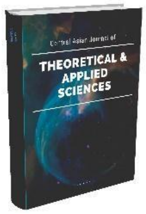

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Design and development of a folding type braille keyboard

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Abstract: *In recent years, due to rapid developments in information technology, modern technologies have begun to rapidly enter human life. These technological advances are creating wide opportunities for everyone (regardless of physical and mental capabilities). Due to these opportunities, people with disabilities also had the opportunity to learn to read and write. People with disabilities who are blind use Braille to learn and communicate in their daily lives. In this age of modern technological advances, it is hard to imagine our daily life without digital devices such as tablets, smartphones, laptops, and computers. Computers play a vital role in the education process of visually impaired people. Computers have a specially designed external USB Braille keyboard that helps blind people with educational processes. This paper proposes a low-cost folding type Braille keyboard. This device is beneficial through its innovative design and its simplicity.*

Keywords: *folding type braille keyboard; blind; visually impaired.*

Introduction. According to the World Health Organization, 284 million people worldwide are considered to be visually impaired, with around 39 million blind [1]. Uzbekistan has around 66,000 blind people, about 41,000 of whom are members of the Blind Society of the Republic of Uzbekistan [2]. In recent decades, various devices and gadgets have been developed for blind and visually impaired people. It is developed an automatic system to identify and manage garments for blind people in [3]. The study, it is aimed to present a system that assists blind people in choosing their clothes. In [4], it is designed and developed a new wearable device that assists visually impaired individuals to walk independently. The proposed device, according to the study, is based on range-based sensors and would perform effectively in both indoor and outdoor environments. Another interesting study found in [5]. In the study, it is developed a braille book reader using Raspberry Pi. In [2], it is developed a display integrated mobile phone prototype for blind people. According to the study, the final prototype was tested at the Uzbekistan Blind Society and useful feedback was received from blind people about its performance. In [6], it is developed a compact braille transput communicator (BRAPTER) which is to aid and support independent living for the visually impaired community. The proposed system consisted of two independent modules: the first module is a handy 'Braille e-notepad' and the second module is a compact Braille embosser. In [7], a simple smartphone-based guiding system for overcoming navigation challenges for visually impaired people is proposed. In [8], it is developed an audio phonebook for the blind people. According to the study, the proposed device was tested by visually impaired people and feedback showed that it could be used without any problem and without special training. In [9], it is given Comparative analysis of technologies and devices for the blind and visually impaired. In [10], it is proposed smart glass system using Deep Learning for the blind and visually impaired. According to the study, the system is fully automatic and runs on an artificial intelligence server and detects and recognizes objects from low-light and dark-scene images to assist the blind and visually impaired in a night-time environment. It is developed a smart gadget for visually challenged people using Raspberry Pi in [11].

The above-mentioned studies are dedicated to the development of various gadgets and devices that are used for various purposes for the blind and visually impaired. The main objective of our paper is to design and develop a folding type of Braille keyboard for blind and visually impaired people. Therefore, the next section of the paper provides information on related work. Information on the overall structure of the paper is given below.

This paper comprises seven sections, where Section 2 outlines the prior research. Following this, Section 3 presents a general overview of the system, while Sections 4 and 5 discuss the hardware and software architectures, respectively. Section 6 provides an initial analysis of the results obtained and presents concluding remarks as well as suggestions for future research.

Related work. The main challenge for using Braille keyboards for blind people is the high cost of the latest commercially available Braille keyboards. In recent years, this problem has been solved by scholars around the world.

