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A Study on the Design of a Braille Printer Working on a Microcomputer

Bilal Gürevin[1] and Emin Güney [2*]

[1]*Department of Mechatronics Engineering, Graduate Education Institute, Sakarya University of Applied Sciences, Sakarya, Turkey*
[2]*Department of Computer Engineering, Faculty of Technology, Sakarya University of Applied Sciences, Sakarya, Turkey*

[*]*(eminguney@subu.edu.tr) Email of the corresponding author*

Abstract – In this paper, a two-dimensional printer mechanism for a Braille printer is designed and implemented at a low cost on an embedded computer. This mechanism was programmed with the help of Arduino Mega and enabled the conversion of texts in electronic media into Braille texts. Various materials such as Arduino Mega, Servo motor, Stepper motor, GT2 pulley, GT2 belt, chrome-plated shaft, 3D printer outputs, and linear bearing were used. In addition, many techniques, such as Solid CAD design programs and C-based programming, were also used. In the realized study, it was recognized that the networks could reach the texts in the electronic environment. For this, a mechanism that moves in the X and Y axes and also makes punctuation in the Z axis has been created. The movement in the X and Y axes is transferred from the stepper motors to the car moving in the X and Y axes with the help of belts and pulleys. Data from Arduino Mega drive this car. There is an apparatus on the vehicle that is used to mark the point on the Z-axis. With this apparatus, a point is placed at each location. In addition, this apparatus is moved by servo. Paper aluminum and a soft floor were placed under the mechanism at the end of this design. The accuracy of the letters was checked by operating the mechanism.

Keywords – Braille, Braille Printer, Braille Translator, Arduino Mega, Visually Impaired People

I. INTRODUCTION

Visual problems and deficiencies directly affect daily life [1]. Therefore, visually impaired people need additional support to improve their daily activities. Reading the documents they come across is one of these activities [2], [3]. Continuous developments of societies bring new needs, new terms, and some differences [4], [5]. To prevent blind people from falling behind these developments, the Braille writing system [6], which is the basis for reading and writing, should be developed and made to meet today's needs [7]. These difficulties experienced by visually impaired people distance them from society and push them to live inside themselves. As a necessity of social life, it is essential to integrate the visually impaired into the community and make them work in all areas of life. Today, many visually impaired people need versions of these documents written in the visually impaired alphabet (Braille Alphabet) to read textual records. From current studies, Ramgopal et al. [7] have presented a system that allows visually impaired people to use the computer environment as an alternative to Braille books. The operation using noise rejection techniques allows the user to take pictures of the text to be read. Thus, user-sensed script points are electromagnetically amplified by precision actuators. Halitha et al. [8] propose a calculation that allows them to convert a particular text for the visually impaired, which they use, into Braille, thus working with the outwardly weakened. Their work includes planning and delivering a Braille System and enabling people with extroverted disabilities to communicate collaboratively. Lee et al. [9] interviewed 30 partially or wholly blind persons enrolled in three support facilities regarding drug intake. As a result of these interviews, they realized an innovative Android drug recognition model and braille embosser system that gave them an advantage. Yamin et al. [10] Institut Teknologi

Sepuluh Nopember (ITS) has proposed an additional braille duplication system as a feature of the braille printer. They photographed the braille alphabet via a smartphone, converted it into text, and sent the result wirelessly to the interface of the braille printer. Experimental results are promising 99%, and the braille document can be reproduced without the original text.

Rahman et al. [11] developed the hardware design and implementation of a portable Bengali Braille embosser for disabled people in Bangladesh. The embossing machine uses a Braille embosser, an octagonal disc-type printhead controlled by a simple microcontroller. The octagonal disk of the head contains two segments containing eight identical dot patterns that make up the characters of the Bengali alphabet. A keyboard with a USB interface is used to create character patterns by driving each disc with a separate stepper motor. Shubhom et al. [12] focus on the inability of blind individuals to access modern technologies due to high cost and portability problems and to provide and support independent communication to the visually impaired in Braille with an affordable communication device, "BRAPTER". This system supports independent living by providing advantages of portability, cost, and compatibility.

In this paper, an Arduino-based application has been developed to help visually impaired individuals. This application is designed to support the ability to read electronic texts in documents. For visually impaired people to understand the text content, it provides the writing of the braille alphabet using a mechanical system. Stepper motors controlled by Arduino programming call the functions that make up the corresponding Braille letter by determining the position of each letter in the entered words. In this way, the terms and sentences in electronic texts are converted into braille, making them readable by visually impaired individuals.

