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► **To cite this version:**

Kayo C. Santana, Abel R. Galvão, Gabriel S. Azevedo, Victor T. Sarinho, Claudia P. Pereira. Braillestick: A Game Control Proposal for Blind Users Based on the Braille Typewriter. 19th International Conference on Entertainment Computing (ICEC), Nov 2020, Xi'an, China. pp.142-147, 10.1007/978-3-030-65736-9_13 . hal-03686024

HAL Id: hal-03686024

<https://inria.hal.science/hal-03686024>

Submitted on 2 Jun 2022

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Braillestick: A Game Control Proposal for Blind Users Based on the Braille Typewriter*

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Abstract. Nowadays, modern technology is increasingly present in society. However, for the visually impaired people, this technological advance is not so inclusive, especially in the learning processes. This article discusses the development of Braillestick, a joystick similar to the braille machine but with a low cost and greater portability for different platforms. This joystick aims to be a pathway for the development and use of serious games for audiences with visual problems.

Keywords: Game Joystick · Braille Device · Assistive Technology.

1 Introduction

By the growth of technology in the 21st century, the use of the internet in routine activities has become practically indispensable [1]. As a result, common activities like scheduling an event on the smartphone, until something more complex like developing natural language bots, has become simpler and possible for people in general. However, when considering people with visual impairments, although some research has focused on the development of learning environments for them [2-4], they do not have in most cases a viable access to current Information Technology (IT) solutions.

Regarding the development of learning environments for visually impaired, the use of digital games can help in amused ways, with different applications in education, culture, training and practicing [4-6]. However, due to the constant IT evolution, the teaching and learning process through games needs to be constantly updated to find accessible ways for all audiences. As a result, it is necessary to develop alternative and inclusive technologies for people with visual impairments that do not deprive the game experience of the final user.

* Supported by organization CAPES.

Looking for an accessible and portable alternative for people with visual impairments to play serious games related to the Braille writing system, this paper presents the Braillestick proposal. It is an adapted game joystick that works like a Braille Typewriter (BT) and allows people to learn and practice the Braille writing while playing.

2 Related Work

The Braille System is a valuable tool for people with congenital or acquired blindness, as long as it allows them to read and write. Braille was created by Louis Braille, in 1825, and today is still the most precious instrument of writing and reading for visually impaired people, allowing direct contact with words [7, 8].

Over the years, some researches have been responsible for spreading the Braille writing process across different devices, such as smartphones, computers and tablets. As an example, Hamzah and Fadzil [9] proposed the Voice4Blind application, which allows users to type using a keyboard adapted for Braille when connected to mobile devices. Per Lee and others [10] and Yang and others [11] proposals, devices that work like a glove were developed, allowing the writing of characters by the movement of the hands, where position and movement of the fingers are similar to the form used on the BT. Similarly, Chakraborty and others [12] proposed the FLight, a system of reading and writing that uses a low-cost wearable glove device that reads Braille printed texts and a special ruler containing blocks for easy writing.

To help visually impaired children, Gadiraju [13] proposed the BrailleBlocks learning system. It consists of a set of wooden blocks and pins representing a Braille cell that can be used by children, together with an interface computer with games for their parents. Google also launched a Braille keyboard for Talk-Back [14], a screen reader application for blind Android users. This proposal seeks to work similarly to the standard systems of this format, with 6 buttons distributed on the sides of the Android device [14].

Similar to those proposals, Braillestick offers an input mechanism that can be used in different applications, and also as a game control for serious games related to the Braille writing system. Unlike such proposals, Braillestick is a hardware solution that works like the BT, using its written mode to convert the Braille writing system to an equivalent in the latin alphabet.

3 Methodology

The Design Thinking methodology was applied in the development of the game device. It was chosen because of its potential to not only look into the product's development, in this case the Braillestick, but also in the target public needs and feedback.

The Design Thinking can be carried out according to 5 main steps [15]: **Empathize**, **Define**, **Ideate**, **Prototype** and **Test**. In **Empathize**, the team

needs to recognize the target audience of the product in order to create a meaningful innovation for them. After that, in the **Define** step, users' problems must be thoroughly reviewed to be overcome, leading to different ideas that will be explored in the **Ideate** step. Finally, the **Prototype** step is reserved to the design of artifacts that will help to get closer to the final solution, being redesigned according users experiences and opinions observed in the **Test**.

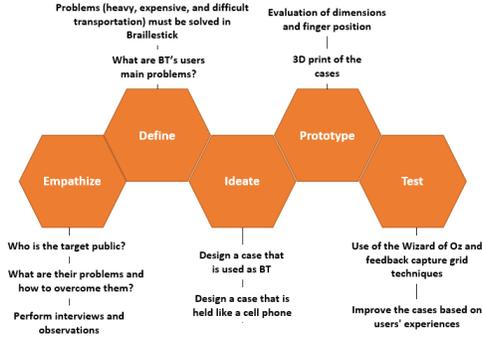


Fig. 1. Braillestick design process methodology. Adapted from [15].

