



## Principles of Creating and Using Special Devices and Braille Displays for the Blind People

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### **Abstract**

Mankind has been innovating and creating new devices for its own convenience. But blind people faced a number of challenges in using such modern devices. Special devices have been developed and are being developed to prevent this. This article explores the working principle of specially designed devices for the blind, including a Braille display device and a special software called a Braille translator. Block diagrams and operating principles of system components are given. The special program focuses on how information that is converted from flat to Braille is displayed on the device. The article concludes with the creation of special libraries for people with complete or partial visual impairment, using specially designed software and devices as a system. These libraries are different from other libraries in terms of cost, which is the reason why such libraries are the optimal option.

**Keywords:** *Blind People; Special Devices; Converter; Braille Display; Refreshable Display; Signal; Microphone; Speaker; Antenna; Memory Device*

### **Introduction**

The reason for the development of mankind as it is today is its ability to be creative, and using this ability, great inventions were created that were considered impossible at the time. The first created invention lays the groundwork for the next invention. The invention of the wheel later paved the way for the invention of the truck or other wheeled device. [1,129]

Information technology is evolving day by day. The development is so rapid that if the industry does not study the news for a year or two and stops researching, it will lag behind the emerging cadres on all fronts. There were times when no industry could be imagined without computer technology. Even modern technologies have entered all spheres of our personal life. Examples include phones, tablets, smart watches, and smart TVs at home. But keep in mind that all new devices and software are designed for ordinary people. Blind people face great difficulties in using these devices. Many special devices and

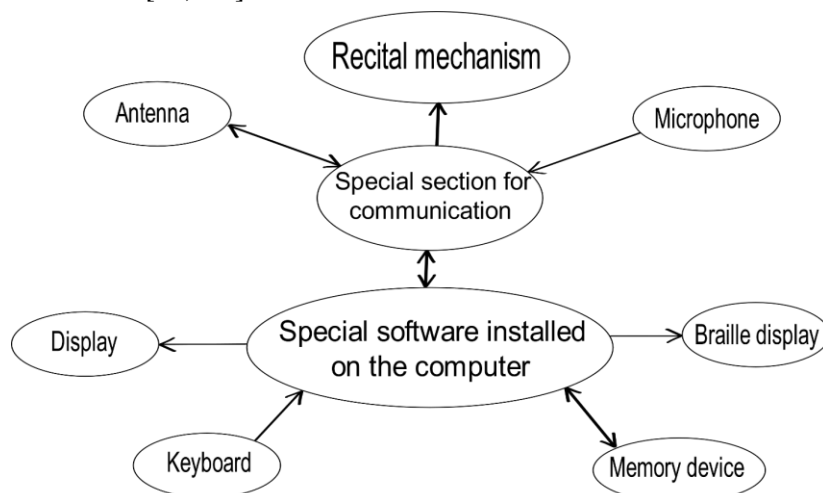
programs have been developed to prevent this. These special devices and applications are getting new looks and new conveniences day by day.

Scientists around the world have been working for years to create devices that can convert flat writing to Braille. Many have tried to solve this problem mainly by converting flat recording to sound. [12,307] Over the years, many converters and various room Braille displays have been created. The Braille display is a special device that allows a blind person to read. Braille displays can be different rooms depending on the architecture of the building. From single-room Braille displays to Braille displays with dozens of rooms. However, the Braille display works with an additional program or a microprocessor with a special code, regardless of how many rooms it has. [17,225] . The principle of operation of this converter is like software in the form of a dictionary that converts characters from one language to another.



Picture 1. The principle of operation of a converter that translates records from different alphabets to the Braille