In [12], it is developed a BrailleEasy, which is a one-handed braille keyboard for smartphones. The developed platform was for one-handed Brailing and consisted of a custom keyboard called BrailleEasy to input Arabic or English Braille codes within any application, and a BrailleTutor application to practice one-handed Brailling. In [13], it is developed an assistive six-dot Braille Cell Keying device for visually impaired students writing with IoT technology, is named PINDOTS. In [14], it is developed a Pocket Braille Keyboard – Reader using Braille Back Service. In [15], it is presented a new text entry method for visually impaired people called OneHandBraille, and the proposed method based on gestures uses only one user's hand to type the Braille Code. In [16], it is developed A New Braille Input Method for Mobile Devices called SBraille. According to the study, the developed keyboard SBraille had advantages in comparison with other braille input methods such as Braille Keyboard, ThaiBraille, and MBraille. Smart Braille Keyboard (SBK) for learning braille literacy in blind or visually impaired people is developed in [17]. The developed keyboard can be connected to a computer or a mobile device, helping those users, especially the young, to learn Braille overcoming difficulties. It is presented a One-Handed Braille and developed a Bespoke assistive technology in [18]. In [19], it is developed a prototype of a braille keyboard for smartphones. The proposed keyboard for smartphones is designed to help blind and visually

impaired people type quick messages. Software for an external USB Braille keyboard for smartphones designed for blind and visually impaired people is developed in [20]. In [21], it is developed a wireless and portable a self learning braille device based on Android smartphone. In [22], research was conducted on mobile braille touch application for visually impaired people using the double diamond approach. In [23], it is developed a Multimodal Braille Keyboard for Android called mBrailler. In [24], it is created a Braille keyboard for the blind called OSKAR. A braille keyboard with 8 buttons is developed in [25]. In [26], it is developed a method, called BrailleÉcran, for smartphones with no physical keyboard. A novel braille pad with dual text-to-braille and braille-to-text capabilities with an integrated LCD display is developed in [27]. In [28], it is developed a vibro-tactile based Braille Display and Keyboard. Finally, an external USB braille keyboard for computers is designed in [29].
To summarize, the overview of the previous contribution mentioned above on Braille keyboards is based on software and hardware approaches. However, none of them is based on a folding-type keyboard. In this study, a folding-type braille keyboard is designed and developed.

3D model of proposed device. The proposed folding type braille keyboard consists of the following components and elements: Microcontroller (A); buttons (B); joystick (C); USB type C cable (D).

A. Microcontroller

The Arduino Pro Micro is a small module based on the ATmega32U4 microcontroller [30-36]. In terms of functionality, the controller repeats the Arduino Leonardo board, which is built on the same ATmega32U4, but has smaller dimensions. Unlike the Arduino Micro board, the Arduino Pro Micro is even smaller. The ATmega32U4 has a built-in USB controller, so it does not require an additional USB-TTL converter chip. Type-C cable is used for programming. Programming is supported by the Arduino IDE.

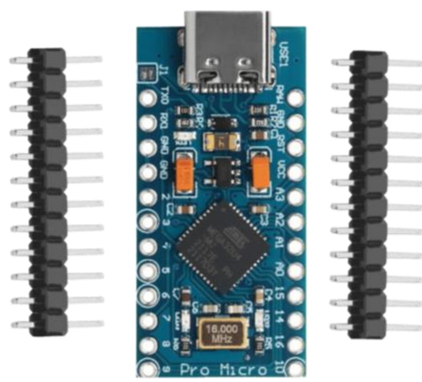

Fig. 1. Arduino Pro Micro

B. Button

A button, also known as a push button, is a basic switch mechanism used to operate a machine or process. Usually, buttons are constructed from rigid materials such as metal or plastic. Buttons are designed to be easily pressed by human fingers or hands and can be either flat or shaped to accommodate this. Most buttons are switches that are biased, but some unbiased buttons still require a spring to return to their un-pushed state due to their physical nature.

The push button is a common feature in a variety of mechanical and electronic devices, including calculators, push-button telephones, and kitchen appliances for both home and commercial use.

Push button is one of the basic components and is widely used in many Arduino projects. In this work, 8 buttons were used to design the proposed Braille keyboard.

