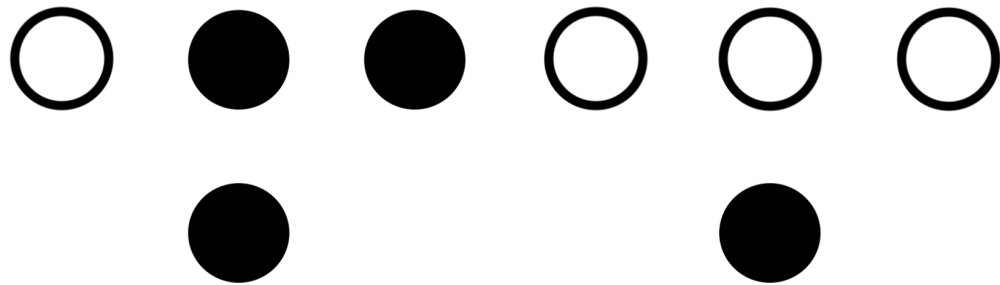


Penta Solutions



Requirements Specification: Brailingo

Submitted to: Dr. Mike Hegedus

Submission Date: 13th February 2022

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13th February 2022.

Dr. Mike Hegedus,
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Re: ENSC 405/440 Capstone Project: Brailingo Requirements Specification

Dear Dr. Hegedus,

On behalf of Penta Solutions Ltd , I am pleased to submit the requirements specification document for our ENSC 405W/440 capstone project Brailingo. The aim of this document is to give an overview in terms of general, technical and performance requirements for this project. Brailingo as a product is meant to be an assisting tool for the visually impaired to comprehend today's text based world.

Brailingo's main aim is to use an optical device to capture text, use a single-board computer to perform character recognition and provide the user with the information extracted in the form of a Braille cell. Feedback will be provided to the user using an audio output device for better performance and notification to the client.

Nevertheless, the requirement specification document will provide a better planning and timeline expectation for accomplishment of the project and help better describe the constraints and the complexities associated with the project.

On behalf of Penta Solution Ltd., I would like to thank you for your time reviewing our requirement document. Please feel free to email me with any questions regarding the document or the project.

Sincerely,

Anastasiia Shpak



Abstract

Today at least 252,000 people in British Columbia have sight loss [4]. There are many devices that can output digital Braille text for blind people. Many of them require digital text as their input. Penta Solution's aim is to manufacture a device, Brailingo, that can convert images of text to digital text and output as physical Braille cells.

This document defines the requirements of a portable device that converts image text to Braille as part of an 8 month Capstone Project, Brailingo. It presents various functional and non-functional requirements that will be used as reference for the design phase. Requirement specification consists of 3 main components: the general requirements, software requirements, and hardware requirements. In each part, it specifies sets of requirements that are imposed during design and verification of the product.

Each of them have been divided into components:

- General Requirements: including system and functional requirements.
- Software Requirements: including general, image processing, and performance requirements.
- Hardware Requirements: includes general, electrical, peripheral requirements.

There are three phases to the project: Prototype Phase, Engineering Prototype Phase, and Product Validation Phase. The Prototype Phase will run from January to April 2022, and the Engineering Prototype Phase will run from May to August 2022. The Product Validation Phase requirements will be applied during future works done after the duration of the 8 month Capstone Project.

This document will conclude with the list of functionalities that will be presented for the Proof-of-Concept demo during the 405W poster presentation outlined in the appendix.



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Glossary

Term	Definition
Braille	Braille is a system of raised dots that can be read with the fingers by people who are blind or who have low vision.
Actuator	A mechanical part responsible for movement by converting energy
Single-board computer	A complete computer built on a single circuit board, with microprocessor(s), memory, input/output (I/O) and other features required of a functional computer.
Matrix	Rectangular array with entities in the rows and columns. Typically is described as an $m \times n$ where m is the number of rows and n is the number of columns.

Table 1 - Glossary



1 Introduction

The Braillingo device allows visually impaired people to read text around them such as signs and books. With the help of an optical device, it captures text images and translates them into a tactile language used by blind people called Braille [1]. The output is then shown in the refreshable Braille board symbol by symbol, that the user can control. The device would mimic the ability of a visual person to independently get information from the outside world.

1.1 Background

Today Braille can be displayed in a variety of ways. Braille displays for e-books, pdfs and web pages and Braille paper are two of the most common ways of reading books for the visually impaired and they give an easy access to all digital text. However, these solutions do not help in case there is a physical text already present. Braillingo will allow blind people to reach these text sources more easily.