II. Materials and Method

The materials and technologies used in the design of the study are introduced in this section. This study aims to convert the texts in the electronic media into Braille fonts that can be read by the visually impaired using the three-dimensional printer mechanism and, at the same time, using Arduino Mega-based programming.

A. Braille Printer Design Phase

The Braille alphabet revolutionized reading and writing for the visually impaired. It comprises six embossed dots arranged in a rectangular shape with two columns of three dots each, forming sixty-four combinations, as shown in Figure 1. Letter identification relies on dot positions from 1 to 3 in the left column. Braille's system evolved from Barbier's complex design, initially developed for military communication in the dark but rejected. Braille modified Barbier's system into the 6-point Braille, enabling rapid symbol transition and transforming communication for blind people.

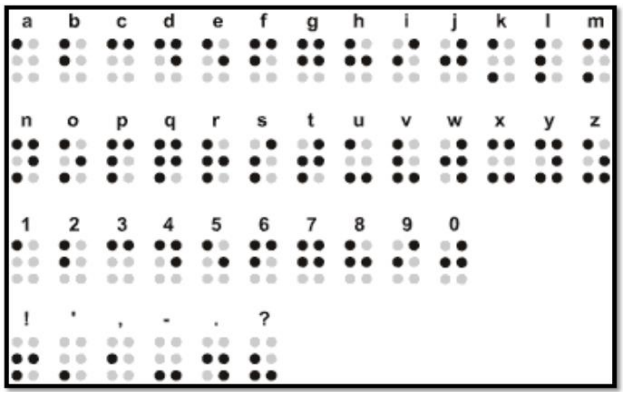

Fig. 1 An overview of the Braille alphabet

The spelling rules of the Braille alphabet are shown in Figure 2. Thanks to this demonstration, the shift, that is, the translation, will be performed by using the spaces between each letter, one below the other and next to each other. The 2.5 mm between each point. 6 mm between each letter. 10 mm between each row. As welll as, there’s 12mm distance between each word.

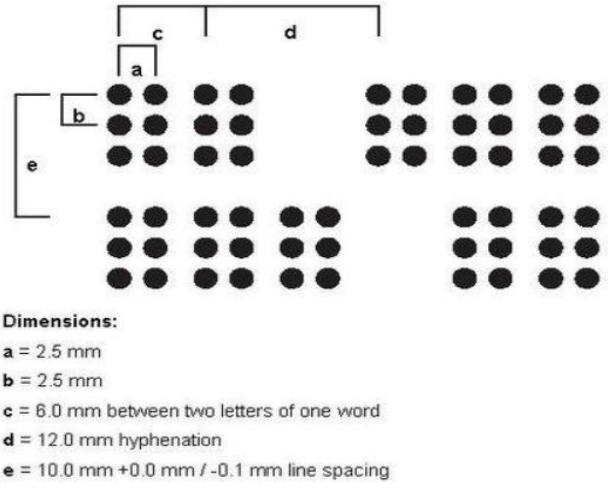

Fig. 2 Distance level between Braille fonts

B. Technical Design Details

As it is known, the Braille alphabet has a structure with an embossed writing system. Therefore, our system needs to work on a piece of paper (A4 paper), that is, by moving on the X and Y axes and at the same time punctuating in the Z axis direction. At the current stage, the mechanical part of our system has been designed and prepared in the SolidWorks program. The technical drawing of the Braille printer mechanism of this paper is given above. The spacers and dimensions of this technical drawing are also in Figure 3. Two different systems move in the X-Y direction on the chrome slides as shown in Figure 3. Movement is provided by a separate stepper motor for the X-axis and a separate motor for the Y-axis. G2 gear pulleys are mounted on stepper motors. These pulleys allow the belt to transmit the movement. The belt extending from the stepper motor to the counter pulley is connected to the cars in between. In this way, the forward and backward movement of the cars will be ensured.