Fig. 1 illustrates the Design Thinking steps applied in the Braillestick's development process. As a result, it is possible to visualize at the Ideate step two modeling proposals for the Braillestick prototype (Fig.2). The suggested fingering position can also be seen in Fig. 2 by the codes (**LT**, **LI**, **LM**, **LR**, **RT**, **RI**, **RM**, **RR**, and **RP**), where the first letter represents the **L**eft or **R**ight hand, and the second the finger name (**T**humb, **I**ndex, **M**iddle, **R**ing, and **P**inky).

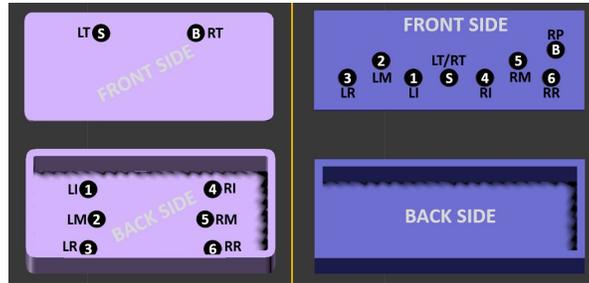


Fig. 2. Braillestick modeling proposals.

These two proposals offer two main differences for users. While the prototype idea on the left side is a proposal to use holding with the hands (similar to a smartphone-joystick), which allows its use in different places, the second one on

the right side is a proposal that needs to be over a surface, being more similar to the BT.

4 Obtained Results

For the development of an initial prototype, the Arduino UNO R3 was chosen, which is an open source hardware platform that is ideal for the creation of devices that allow interaction with the environment using buttons and sensors as input [16]. Arduino has a bootloader implemented on the board and an interface with the computer that uses the Processing language, based on the C/C++ language [17]. Among the attributes of the platform, it is possible to highlight the ease of use and the cost-benefit, since it is affordable.

For the input of Braillestick, the BT was initially observed. It has 6 buttons responsible for writing the characters in Braille. Each pressed button creates a relief in a different place in the Braille cell, representing different characters according to the pressed buttons simultaneously.

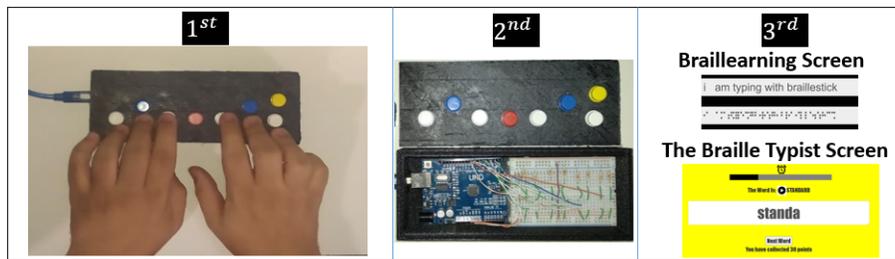


Fig. 3. Braillestick's use scheme.

Fig. 3 shows how the Braillestick works. At 1st moment, the user presses simultaneously buttons from 1 to 6, according to the Braille character he wants to write. After that, at the 2nd moment, the Arduino checks the states of the buttons and sends to a device (e.g. computer), through serial port (USB), a code to identify which buttons were pressed. Finally, at the 3rd moment, the device receives that code and processes it through a driver, developed in Python programming language, for reading the Arduino output and to match the received code with the corresponding letter of the Latin alphabet. For each obtained letter, the **Braillelearning** [18] software illustrates the displayed text and the respective braille representation. Moreover, in an entertainment perspective, the **The Braille Typist** game shows the obtained braille training and learning by matching letters according to the game logic.

At this point, Braillestick's prototype (Fig. 3) is already working, according tests performed with the development team in the Braillelearning software, that investigates not only the process of writing but also the shape and dimensions of the case, providing an ideal finger position.

Until now, the tests were developed by using Braillestick as an input device in Braillelearning Software, this way, we were able to test if all possible combinations were working fine, according to the Braille Alphabet. Besides that, it was also tested Graphic accentuation and other symbols used to perform numbers and capital letters.

5 Conclusions and Future Work

Braillestick's development and research refers not only to the production of a game joystick but also to the development of a low-cost assistive technology to help the social and digital inclusion of visually impaired people.

While a Braille Typewriter machine costs around \$800.00, Braillestick's production costs were around \$60.00 (arduino, 3d print, and other components), representing a price reduction of 75%. Besides that, Braillestick is also lightweight and easy to transport, attending 3 of the main problems related by users about the Braille Typewriter.

Until then Braillestick's case and its logical part are already developed and working fine. The next steps of the research target the test by visually impaired people, with its use on the Braillelearning learning object that is already developed and is working, and with the blind game The Braille Typist, that is currently under development.

As future works, we will also explore the input and precision rates of visually impaired users in typing games using Braillestick and other devices (regular joystick and keyboard, both mapped to work similar as a braille typewriter) to see the benefits of the proposed console when compared with other devices. Furthermore, the development of new games is also expected to disseminate the joystick use and even the Braille learning and application.

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