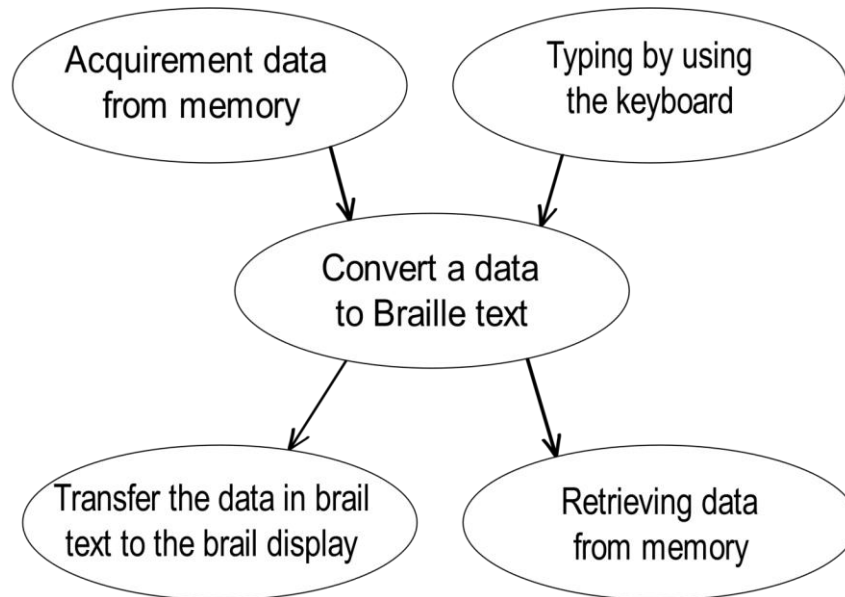
Software, such as converters, requires computers or special coded microprocessors. [11,167] Converters use a variety of other devices as well. Figure 2 The converter works in conjunction with a microphone, speaker, antenna, memory devices, display and braille displays, and other devices according to the design method. This is where data comes in or out based on the devices you work with. However, there are special parts for such communication, such as memory devices or memory devices, from which information enters and leaves. [22,151]



Picture 2. The principle of operation of converters with additional devices in current days

The principle of operation of special programs (converters) shown in Picture 2 nd. may change due to the addition of other new devices that will be added to this converter. This block diagram describes how to work with the most commonly used devices today. The non-participation of some devices in the circuit is also due to the operation of the converter. [10,278]

The main function of Braille converters is to convert data from flat to Braille. [2,67] In this case, depending on the different tasks, the principle of operation of the converter may change. That is, we encounter situations where the process of programming and transmitting flat data is different. Flat record data can be retrieved directly from memory or entered using the keyboard. Data converted to Braille can be stored in memory for immediate transmission to Braille or for later transmission. [21,155] This process is shown in Figure 3 below.



Picture 3. General operation principles of Braille converters.

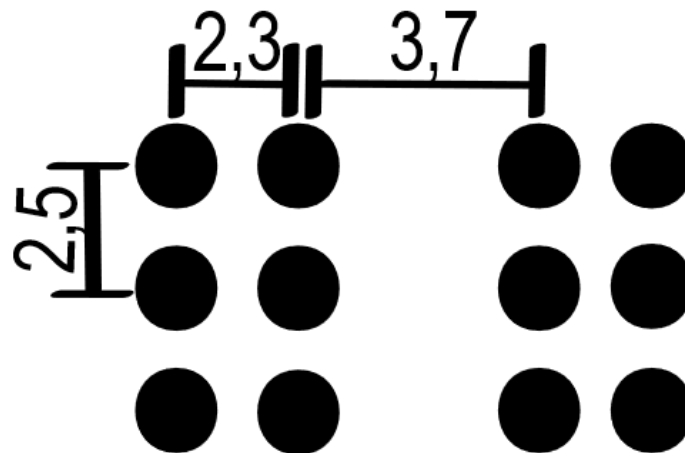
Braille converters are special programs written on a computer or microprocessor that require additional devices to work together. [9,212] The device that can achieve the most optimal results with such converters are Braille displays. Braille displays have made it possible for the blind to understand electronic recordings, such as healthy people. Different countries around the world have created different-looking, single- and multi-room Braille displays. [13,48] Figure 4 illustrates the principle of operation of a Braille display that transmits a signal to a blind person in Braille. The Braille display in this image is a special program installed on a computer, which is designed to display the signal from the converter in Braille.



The principle of operation of the Braille display, which converts the signal from a special program into information in Braille

Not all Braille displays are designed to display computer signals. [3,322] These Braille displays are special external peripherals. Braille displays have also been developed that can be converted into a microprocessor built into the device. The advantage of such Braille displays is that they can work independently without the need for a computer or other gadget. [20,39].

