

ECE 445
Senior design project laboratory
Project proposal

TOOL THAT TRANSLATES PRINTED TEXT TO BRAILLE

Team No. 76

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1. Introduction

1.1 Problem

According to the World Health Organization, currently there are around 39 million people who are legally blind around the world. Right now there are not many resources available for people who can only read braille to read physical written text from a book or magazine, and those that are available are very expensive.

1.2 Solution

Our solution is to create a tool that can be placed over printed text and translate it to braille so that blind people can read it. This tool will be divided into two parts that will be connected between each other through several wires that will transmit power and data.

The first part will be a handheld device with a camera to recognize the letters in a word. The user would hold this handheld device with one hand and place it on top of written words.

The second part will be a box that will contain the pcb with the microprocessor and an external battery module. It will receive the images taken by the camera, process them to recognize every letter on the word and finally output on top in braille the characters of that word one by one using pins that can be pushed up and down to create braille characters.

The person using this device will place one of their fingers on top of the moving pins used to create the braille characters to read the printed text.

After showing all the braille characters in a word, the user can simply move to the next word for it to be shown in braille.

1.3 Visual Aid

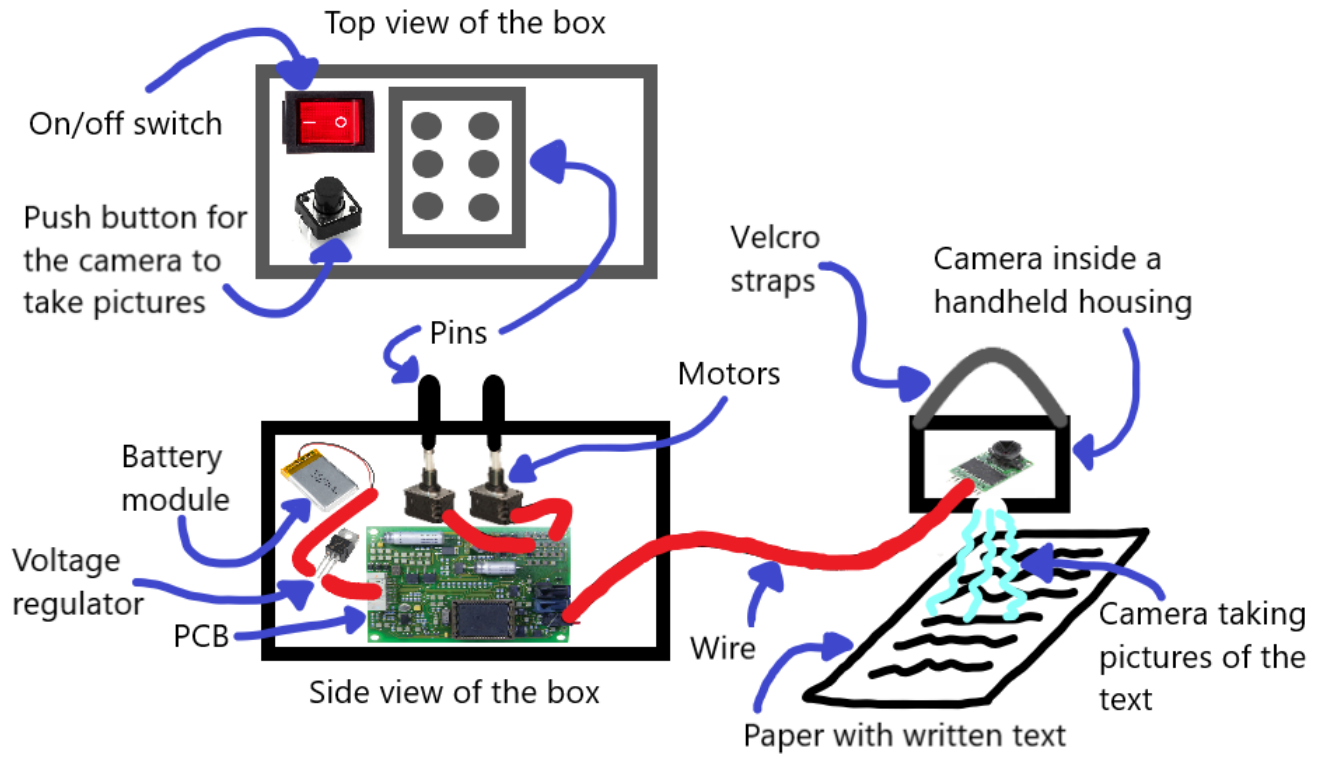


Figure 1. High-level overview of our design

1.4 High-level Requirements

We aim to accomplish these three high-level requirements:

- Text character to braille display accuracy is at least 90% .
- Entire unit weighs less than 2kg for portability.
- Battery life lasts 8 hours for an all-day battery life.