According to CTV News, more than 90 percent of Canada's 830,000 vision impaired people cannot read Braille, since reading can now be replaced with audio books and voice control [1]. However, Braille gives the ability to understand grammar and spelling, something audio cannot fully replace. And, as a result, statistics show that the drop of literacy among blind people also affected the employment rate [1]. Braillingo has a potential to encourage visually impaired people to learn the writing system of raised dots and improve their literacy.

1.2 Scope

This document describes the functional requirements of Braillingo. Requirements are divided into general, software and hardware categories. Each requirement is classified into one the three development stages: proof-of-concept, engineering prototype and product validation that are described in the requirement classification section. Potential requirements are marked as optional.

1.3 Intended Audience

This document is created for the members of Penta Solutions Ltd, professor Michael Hegedus, teaching assistants and potential clients. The future development of the project will be based on the requirements listed below.



1.4 Requirement Classification

Req {Section}.{Subsection}.{Requirement Number} {Project Stage}{Optionality}

Project Stages

- A = Proof-of-Concept
- B = Engineering Prototype
- C = Product Validation

Optionality:

- /O = Optional
 - Optional requirements are not critical for the device to deliver its core functions.

For example, Req 3.2.5 B/O is an **optional** requirement from section 3, subsection 2, numbered 5 for the Engineering Prototype Project Stage. Similarly, Req 5.1.1 C is a requirement from section 5, subsection 1, numbered 1 for the Product Validation Project Stage.



2. System Overview

Brailingo is a portable device used to perceive the text from different physical sources such as physical books and translate it into Braille characters. Our product is designed for the visually impaired people, and provides them with a more convenient and adjustable solution to read in different environments than the existing devices in the market. It is our goal to create a portable and easy-to-use device for people who cannot see text in their daily life.

The Brailingo hardware components include an optical sensor, a processing unit, 6 linear actuators, user input switches, and audio output. The user input switches will allow the user to take or retake photos and navigate through text the bi-directionally. The optical sensor is acquiring the images containing texts that exist in different reading environments with appropriate resolution, regardless of the lighting condition. The audio output lets the user know if a photo is taken and whether the processing unit can detect text in the image taken. As for the processing unit, it is supposed to detect text in the image, translate the text into Braille characters, and output the digital signals corresponding to different characters. After receiving those digital signals, linear actuators perform small rising mechanical movements to create Braille cells for users to feel.

