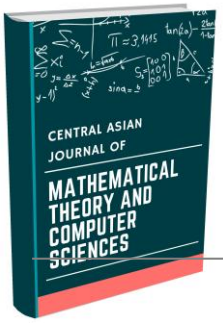

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Development of Software for an External Braille Keyboard for Smartphones

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Abstract

The 21st century is remembered as a period of great technological achievements in human history. As an example, we can cite Smartphones, which are widely used today. Various tasks can be done remotely and efficiently with the help of smartphones. Smartphones have become one of the most important assistants for everyone, including blind people. This paper develops software for an external USB Braille keyboard for smartphones designed to help blind and visually impaired people type quick messages.

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Introduction. According to the WHO report, over 2.2 billion people are blind or visually impaired, and the numbers are rising [1]. Blind or visually impaired people use smartphones on a daily basis for navigating from one place to another, for educational purposes and reading and writing messages and in various other daily tasks. In 1824, Louis Braille developed a special system called the Braille system for the blind and visually impaired to read and write. With the help of this system, blind and visually impaired people will be able to read and write freely. In the last decade, various Braille-based gadgets have been developed for the blind and visually impaired. It is developed a self-learning braille keyboard in [2]. In the study, it is used switches like SHIFT, SPACE, BACK SENSE, CAPS LOCK and SPEAK. In [3], it is developed an Arduino Wearable Keyboard (AWK). The keyboard consisted following components: Arduino Uno Board, LCD Screen, Bread Board, Push Buttons and Resistors. It is developed self-learning Braille application for visually impaired people in [4]. In the study, it is described Arduino based Hardware Implementation of the Braille teaching device. In [5], it is developed a Braille keyboard for blind people which can interface Braille keyboard with a PC through an open source software cool term.

Another interesting study found in [6]. This study aimed at developing a self-learning braille device which can help students with visual impairment in learning the system of writing braille letters independently, without reliance on companion teachers. It is developed a formulae trainer for visually impaired in [7]. The trainer is implemented by interfacing Emic2 (text to speech converter) with Arduino Uno. In [8], it is developed IoT based full duplex smart braille system for blind and deaf. In [9], it is developed Braille language software for blind and deaf people. It is developed a device for persons with low vision in [10]. The device has eight buttons, two of them are predefined, and the other 6 form the Braille language cell. In [11], it is developed a mobile Braille touch application for visually impaired people using double diamond approach. In the study [12], it is developed a display integrated mobile phone prototype for blind people. The phone is designed to help blind and visually impaired people make calls based on Braille keyboards. It is developed an independent learning system Arabic letters for blind People in [13]. Finally, it is designed an external USB Braille keyboard for computers in [14].

To summarize, the overview of the previous contribution mentioned above on Braille gadgets for the blind and visually impaired people is hardware-oriented and not intended for convenient smartphone integration. In this study, we develop software for an external Braille keyboard for smartphones.

Hardware development. The hardware development process of an external Braille keyboard for smartphones consists of the following hardware components:

ATmega32U4 microcontroller;

Buttons (push-button);

USB type B Micro Male cable.

ATmega32U4 microcontroller.

The ATMega32U4 is a low-power 8-bit AVR RISC-based microcontroller which has memories such as 32KB self-programming flash program memory, 2.5KB SRAM, 1KB EEPROM and also USB 2.0 full-speed/low-speed device, 12-channel 10-bit A/D-converter, and JTAG interface for on-chip-debug [15-21].

Fig.1. ATmega32U4 microcontroller

Push-button. A push-button (also referred button) is a simple switch mechanism which can control some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal. It is used in many Arduino-based projects to control and push devices.

Fig. 2. Push-button

USB type B Micro Male cable. The micro B type connector holds 5 pins to support USB OTG, which allows smartphones and other similar mobile devices to read external drives, digital cameras, or other peripherals as a computer might.

Fig. 3. USB type B Micro Male cable

Software development. The software development process of an external Braille keyboard for smartphones consists of the following software tools and libraries:

Arduino Integrated Development Environment (IDE);

Libraries: Mouse; Keyboard.

Arduino IDE. It is open-source software that is used to write and upload code to Arduino boards. The IDE application could run on various operating systems such as Windows, Mac OS X and Linux. The IDE supports programming languages such as C and C++. A program or code written in the Arduino IDE is often called a sketch [22]. To upload the sketch written in Arduino IDE, it is needed to connect Genuino and Arduino board with IDE. The sketch is saved with the extension '.ino.'

Used libraries. It is used the following libraries to develop software for an external Braille keyboard for smartphones: mouse and keyboard.

Mouse. The mouse library functions enable ATmega32U4 or SAMD micro based boards to control cursor movement on a connected computer through their micro's native USB port. When updating the cursor position, it is always relative to the cursor's previous location.

The mouse library has the following functions: Mouse.begin(); Mouse.click(); Mouse.end(); Mouse.move(); Mouse.press(); Mouse.release(); Mouse.isPressed().

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The mouse library has the following functions: Mouse.begin(); Mouse.click(); Mouse.end(); Mouse.move(); Mouse.press(); Mouse.release(); Mouse.isPressed().

