their fabrication cost with commercial devices, while maintaining performance and functionality.

4. Finally, for every product herein described, a correspondent make yourself manual is written and distributed via internet for free. The idea is that anyone can download it and construct his/her own solution, thus going toward the social assistive technology concept.

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