Fig. 2. Button

C. Joystick

Arduino PS2 joystick is a thumb-operated device that, when put to creative use, offers a convenient way of getting operator input [37]. It fundamentally consists of two potentiometers and a push-button switch. The two potentiometers indicate in which direction the potentiometer is being pushed. When the joystick knob is pressed, the switch sends a low or ground signal. The Arduino PS2 joystick module is used in this keyboard due to its low cost and ease of use.

Fig. 3. Joystick

D. USB type C cable

USB Type-C is the latest and fastest USB standard. Many new devices now come with one or more Type-C ports built in.

Type-C USB connectors feature symmetrical terminals on both the port and plug, resulting in effortless insertion. They are versatile and can be adapted to connect with various USB types, facilitating the transfer of power and data to and from all previous generations of USB devices.

Fig. 4. USB type C cable

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By combining all the hardware components mentioned above, one can design a folding type Braille keyboard. 3D view of the proposed device is presented in Figure 5.

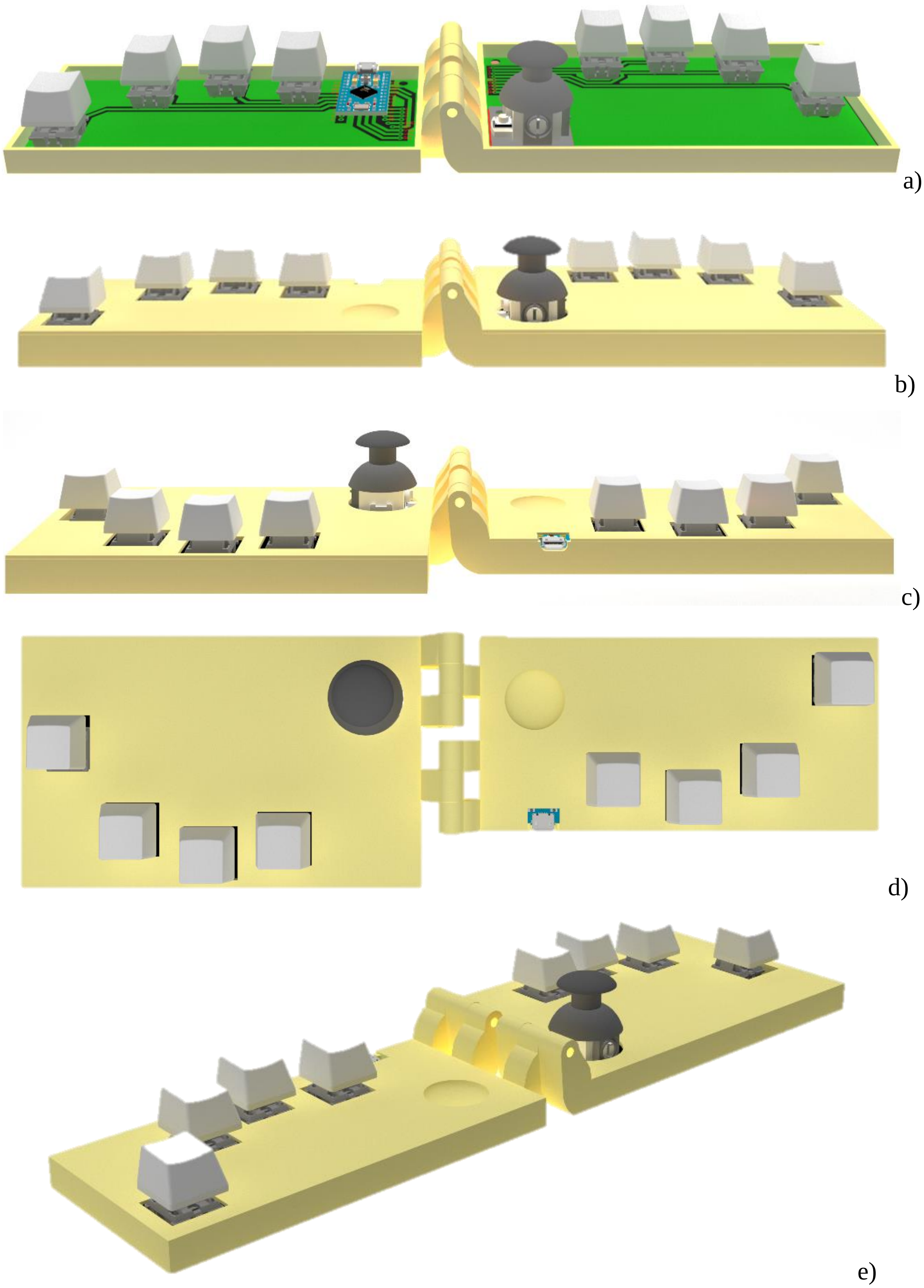


Fig.5. 3D view of the proposed folding type braille keyboard