Keyboard. The keyboard library functions enable 32u4 or SAMD micro based boards to send keystrokes to an attached computer through their micro's native USB port.

The keyboard library has the following functions: Keyboard.begin(); Keyboard.end(); Keyboard.press(); Keyboard.print(); Keyboard.println(); Keyboard.release(); Keyboard.releaseAll(); Keyboard.write().

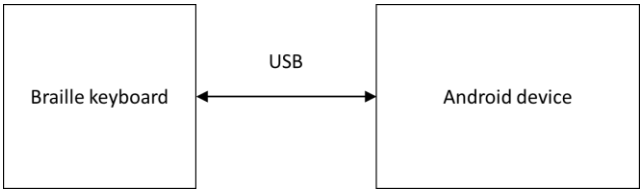

Fig. 4. Braille keyboard to Smartphone (Android device) connection

As can be seen from the figure above (See Fig. 4) an external Braille keyboard is connected to Android with the help of USB technology.

Fig. 5. Plugging in an external Braille keyboard to an Android device

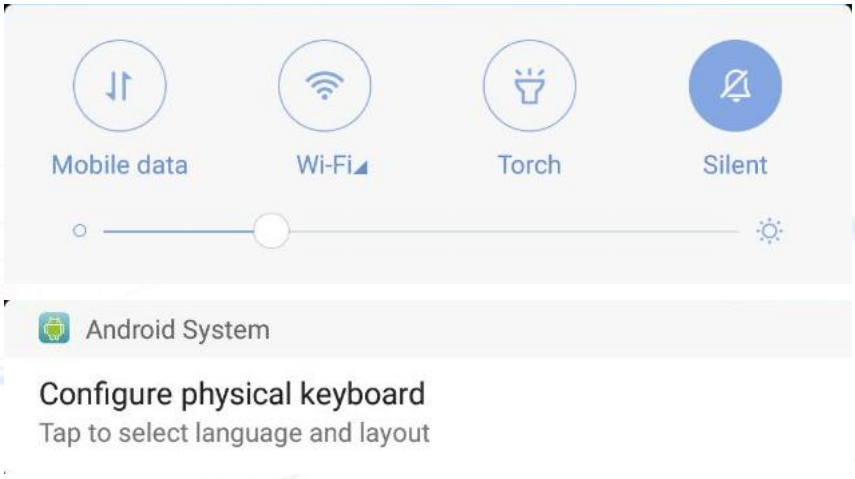

Fig. 6. The external Braille keyboard appears on the device as an external USB device

As can be seen from the figure above (See Fig. 6), when an external Braille keyboard plugs into an Android device, the keyboard appears on the device as an external USB device.

The figure (See Fig. 8) below shows a message written in the message section of the smartphone using the proposed external Braille keyboard. This message is “xabar” in Uzbek, which means “message” in English. The following combinations were executed to write this message (See Fig. 7).

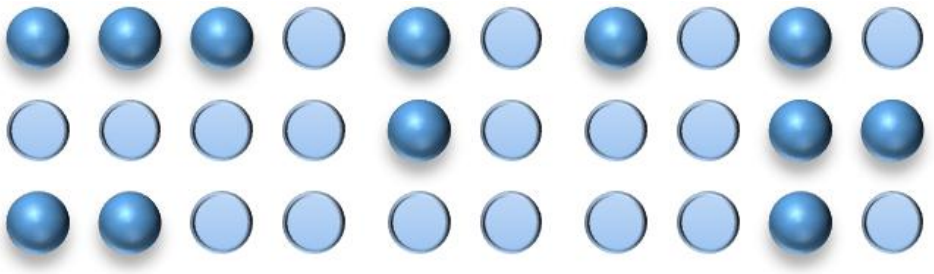

Figure 7. The word “xabar” in Uzbek is written using the Braille alphabet

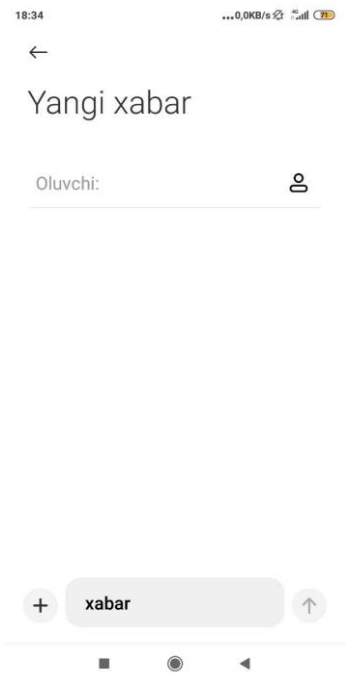

Figure 8. A message written using the proposed external USB Braille keyboard

Conclusion. Smartphones play a vital role in visually impaired and blind people's lives. They rely on smartphones in their daily activities. In this work, we have developed software for an external USB Braille keyboard for smartphones. The software performs convenient integration to smartphones (Android) using an external USB Braille keyboard. Most of the existing Braille-based phones are not designed to support touch technology and are expensive. Due to the support of the USB technology, the external Braille keyboard working on the basis of the developed software enables visually impaired and blind people to write messages using the Braille system by plugging in the external USB Braille keyboard to their existing smartphones (Android).

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