2. Design

2.1 Block Diagram

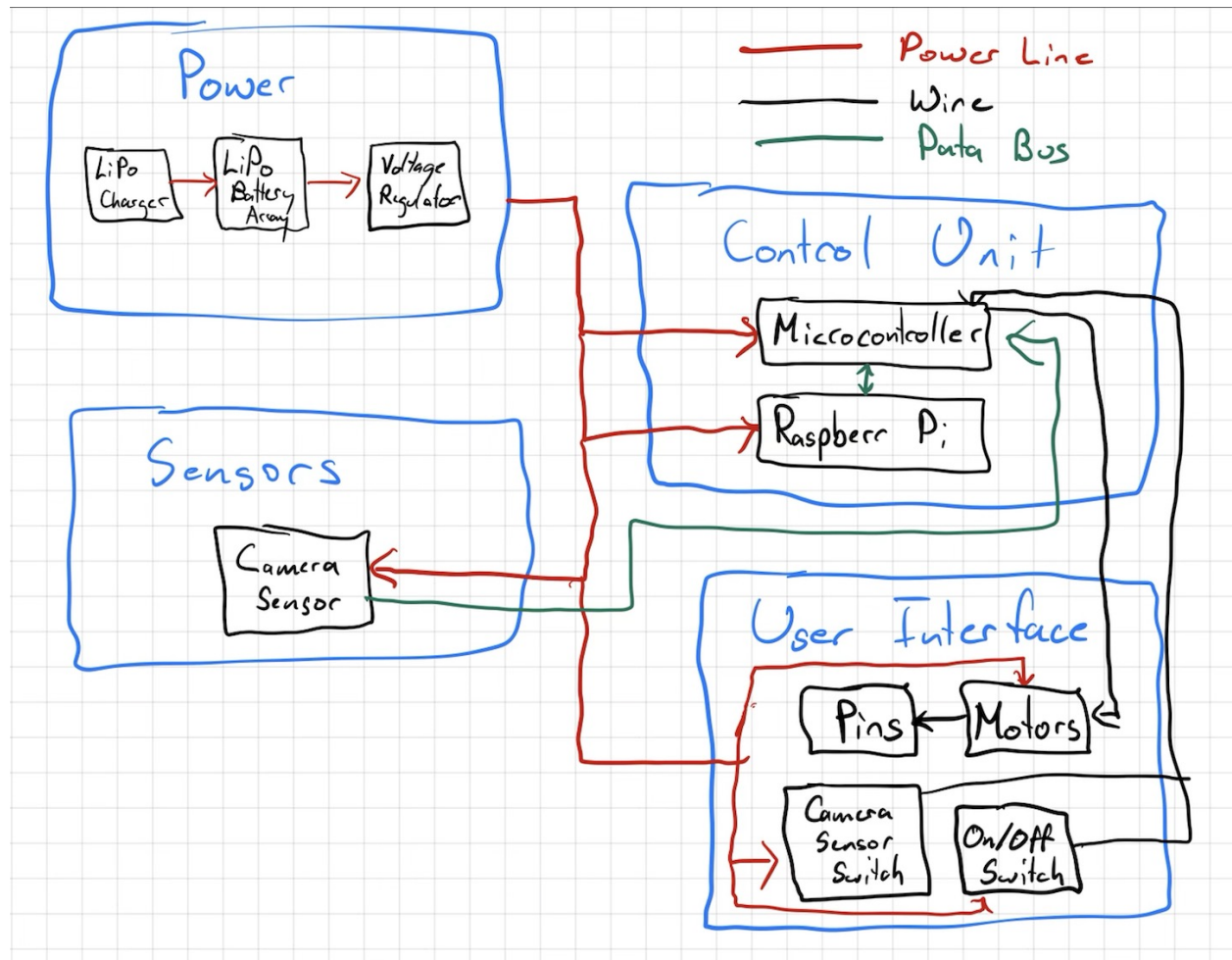


Figure 2. Block diagram

2.2 Subsystem Overview

2.2.1 Power Management Subsystem

The power module will power the whole system and:

- 1) Be lightweight for ease of transporting
- 2) Powerful enough to sufficiently power the whole system
- 3) Have theoretical “all-day” battery-life (at least 8 hours)

The power module will consist of an array of Lithium Polymer (LiPo) batteries and charger encased in a plastic housing. The current energy need is unknown (volts/amps/watts), thus the

exact “dimensions” of the battery array is unknown. A charging module will be added in order to evenly distribute charge across the batteries to ensure optimal battery health.