Braille displays will have their own standard dimensions, just like Braille dots in Braille books. There are 6 dots in a room, and the number of rooms depends on the structure of the Braille display. [8,45] In this case, the distance between the 2x3 points in each room is 2.3 millimeters in width and 2.5 millimeters in height. The distance between the rooms is 3.7 millimeters. Figure 5 shows these intervals in detail. The placement of Braille dots in this standard is the most convenient size for the blind, allowing them to easily understand Braille letters. Deviations from these standards during the creation of Braille displays can cause them inconvenience. Therefore, it is not recommended to deviate from such standards. [16,134]



Picture 5. Standard sizes of Braille dots (in millimeters)

The principle of operation of Braille displays is to create embossments from 2x3 points on the device and return them to their original position after touching it with a finger, and then emboss the next letters again. [7,124] In multi-room Braille displays In the case of a series of letters in Braille rooms, the letters in a single-room Braille display are embossed in the same room. [19,217] Note this in the process of creating a single-room Braille display. It should be noted that when the first letter is embossed during the embossing process and during the second embossing process, a convenient time unit should be selected for the blind person. Figure 6 below shows this time interval as n-sec and shows how a one-room Braille display works when the device word is displayed.



Picture 6. One-room Braille display of the word "device"

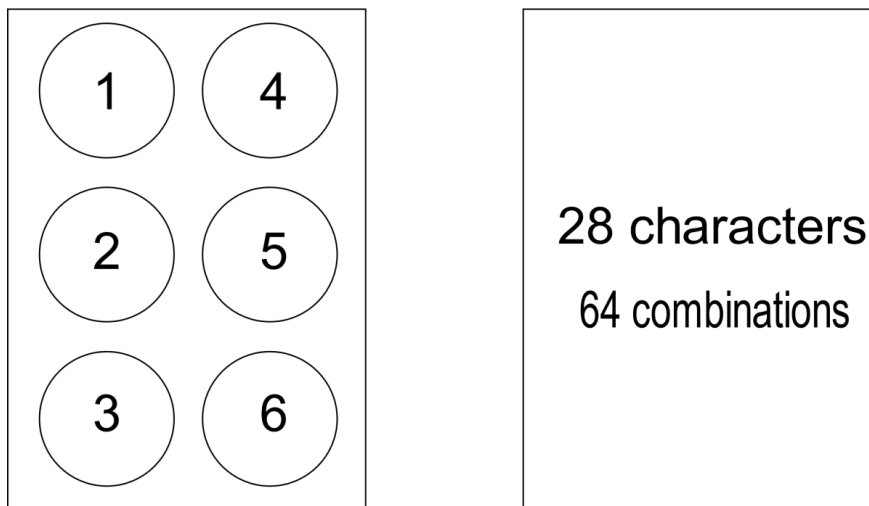
In the first step, the letter "d" is transmitted in Braille, and after the blind person presses the bulge with his finger, he moves on to the second step. In the second step, the process of returning the bulge to its original position takes about n seconds. In the third step, the letter "e" is transmitted in Braille. In this case, the process continues.

The Braille display is planned to be built on the Arduino device, which is a small board with its own microcontroller and memory. There are many types of Arduino: Arduino Yun, Arduino Uno, Arduino Duemilanove, Arduino Diecimila, Arduino Nano, Arduino Mega, Mega 2560, Mega ADK,

Arduino Leonardo, Arduino Micro, etc. [4,213] varies depending on. The Arduino is for researchers in the fields of mechatronics and robotics. The device can be used to create a variety of devices, fun operations, and even robots by writing small or large programs. Programs for the Arduino are written in C ++. [6,79] Combining electronics and programming, this device has the ability to create amazing things. We have chosen the Arduino Uno for the device we are going to create, and the general characteristics of this device are as follows:

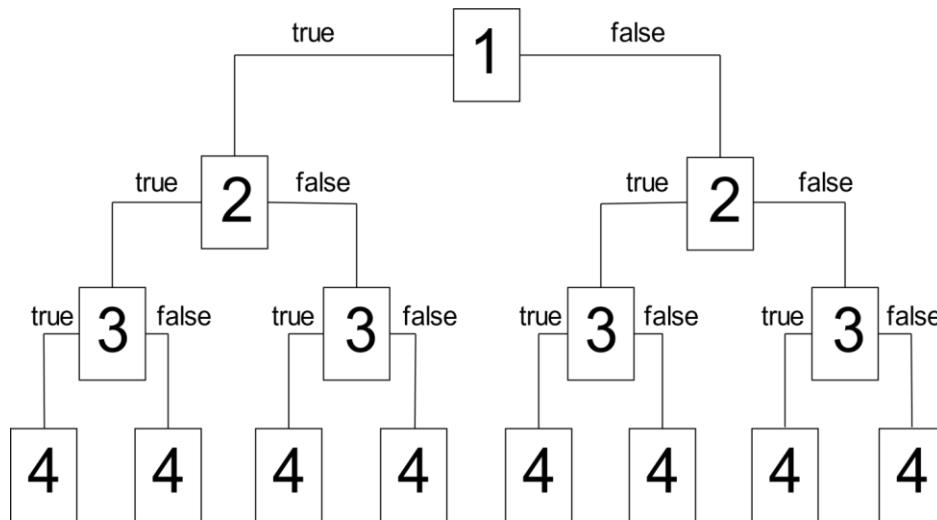
Microcontrollers: ATmega328;  
 Operating voltage: 5 V;  
 Input voltage (recommended): 7-12 V;  
 Input voltage (maximum): 6-20 V;  
 Digital input / output: 14 (6 of them can be used as KIM (Shirotno-Impulsnaya modulation));  
 Analog input: 6;  
 Input / output alternating current: 40 mA;  
 3.3 V AC for input: 50 mA;  
 Flash memory: 32 KB (ATmega328) is used as a 0.5 KB bootloader;  
 RAM: 2 KB (ATmega328);  
 EEPROM: 1 KB (ATmega328);  
 Frequency: 16 MHz;

Specific software is also developed to make such Braille displays work properly. Before developing this software, it is necessary to first create an algorithm to run it. consists of a point.



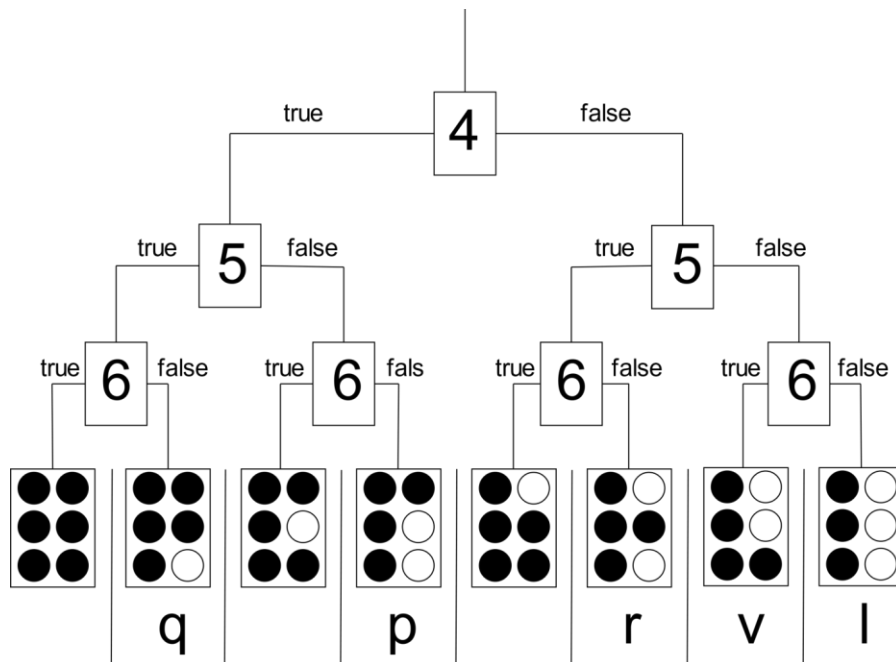
Picture 7. Total characters and key points on a one-room Braille display

Through the 6 points given in Figure 7, we obtain a total of 64 combinations, taking into account whether they are embossed or not. In this case, if we divide 28 of the 64 combinations into special characters and commands, the remaining combinations will be left blank for future use of other commands or symbols. And that gives us more opportunities. The algorithm belongs to the branching type based on yes or no and is based on the elements of the truth table. In this case, when placing on the Braille display, our six main points are given as true or false, depending on whether they are embossed or not. Swollen points are considered true, non-swollen points are considered false. First the first point, then the second point, in this example six all the points are considered in sequence, and at the end of the work the letters of the Latin alphabet are formed on the Braille display.