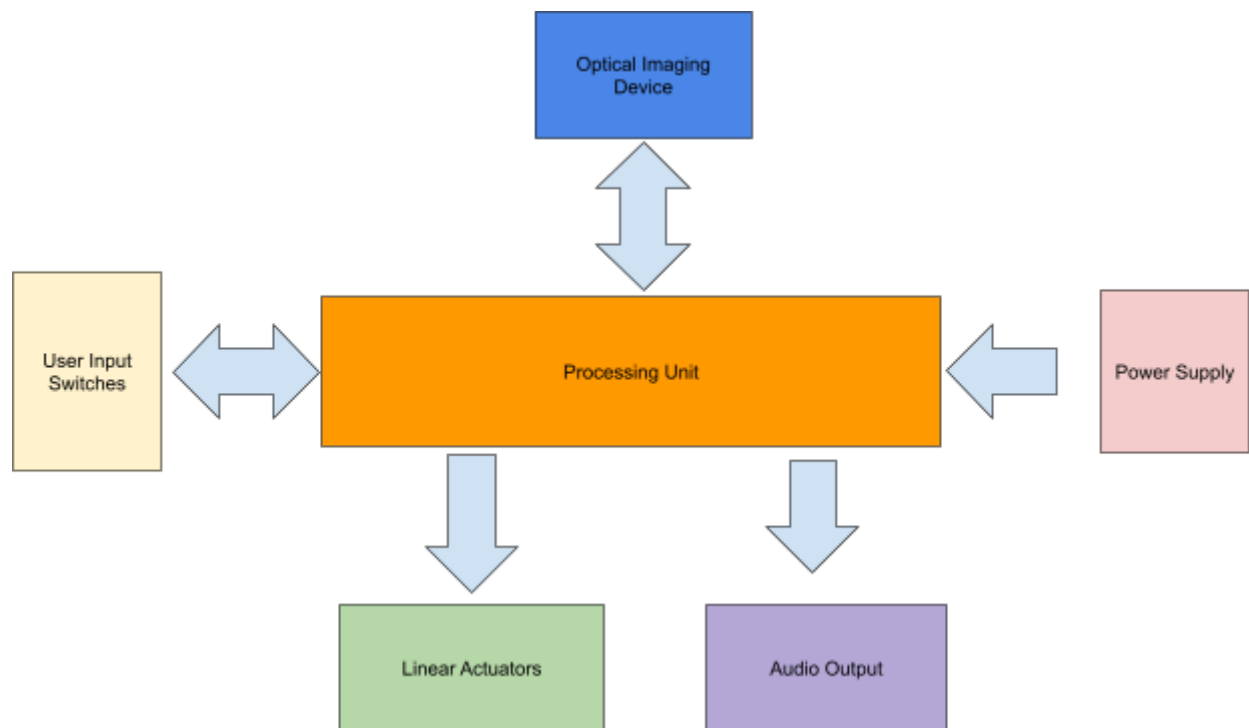


Figure 1 - Hardware Block Diagram



3 General Requirements

This section outlines the general requirements of the device and is divided into system requirements and functional requirements.

3.1 System Requirements

Requirement ID	Requirement Description
Req 3.1.1 A	The system will consist of a processing unit, actuators for Braille cells, user input switches, image capturing system, and audio output.
Req 3.1.2 A	The system should be able to run on a single board computer.
Req 3.1.3 A	The computer should have enough memory to store the software, images, text, and Braille mapping.
Req 3.1.4 A	The device should have an on/off switch.
Req 3.1.5 C	The device should be portable and light in weight.

Table 3.1 - System Requirements

3.2 Functional Requirements

Requirement ID	Requirement Description
Req 3.2.1 A	The device should allow user input to capture and recapture images.
Req 3.2.2 A	The device should provide audio feedback to the user such as to inform the user about the readability of the captured image's text.
Req 3.2.3 A	The device should correctly extract text inside the image captured.
Req 3.2.4 A	The device should map detected text to corresponding Braille characters.
Req 3.2.5 A	The device should output the Braille character onto the corresponding actuators on the Braille cell.
Req 3.2.6 A	The device should allow the user to navigate through detected text bi-directionally.
Req 3.2.7 A	The device should notify the user of the power state.
Req 3.2.8 B/O	The device should notify the user of the charge state.
Req 3.2.9 B	The device should be able to detect text in different light conditions.

Table 3.2 - Functional Requirements



4 Software Requirements

4.1 General Requirements

Requirement ID	Requirement Description
Req 4.1.1 A	The software should map text to English Braille.
Req 4.1.2 A	The software should signal the hardware corresponding with the mapping of Braille.
Req 4.1.3 A	The software should notify the user if an exception occurs.
Req 4.1.4 A	The software should handle interrupts from user input appropriately.
Req 4.1.5 A	The software should alert the user when the beginning of the text or end of the text is reached.
Req 4.1.6 A	The software should do a one-to-one transcription of printed English to Braille (English Braille Grade 1 Complexity [2]).
Req 4.1.7 C	The software should use standard English Braille contractions and abbreviations (English Braille Grade 2 Complexity [2]).

Table 4.1 - General Software Requirements

4.2 Image Processing Requirements

Requirement ID	Requirement Description
Req 4.2.1 A	The software should detect the presence or absence of text.
Req 4.2.2 A	The software should be able to detect text of different fonts and sizes.
Req 4.2.3 B	The software should detect margins and boundaries of text.

Table 4.2 - Image Processing Requirements



4.3 Performance Requirements

Requirement ID	Requirement Description
Req 4.3.1 C	The software should have a startup time of 0 to 5 seconds.
Req 4.3.2 C	The software should extract text from the image within 1 seconds.
Req 4.3.3 C	The software should classify text to corresponding letters with 90% accuracy.
Req 4.3.4 C	The software should be able to detect images under different lighting conditions and angles.

Table 4.3 - Software Performance Requirements



5. Hardware Requirements

The main two aspects of our device is to be able to identify and extract text and display those characters to the Braille cell.

5.1 General Requirements

Requirement ID	Requirement Description
Req 5.1.1 A	The wire colors should adhere to Canadian Wiring Color Codes.
Req 5.1.2 B	The actuators should form a 3x2 matrix for each Braille cell pin.
Req 5.1.4 B	The audio volume should be adjustable by the user.
Req 5.1.5 B	The electrical system should have a safety mechanism to avoid harm to the user.
Req 5.1.6 C	The hardware components should have proper casing to avoid electrical harm.