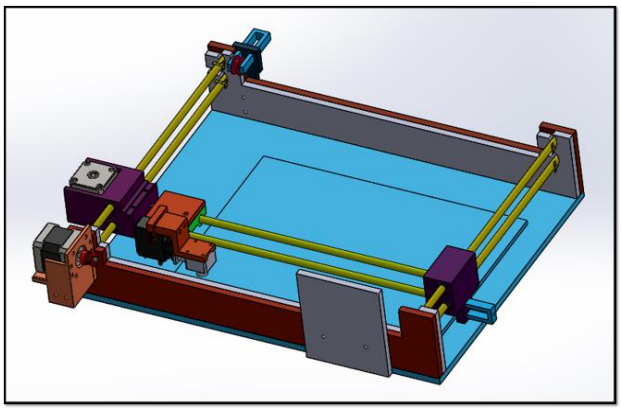

Fig. 3 Braille printer mechanism design

The same method is applied in both the X and Y axes. G2 toothed pulley is used in this mechanism. The radius of the G2-toothed pulley is 6mm. If we calculate the circumference of our pulley from the 2*π*r formula, it will be 37.7 mm. The Nema 17 stepper motor has a 200-step rotation feature. That is, each step consists of 1.8° angles. This means that each time the pulley rotates, it will advance horizontally by 0.188 mm. In line with this mentality, there will be defined sequences belonging to each letter. When any letter is entered, the engine will be driven by going to the series of that letter. We cannot drive in mm via software. Therefore, with the above calculations, we will calculate how many mm the belt will advance, convert it to steps, and transfer it to our engine. The connection diagrams of the motors, which also provide movements in the X, Y, and Z axes, are given in the figures below. In this context, the electronic design is as in Figure 4 and Figure 5.

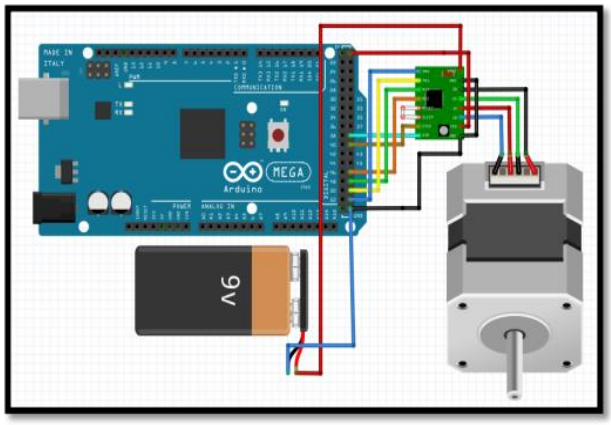

Fig. 4 Arduino Mega and stepper motor wiring diagram

Since it would be difficult to calculate and enter the steps one by one in this program, the distance between them was calculated and facilitated. In this way, we will be able to move the motor in millimeters on the X and Y axes as we want. The radius of our GT2 gear pulley connected to the stepper motor is 12 mm.

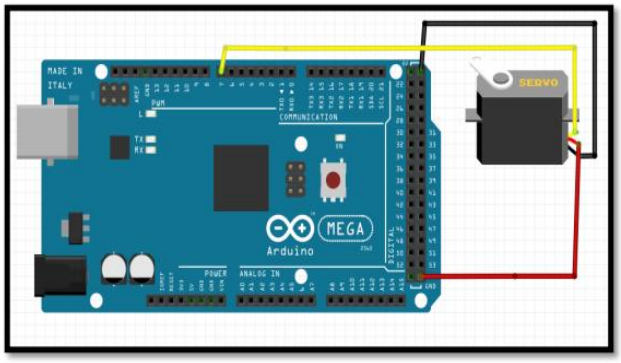

Fig. 5 Arduino Mega and servo motor wiring diagram

When the formula "2*π*R" is used to find the circumference of the pulley, the circumference of the pulley is 37.7 mm. exists. This means that when the pulley rotates one revolution (360^{o}), a horizontal advance of 37.7 mm will be seen. The Nema 17 stepper motors used have 1.8o steps. So, when the motor is told to move 1 step (1.8^{o}) at the complete step, it is 0.2 mm horizontally. After that, the function that will provide millimetric

movement at the desired distance is written directly on the horizontal.

Arduino board based on ATmega2560 has 54 digital I/O pins, as shown in Figure 6. Fourteen of them can be used as PWM outputs. It has 16 analog inputs, 4 UART (serial ports), a 16 MHz crystal oscillator, a USB connection, an adapter input, an ICSP output, and a reset button. Compatible with all shields designed for Arduino Duemilano and Diecimila.