Some downsides to such a battery module would be that LiPo batteries require extra care in their recharge cycles as they must be evenly charged, and also not overcharged. Further, LiPo batteries can become hazardous if punctured, and such a safety hazard would have to be addressed through the design of the casing.

2.2.2 Sensor Subsystem

A handheld housing will have a camera sensor attached to it, which would be transmitting image data to the microcontroller. The housing will have to be ergonomic to hold and made of some lightweight material, like plastic. We may additionally add some way for the user to attach the housing (e.g. velcro straps) for convenience.

2.2.3 Control Unit Subsystem

A custom PCB will be designed in order to connect all other subsystems. The PCB would connect the pin motors for the braille “display”, the handheld housing containing the camera sensor, and the external battery module in order to power all the other components. The PCB would also control the recharging of the battery module to ensure optimal battery health.

The microcontroller will take images from the camera sensor to process the text characters in the image. The image processing, or more specifically the OCR (Optical Character Recognition), will be done through open source computer vision and machine learning libraries such as OpenCV or Tesseract. The microcontroller will also control the motors that will drive our pins to form braille characters.

Also, a Raspberry Pi or a similar microcontroller will interface with the microcontroller used in our custom PCB as a more powerful chip may be required for better OCR performance. However, Arduino could also be a viable option.

2.2.4 User Interface Subsystem

Motors controlled by the microcontroller will be used to move up and down 6 small bars through holes made on top of the box to form braille characters. The bars required to form each character in braille will move up and down in a synchronous way so that the user can read them with their finger.

2.3 Subsystem Requirements

2.3.1 Power Management Subsystem

1. The Voltage regulator will limit the Voltage to the correct value for each system component.
2. The Power Management Subsystem will be able to safely charge the battery

2.3.2 Sensor Subsystem

1. The camera must be able to take at least a 720p resolution photo and send the data to the Control Unit system whenever the take photo button is pressed.

2.3.3 Control Unit Subsystem

1. The ML algorithm on the Raspberry Pi must be able to analyze image data and convert to character texts with 90% accuracy rate.
2. The character text data is converted into signals that are sent to the motors to form Braille characters for all 63 Braille characters

2.3.4 User Interface Subsystem

1. The Motors must be able to lift the pins 0.5 ± 0.1 cm high and to lower them in less than 1 second when forming the braille characters.

2.4 Tolerance analysis

The Image-to-Text-Character recognition aspect of the project poses a risk to a successful completion of the project. At a high level, this project aims to make data more accessible by translating it into a different form. However, the integrity of the data depends on the accuracy of the translation from image data into text characters. Thus, a malfunctioning image-data-to-text-character translation would prove fatal to the success of the project. However, the feasibility of this component is definitely possible as there are many open source libraries that have trained machine learning models that simulate this very process.

3. Ethics and Safety

We will mainly follow the IEEE Code of Ethics [2] while carrying out our project. The main aspects to take into account are:

- Image data must be collected onto the system in order to carry out the translation to text characters. Image data is sensitive and private information. We feel strongly about maintaining the privacy of users and protecting the integrity of the image data. All image data that is collected will be localized only to the system, and never shared on the internet. This way, we will minimize the number of access points to the data, lowering the risk of a data leak. The image data will also periodically be deleted to preserve space on the system, and also again lower the risk of a data leak.
- We will ensure good teamwork, treating everyone in an equal manner and with respect. We have created a shared Google drive folder to make sure that all team members have access to all the project related documents.
- Further, we will keep the user's safety as the top priority. Our project uses Lithium Polymer (LiPo) batteries in the power subsystem. LiPo batteries are notorious for being a potential safety and fire hazard when punctured, mishandled, or charged in a way that is not intended. Therefore, it would be our responsibility to avoid such a safety risk as much as possible. We would address this through the design of the power subsystem housing, and the way that the battery charging system is designed. The housing will be built to withstand everyday abuse, and the charging system will be programmed to avoid mischarging of the batteries.

4. References

- [1]. WHO. "Blindness and vision impairment" (2022), [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment> (visited on 02/09/2023).
- [2]. IEEE. "IEEE Code of Ethics." (2020), [Online]. Available: <https://www.ieee.org/about/corporate/governance/p7-8.html> (visited on 02/09/2023).