Table 5.1 - General Hardware Requirements

5.2 Electrical Requirements

Requirement ID	Requirement Description
Req 5.2.1 A	The single-board computer should be powered with 3V to 12V for the device to operate.
Req 5.2.2 A	The input power should be or converted to DC power.
Req 5.2.3 A	The single-board computer should be able to powered by plugging into an outlet
Req 5.2.4 B/O	The battery should have recharging capabilities.
Req 5.2.5 B/O	The battery should be able to supply power for up to 12 hours.
Req 5.1.6 C	The electrical system should have self-protection against human error.

Table 5.2 - Electrical Requirements



5.3 Peripheral Requirements

Requirement ID	Requirement Description
Req 5.3.1 A	The optical device system should be able to capture and perceive text clearly.
Req 5.3.2 A	The Braille actuator pins should be able to handle pressure from the user without retracting.
Req 5.3.3 A	The Braille actuator pins should be able to output the next set of characters within 1 second when navigating text.
Req 5.3.4 A	The audio device should be audible enough for the user to be alerted.

Table 5.3 - Peripheral Requirements

5.4 Mechanical Requirements

Requirement ID	Requirement Description
Req 5.4.1 A	The top of the Braille actuator pins when retracted should be leveled or below with surface.
Req 5.4.2 A	The top of the Braille actuator pins when raised should be above the surface of the lid by at least 0.5 mm
Req 5.4.3 B	The housing should fit all electrical components associated with the Braille cell system.
Req 5.4.4 B	The housing should have appropriately sized holes for the Braille cell actuators and user input switches.
Req 5.4.5 B	The housing should have its inputs labeled in Braille and tactile text for ease of use.
Req 5.4.6 B	The optical device should be wearable by the user.
Req 5.4.7 B	The wearable optical device housing should be sturdy enough to hold the optical device in place.
Req 5.4.8 B	The housing should have an indicator of the Braille cell orientation.
Req 5.4.9 C	The spacing of actuator pins from each other and other cells should adhere to Braille Authority of North America's Standards for Braille Signage as close as possible [3].

Table 5.4 - Mechanical Requirements



6 Conclusion

In a nutshell, Brailingo will be targeted to the visually impaired to provide them with support and comfort with text related matters such as physical books. Brailingo will be able to capture images and detect text in images and output the text in Braille form on actuators. It will be designed in such a way so as to make it portable and affordable by anyone who requires visual assistance. With the Requirement Specifications General Requirements, Software Requirements, and Hardware Requirements, the essential components for the product's development will be carefully chosen while keeping in mind user security, safety, and user friendliness.

7 References

- [1] A. Mulholland, "With new technology, few blind Canadians read braille," *CTVNews*, 17-Apr-2010. [Online]. Available: <https://www.ctvnews.ca/with-new-technology-few-blind-canadians-read-braille-1.503149>. [Accessed: 13-Feb-2022].
- [2] "English Braille - Wikipedia", *En.wikipedia.org*, 2022. [Online]. Available: https://en.wikipedia.org/wiki/English_Braille. [Accessed: 13-Feb-2022]
- [3] "Size and Spacing of Braille Characters", *Brailleauthority.org*, 2022. [Online]. Available: <http://www.brailleauthority.org/sizespacingofbraille/>. [Accessed: 13-Feb-2022]
- [4] "Blindness in Canada". [Accessed: 13-Feb-2022] <https://cnib.ca/en/sight-loss-info/blindness/blindness-canada?region=bc>



8 Appendix

Proof-of-Concept

The functionalities that will be presented for the Proof-of-Concept during the 405W poster presentation are the following:

Functionality	Related Requirements
The device should distinguish between pictures without or without text and notify the user via audio output if none are detected.	Req 3.2.2 A Req 4.2.1 A
The device should be able to correctly extract text inside the image captured and output to Braille actuators.	Req 3.2.3 A Req 4.2.1 A Req 4.2.2 A Req 4.2.3 B
The device should allow the user to navigate through detected text bi-directionally.	Rec 3.2.6 A
The device should notify the user of the current power state.	Req 5.3.4 A

Table 9.1 - Functionalities to be presented for Proof-of-Concept