Picture 8. The first four stages of the algorithm and their classification according to the elements of the truth table.

As you can see in Figure 8, the work starts at the first point and then continues at the other points. Because of the complexity of the algorithm, it was necessary to break it down into parts. Figure 8 shows the first part, and the process continues after the fourth stage. The reason is that there are still two more dots on the Braille display. Figure 9 shows the continuation of the first part of the fourth stage of the algorithm, which consists only of truths.



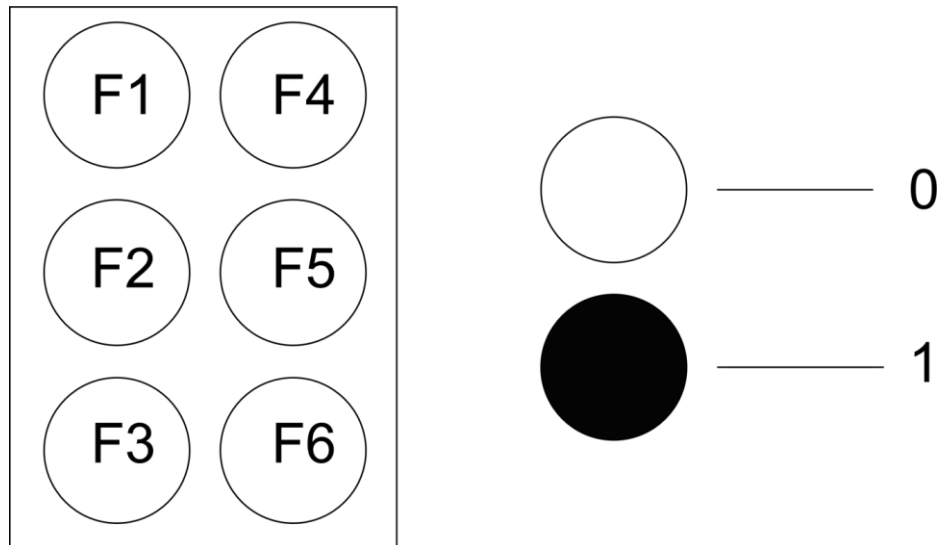
Picture 9. The next steps of the algorithm and its formation in the form of Braille letters.

If we look at the first part of the algorithm, the fourth stage was divided into eight types according to the truth and falsehood from above, and in Figure 9, only the first part of this fourth stage was continued, and the remaining seven parts were not shown. The remaining 7 parts are each made up of

eight different combinations, as shown in Figure 9. Therefore, we can say that this algorithm has 64 combinations with 6 different basic points.

Now let's talk about the structure of the program based on this algorithm.

```
{
int F1,F2,F3,F4,F5,F6;
if (F1=1 && F2=1 && F3=1 && F4=1 && F5=1 && F6=0)
{cout<<"q"; }
if (F1=1 && F2=1 && F3=1 && F4=1 && F5=0 && F6=0)
{cout<<"p"; }
if (F1=1 && F2=1 && F3=1 && F4=0 && F5=1 && F6=0)
{cout<<"r"; }
if (F1=1 && F2=1 && F3=1 && F4=0 && F5=0 && F6=1)
{cout<<"v"; }
if (F1=1 && F2=1 && F3=1 && F4=0 && F5=0 && F6=0)
{cout<<"l"; }
... (all letters are entered this way)
return 0;
}
```