Fig. 6 Arduino MEGA

In this study, a 6-pin unipolar stepper motor (NEMA 17) was used. A4988 driver board is used while driving this stepper motor. If we examine our A4988 driver card used in this study, Enable: is the terminal that makes the driver active or passive. The line on it means that it is active at 0V. As long as we leave this pin at 5V, our driver will not work. MS1, MS2, MS3: These pins represent the resolution of our stepper motor as seen in the table below. That is, half step, like full step, determines in which mode it will work (Figure 7).

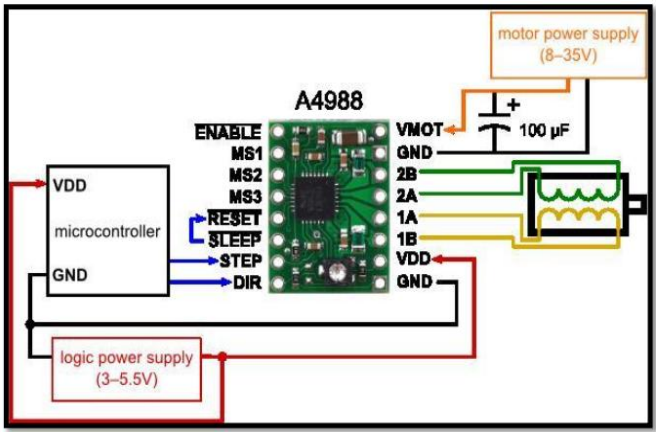

Fig. 7 A4988 stepper motor driver

Figure 8 shows the entire flowchart of the program. As seen in the diagram, it is checked whether the certificate port is open by resolving it to the reference. Afterward, axial movement speed, point shift speed, number of letters per line and word file text are read. The text is converted into characters and the axial movement is realized. The number of characters is reduced from the text in the memory. When all characters are reset, the writing process is completed and the program is terminated.

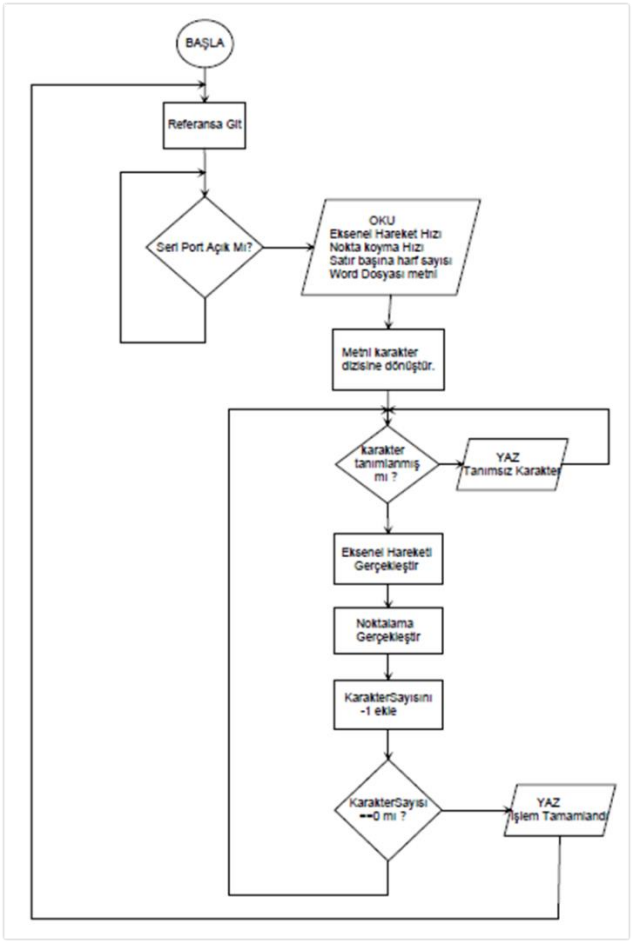

Fig. 8 Program flow chart in general

III. CONCLUSION AND DISCUSSION

This article proposes an Arduino Mega card and a two-dimensional printer mechanism for a Braille printer based on the position control of stepper motors. A4988 driver board used while driving stepper motors is preferred as a microcomputer. While writing the program, the development of the program functions and, at the same time, the extraction of the program algorithm was carried out. Since many machine elements such as the

toothed pulley, pinion, belt mechanism, linear bearing, chrome shaft, and bolt are used together with software data, comprehensive information on machine elements has also been presented. In addition, thanks to the designs made in Solid Cam, both solid modeling and techniques on 3D printers are presented in this study. Efficiency and functionality are provided by using the plexiglass material used in the design.

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