Optical Text-to-Braille Translation Device

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Problem Statement

Visually impaired people (VIPs) encounter significant challenges in accessing written information. Learning Braille from a young age aids with literacy, enhancing future life implications for VIPs. However, there is a lack of interactive educational devices for younger VIPs.

Engineering Goal

The goal is to design an assistive device for VIPs that uses optical character recognition (OCR) to take pictures of text in the environment. The device translates text from the image into Braille configurations and provides a tactile medium for the VIP to read the translated Braille

Methodology

Initial sketches
Brainstorming, idea development and need investigation

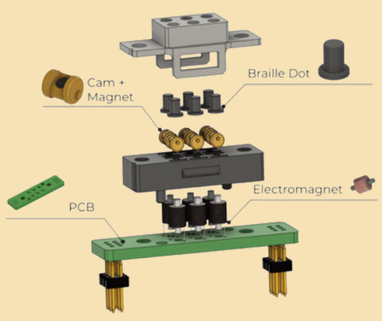
CAD Modeling
Design variations, visualization, design decision making

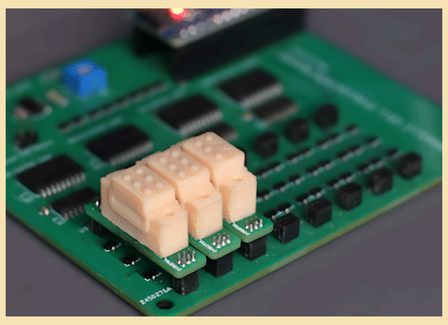
Electromechanical construction
3D printing Braille cells and tools, solenoid winding, PCB soldering, cam + magnet placement

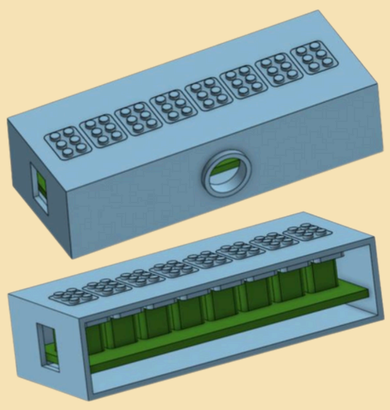
OCR implementation
Microsoft Tesseract, Margin conditionals, input from camera, character by character translation

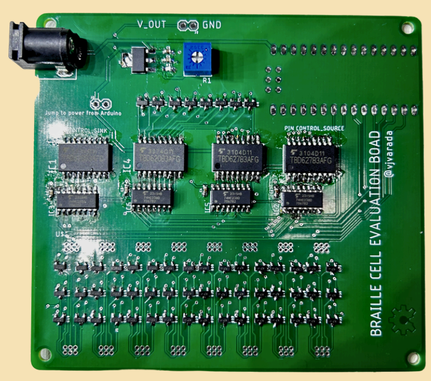
Text Conversion + Display
Text to Braille Module Conversion, ESP32-S3 to Arduino Nano, Arduino code to select, set, reset, and turn off pins.

Current Design







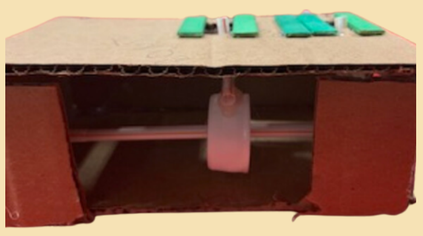


Requirements

Type	Level 1 Requirements	Yes/No
Functionality	The device shall be able to record text from a surface	Y
Functionality	The device shall be able to convert the text into Braille characters	Y
Functionality	The device shall be able to present the Braille characters (at least 6) to the users	Y
Functionality	The device shall be able to help the user position the device in front of text	Y
Physical	The device is portable, and can be operated outside of the home	Y
Physical	The device shall weight less than 450 grams	Y
Physical	The device shall be less than 8 cm tall, 10 cm wide, and 5 cm deep	Y

Design I

Axle-display

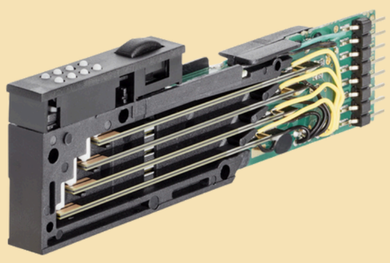


Pros:
- cost-effective
- simplistic design

Cons:
- difficult to control a greater # of moving pieces

Design II

Piezoelectric Braille Cell

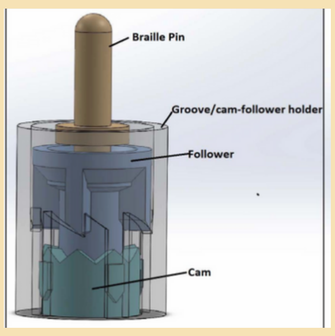


Pros:
- compact
- easy to implement

Cons:
- very costly → limits # of cells

Design III

Cam and Follower Assembly



Pros:
- simplistic design
- solenoid powered

Cons:
- large motor
- costly

One-Dot Test

To determine if the Arduino Nano, Braille cell PCB Board and individuals Braille cell modules are functional and can work together, a “One-Dot Test” will be implemented. This test verifies that the Braille cell is able to receive signals from an Arduino Nano and that one pin can raise up and down. Using code written in the Arduino language, a signal is sent to the Arduino Nano to select the module and pin, and then set, reset, and turn off the pin.

Text Recognition and Conversion Test

To determine if the camera and written code are functional, a “Text Recognition and Conversion Test” will be implemented. This test will begin with running the camera and taking a picture. Then, the OCR methods will run on the ESP32-S3 Board, extracting the text from the image that was just taken. Finally, this text will be converted to boolean formats of the Braille cell modules to present.

Conclusion

- Assistive device is more affordable and portable than existing devices on the market
- Easily adaptable to include more Braille characters
- Simplicity of device allows for easy and adaptable Braille education

Future Works

- Wi-Fi and Bluetooth features to connect with smartphones and headphones
- Buttons or settings to change the Grade of Braille and adjust the speed of reading for greater personalization
- Audio feature to read Braille while listening to the audio

Citations:

Control Systems Technology Group. (2019). 0LAUK0 PRE2018 3 Group 13 Braille mechanisms - Control Systems Technology Group. Dsdwiki.wtb.tue.nl. https://dsdwiki.wtb.tue.nl/wiki/0LAUK0_PRE2018_3_Group_13_Braille_mechanisms

Varada, V. (2023). Electromechanical Refreshable Braille Module. Hackaday.io. https://hackaday.io/project/191181-electromechanical-refreshable-braille-module