Braille Study Aid

ECE 445 Project Proposal - Spring 2021

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1 Introduction

1.1 Objective:

Braille is a tactile written language used by people with visual impairments. Our goal is to create a device to help introduce and improve braille literacy. Because most seeing teachers are not familiar with Braille, we want to provide an easier way to learn independently. The study aid will allow for a quick succession of practice at the user's own pace while providing audio confirmation on each word. The aid will cycle between a hundred introductory words, displaying Braille and auditory representation.

1.2 Background:

Despite the rise of audiobooks and technology replacing Braille in some domains, audio can not completely replace the role of reading and literacy which Braille makes accessible. According to a breakdown in Scientific American, Braille readers in MRI studies activated the same region of the brain associated with reading visually [1]. Braille reading also correlates with career outcomes. In the blind community, 90% of Braille literate adults are employed compared to only 33% of those who can not read Braille [2]. Reading, whether visually or tactilely, offers greater independence and understanding of language. Despite the advantages learning Braille offers, the National Federation of the Blind reported that only around 10% of blind children are learning Braille [3].

1.3 Physical Design:

The following is a physical representation of our design. We intend to include 5 slots for Braille characters to be shifted out to the user. They will rotate through a section of bristles to help separate the user from the moving parts. Our design also includes a speaker to output an audible representation of the currently displayed word. The two buttons will cycle between new words and queue the speaker to provide audio feedback. All moving parts and wiring will be contained in a metal casing.

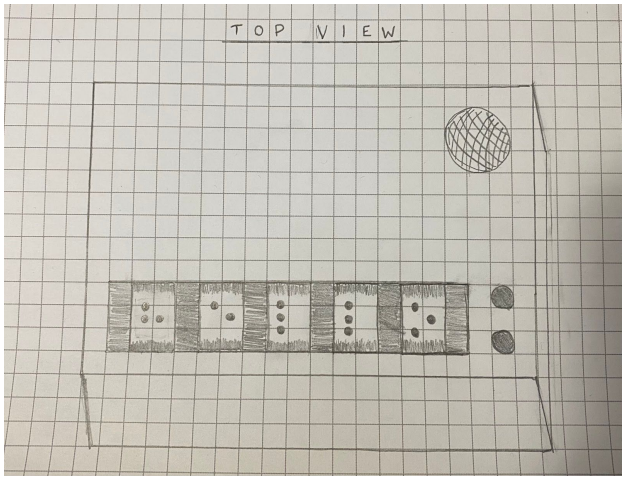

Figure 1: Anticipated exterior design of the Braille Study Aid

1.4 High-level requirements list:

1.4.1: The study aid must display five braille characters.
1.4.2: The study aid must provide audio for the word being displayed.
1.4.3: The study aid must allow the user to switch to the next word.