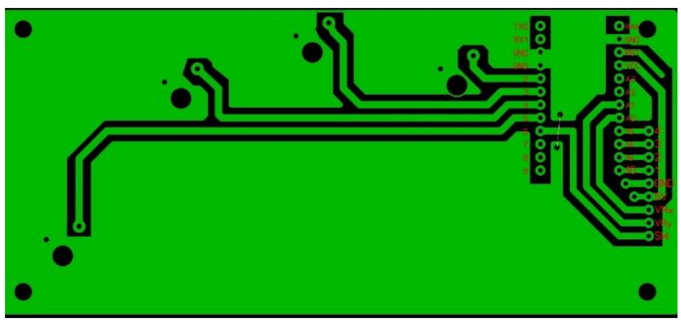
According to the figure (see Fig. 5) shown above each letter means the 3D view of the proposed braille keyboard from different angles: a) 3D view of the proposed device, where the internal components are visible; b-c) 3D view of the proposed device from the side in different forms; d) 3D view of the proposed device from the top; e) 3D view of the proposed device from the full side.

Development of the proposed device.

In the development of the device, the following was done step by step:

1) Designing the circuit board of the device;
2) Printing parts of the device from a 3D printer;
3) Welding of components of the device;
4) Putting the device into ready working condition.

A program called Sprint Layout was used to design the circuit board of the device. Sprint Layout - CAD layout of printed circuit boards. The application offers dozens of tools for designing boards: adding radio elements, tracks, soldering points, and drilling. Professionals will be pleased with the function of preparing printing on transparent film materials, and support for layers. Working with Gerber and HPGL files expands the scope of Sprint-Layout: they allow you to perform CNC milling directly from the layout.


a)