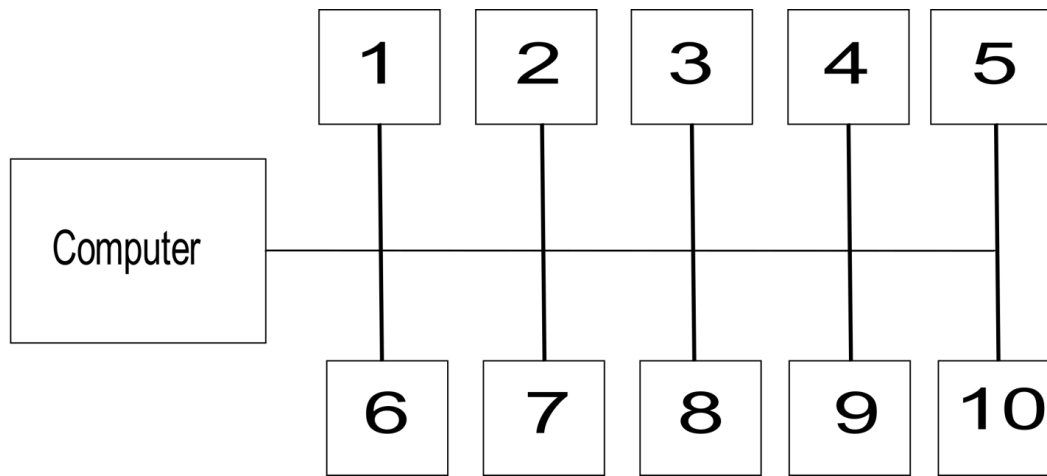


Picture 10. Marking the dots on the Braille display in the program and varying them depending on the embossing position.

In this program, our six key points are assumed to be F1, F2, F3, F4, F5, F6. The bottom should be  $f(x)$  with a separate bulge sensor. The program is given 1 or 0 signals depending on whether there is a bulge. The above program is designed to detect a single letter, which is further complicated when a program is created in which the words in a sequence of letters are displayed in full on the screen.

These special devices are a great way for blind people to access gadgets at home and at work. The limiting factor in the proliferation of these devices is their cost. In this case, we will take a general approach to the blind, not an individual approach. [5,49] For example, the establishment of libraries equipped with special equipment for the blind. Such specialized libraries are relatively inexpensive due to their small size. Let these libraries consist of small rooms with a capacity of ten people. The number of rooms is created by predicting users' future visits. [15,140] Each room has a computer librarian. There will be single seats with ten tables and chairs. Each table is fitted with Braille displays in the form of a case with a handle. These one-room Braille displays can be connected to a computer via special cables. In

this case, the software that transmits data to the ten Braille displays is selected. This specially selected software will be installed on the librarian's computer and will be monitored by the librarian. Figure 7 shows the location of the computer and the customer seats.



Picture 7. Location of special computer and Braille displays in the library.

When a blind person comes to the library, he tells the librarian which book he came to read. The librarian selects the required literature from a special program on the computer, connects it to an empty Braille display, and directs the blind person to the desired location and the desired display. It can serve up to ten people. Given that computers can hold so many e-books, it is possible to create science libraries with a very rich collection of books for the blind with such specialized libraries. From an economic point of view, these libraries are very inexpensive. Because one room of such a library is enough for a computer with one special software and ten Braille displays. This can be very effective and optimal.

### ***Conclusion***

For people who have lost all or part of their vision, the converters and Braille displays I mentioned above are a great way for them to learn and enjoy the news. Such devices have been developed by scientists in different countries today, and we can find many different types of devices. [18,94] However, these devices are very expensive. This, in turn, reduces the optimization of the devices and greatly hinders their access to all those who need such a device. Not every blind person can afford to buy and use a device at such a high price. The only solution to this situation is to set up our own production of such devices. When such special converters and Braille displays are developed by our scientists, it will be possible to provide all the needy people with modern devices.

It is highly advisable to use Arduino devices to develop such devices. Because Arduino devices have a wide range of capabilities, they are very convenient for creating new devices. Arduino varies depending on power and strength: Arduino Yun, Arduino Uno, Arduino Duemilanove, Arduino Diecimila, Arduino Nano, Arduino Mega, Mega 2560, Mega ADK, Arduino Leonardo, Arduino Micro and others. The inventor will be able to choose one of the types he wants, depending on the structure of the device he is creating.

The special devices and libraries discussed above are also very convenient and inexpensive, as they can serve about a dozen customers based on a single computer and a single database. By implementing this idea of creating optimal private libraries, a large part of the needs of educational institutions for the blind can be met.



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