2 Design

2.1 Block Diagram:

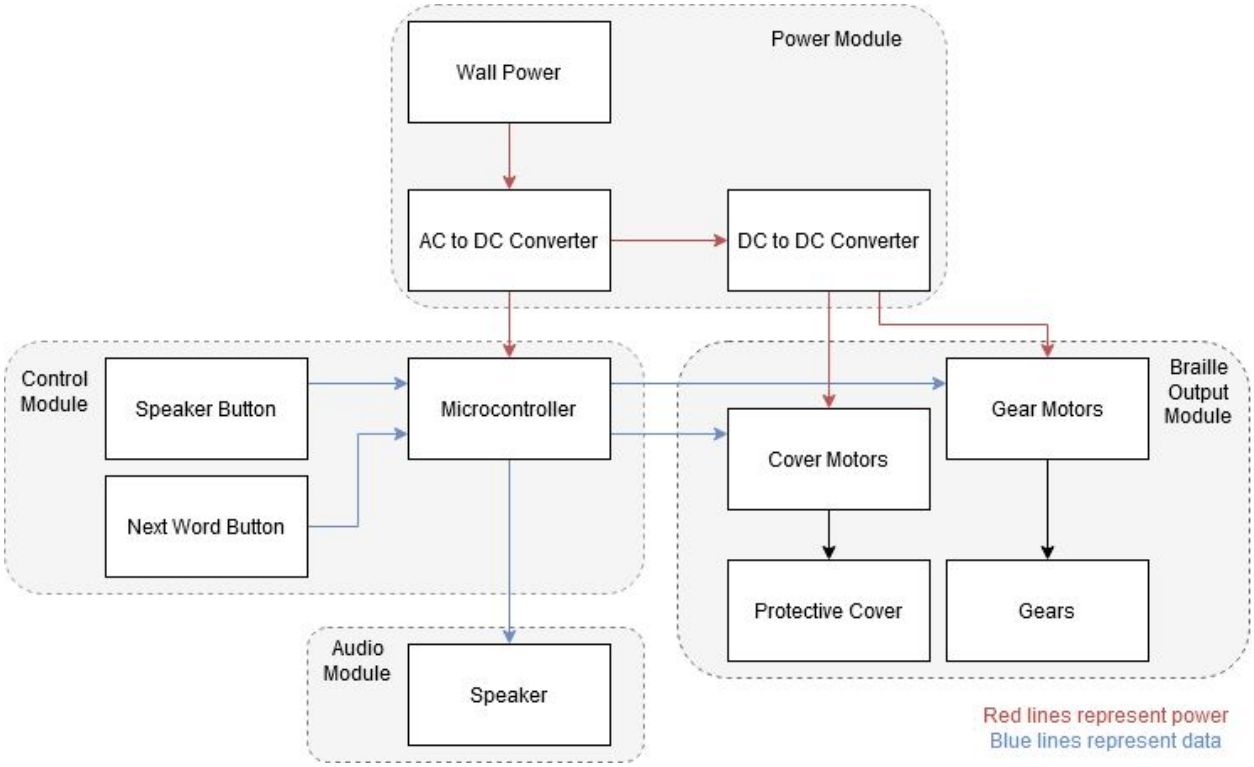

Figure 2: Braille Study Aid block diagram

In order to implement our Braille teacher to the specifications described, we require four main modules: power, control, audio, and Braille output. The power module will convert AC wall power to the DC power specifications of both the controller and motors. The control module will convert user input into instructions for the motors and speaker, positioning the motors appropriately and activating the speaker at the user's request. The audio module is responsible for reading out the word being tested. Finally, the Braille output module accomplishes the goal of displaying the tested word in Braille using the gear mechanism. It includes a protective cover to prevent confusion or interference as the gears move between turns.

2.2 Functional Overview:

Power Module - Take in 120V AC from the wall socket and utilize an AC-DC converter to bring this down to a usable DC voltage that will supply power to microcontroller, motors, and speaker.

Control Module - Microcontroller is responsible for communicating servo orientations necessary to form a Braille word when the next word button is pressed. It also sends the speaker a PWM signal for the current word when the speaker button is pressed.

Audio Module - Take signal from microcontroller to audibly output the current word on the gear display. The speaker is activated by the microcontroller when the speaker button is pressed.

Braille Output Module - Motors take signal from microcontroller detailing what position each gear needs to be to display the next word. Upon a new word button press the protective cover motor will move out to prevent the user from accessing the spinning gears and the cover will retract once new word is in position.

2.3 Block Requirements:

Power Module - This must deliver 5V with a small ripple continuously to the microcontroller. The power module must supply each gear motor and cover motor with 4.8-6V at 550-650mA. Finally the power module must supply the speaker module with 5V at 600mA.

Control Module - This must be able to simultaneously output 6 PWM signals at once each with a minimum pulse width of 0.7ms. The control module must also communicate with the speaker to play 8kHz audio. The microcontroller must start communication when respective “play word” and “next word” buttons are pressed.

Audio Module - This must output audio at least 8kHz to encompass the frequency content of human voice. It will be powered with 5V at 600mA from the power supply.

Braille Output Module - Servos must be capable of rotating 360 degrees and stop at 26 equally spaced points along this rotation. Servos will be powered with 4.8-6V at 550-650mA by the power module. Character gears must be able to accommodate 26 braille cells along their circumference. Given the dimension of a single Braille cell, the circumference of the gear must be approximately 2.75in.

2.4 Risk Analysis:

We anticipate the gears and their motors will require the most attention for a successful completion of our project. The gears will need to represent at least 26 unique characters, resulting in 26 separate edges on the circumference of the gear. Having this amount of edges to an approximately three inch gear will require precision in our manufacturing and our code to orient the gears appropriately. We will also need to account for a motor being stalled or stopped

abruptly as to not misorient the characters or harm the motor itself. We are confident that we can solve these potential issues and more through our timeframe. We also anticipate that having the computerized audio output coming from the microcontroller signal to the speaker to be a hindrance towards the success of our project.

3 Ethics and Safety

Our design is aimed at mitigating any potential safety concerns. Our mechanism for interchanging the Braille characters will involve a spinning gear, so in order to avoid the user from mistakenly halting the motor or jamming a finger, we intend to shift a cover over the characters to block the gears from the user while they reorient. This cover will ensure that the interaction between the user and a moving gear can be isolated.

Another design aspect centered around safety is our decision to use a typical AC wall outlet as our power source. Instead of relying on a portable power supply, we can use the standardized 120V/15A source to ensure consistent and safe inputs. Our design also includes several power converters that will allow for appropriate levels of power to be supplied to the microcontroller and motors.

With a predetermined catalogue of words being imputed to our study aid, we are eliminating any potential ethical issues regarding inappropriate words, such as profanity or harassment, from being taught. This mitigation aligns with IEEE Code of Ethics, 7.8.II: “To treat all persons fairly…” [4]

References

[1] scientificamerican.com, “Reading Braille Activates the Brain’s Visual Area”, 2011. [Online]. Available: https://www.scientificamerican.com/article/the-reading-region/. [Accessed: 14- Feb- 2021].

[2] E. C. Bell, N. M. Mino, “Employment Outcomes for Blind and Visually Impaired Adults.” *The Journal of Blindness Innovation and Research.* Vol 5, No 2 (2015). [Online]. Available: https://www.nfb.org/images/nfb/publications/jbir/jbir15/jbir050202.html. [Accessed: 14- Feb- 2021].

[3] nfb.org, “Blindness Statistics”, 2019. [Online]. Available: https://www.nfb.org/resources/blindness-statistics. [Accessed: 14- Feb- 2021].

[4] Ieee.org, "IEEE IEEE Code of Ethics", 2021. [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 16- Feb- 2021].