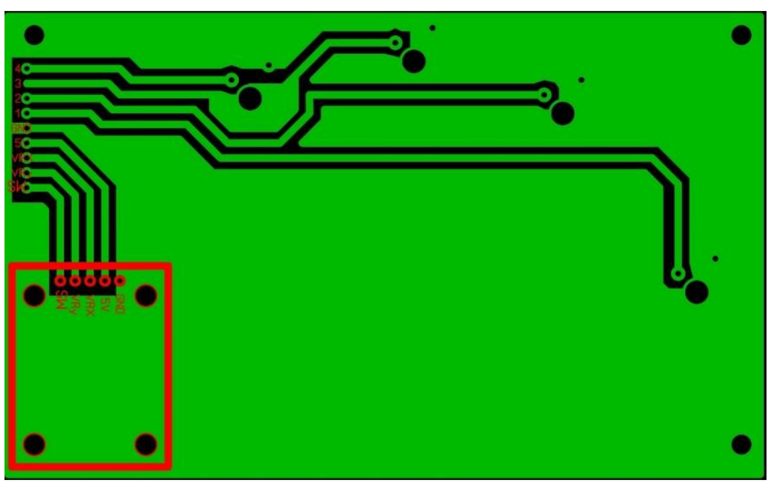
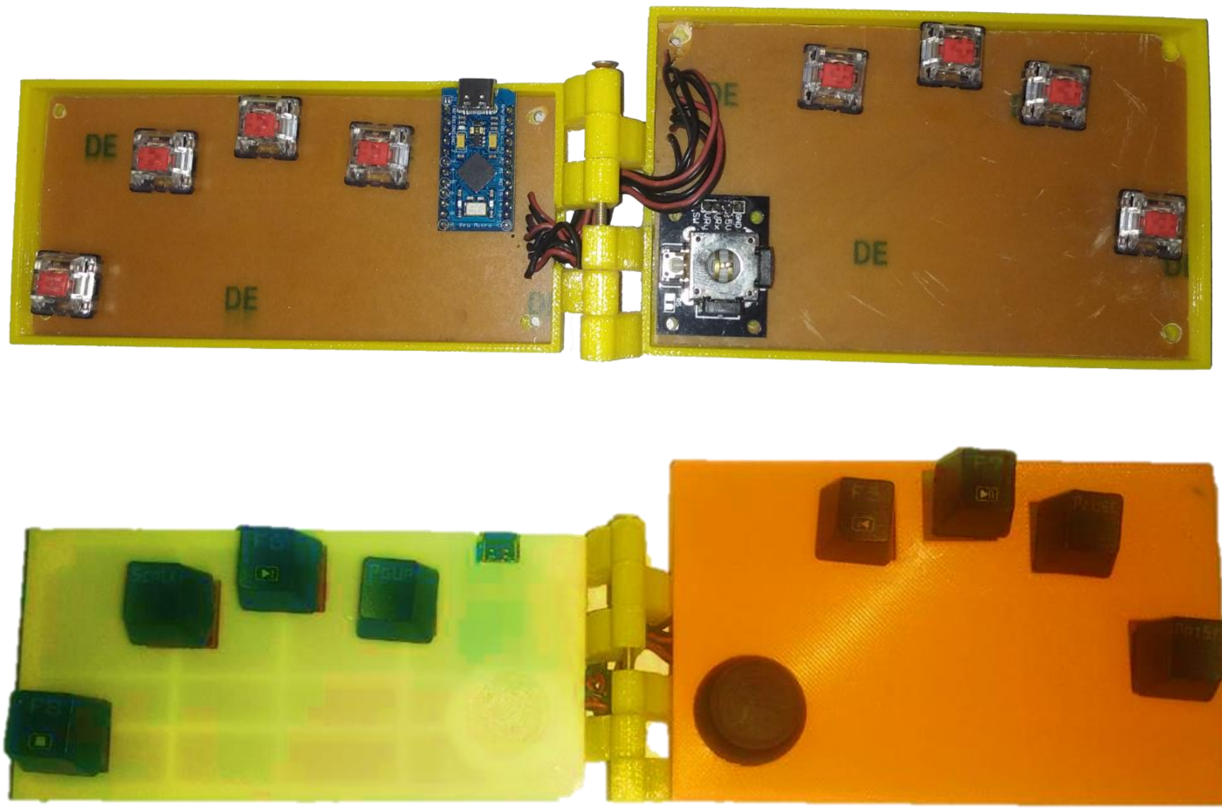

b)

Fig.6. Electronic circuits of the device.

According to the figure (see Fig. 6) shown above each letter means the Electronic circuits of the proposed braille keyboard for two separate folds: a) Circuit board schematics to install the Arduino Pro Micro and 4 keys; b) Circuit board schematics to install the joystick and 4 keys.



a)

b)

Fig.7. The working state of the proposed braille keyboard

According to the figure (see Fig. 7) shown above each letter means the working state of the proposed braille keyboard: a) the state where the keys and the upper 3D-printed shell part of the proposed device are not installed; b) the state where the keys and the upper 3D-printed shell part of the proposed device are installed.

Conclusion. Individuals who are visually impaired or blind often struggle to understand unfamiliar reading-writing systems (traditional reading-writing system which is not specialized for blind and visually impaired people). To solve this problem, the Braille system was developed. This paper develops a folding-type Braille keyboard for computers. The proposed device's design is unique and compared to other counterparts much more comfortable for typing. Because the proposed device has very light touchable keys.

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