Braille Translator

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1 Introduction

1.1 Objective:

One thing most people may take for granted is their ability to read the simplest of things, like; menus, magazines, newspapers and more. While braille is available for people who cannot see, it can be difficult for them to even find books printed for them, so these everyday items are almost never available. It is thought that every year, in the United States alone, 75,000 people will become blind in some capacity[1]. Most people may believe that advances in technology will lead to improved lifestyle and opportunities for the blind. This is actually a myth, and it has been found that most blind people who rely on their ears and technology end up being deficient in other areas when in school and the work environment[1]. Substituting reading and writing with technology may seem like a good thing, but think about how technology has affected people who have full sight. Instead of having to go get a newspaper, or to the library, we have access to the same things at our fingertips. We didn't replace reading and writing for ourselves, if anything we have further integrated these activities in our lives.

This is where we would like to make a difference. Our goal is to be able to help blind and visually impaired people to be able to read items that fully abled people can. We would like to make a device that blind people would be able to bring to places like restaurants, libraries and classes. This device will enable them to read text written on most flat surfaces by producing a braille version of it in real-time. We can help the blind community by developing this portable device.

1.2 Background:

There has been enormous progress in the field of developing products to help the disabled, especially in helping the blind with reading using braille[3]. However, there is no such product to help the blind and visually impaired read menus as most restaurants don't keep a braille version available. This can be discouraging as they become dependent on others to read the menu to them, which is not always feasible. Our solution to this problem is to develop a hand held device that one can place over a sheet of paper or menu. his device will then take a picture of the underlying text using the camera and will use OCR to convert the digital text to scanned text which will then allow us to convert the captured text to braille. The converted braille message will then appear on the refreshable braille display above and the user will be able to read the text in braille.

This product was designed by our friend Abhijoy Nandi who is majoring in Industrial Design at the University of Illinois Urbana Champaign and wanted to see this device ultimately being used in restaurants by visually impaired beings to be able to read menus and also other texts from papers like flyers, textbooks, posters, etc. We hope that this device ultimately eases the day to day tasks of the visually impaired.

1.3 High Level Requirements:

- The device should be able to capture an image clear enough for the OCR to detect that there is text in the image around 80% of the time
- The device is able to convert the captured image into strings of up to 32 characters in under 3 seconds.
- The device is able to display a string of characters in braille 4 characters at a time.

2 Design

In order for this device to function, it will need to have: a power supply unit, an image capture unit, a processing unit, an input unit and a braille display unit. The power supply unit will ensure that power is safely delivered to all components. The image capture unit will ensure that the device can capture an image. The input unit is responsible for receiving user input. The braille display unit is responsible for displaying braille characters using solenoids (This part has been abstracted since it will need solenoids fitted on to a metal plate - to be done at the machine shop.) The processing unit is responsible for maintaining accurate functionality for all other units. Additionally, the braille unit is also responsible for converting the captured image to a string.

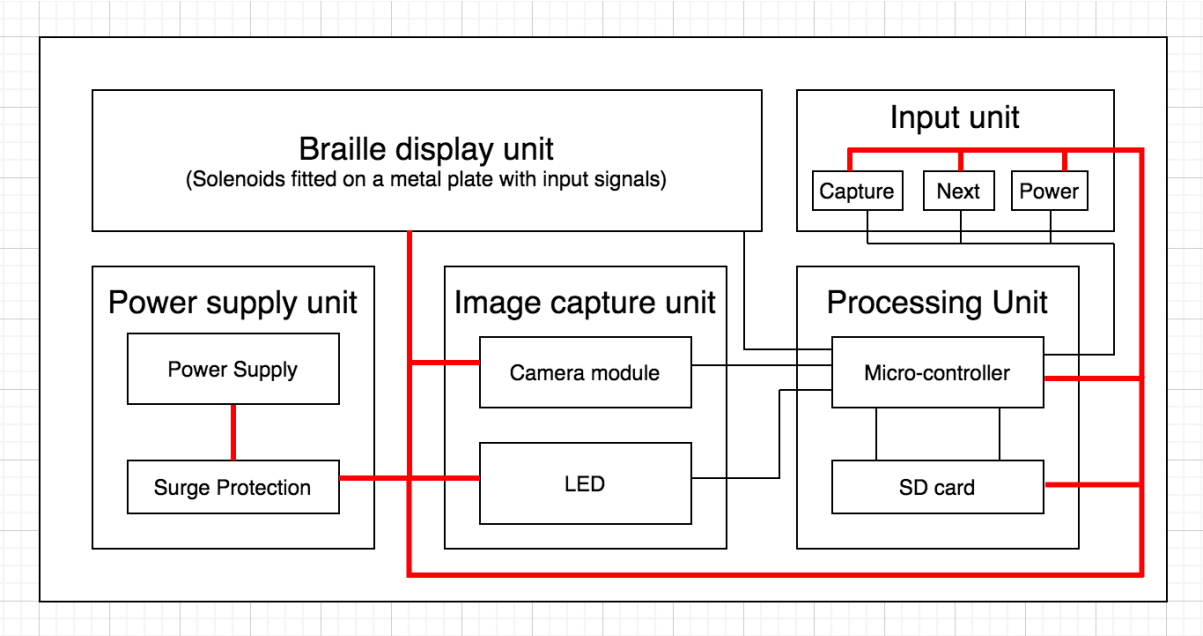

Figure 1: High level block diagram for braille translator device.

2.1 Power Supply Unit:

This unit will supply power to the entire device safely and ensure a consistent flow of voltage across all components

2.1.1 Battery Pack/ Wall Socket input (Power supply):

We will be selecting either a battery pack or a wall socket power supply depending on whichever component seems easier to implement. Our preference however is to have a battery pack so that this device can be portable.

2.1.2 Voltage Stabilization:

For this portion, we want to implement a component that safeguards the other circuit components from short circuits and prevents voltage fluctuation.

2.2 Image Capture Unit:

This unit will be responsible for capturing an image in a dimly lit setting since the device will prevent most of the light from falling onto the underlying sheet.

2.2.1: Camera Module:

A camera module will be fixed in place so that it can take a picture when the processing unit sends out a signal to this unit.

2.2.2: LED:

An LED will be placed near the camera so that the device can capture images in dim settings.

2.3: Processing Unit:

This unit will be responsible for interpreting user inputs, processing the state machine and providing control signals to most of the other components in this device.

2.3.1: Microcontroller:

We plan to use a microcontroller chip that can handle the operation of the entire device ensuring that there is no visible delay between the user input and the machine's output.

2.3.3: SD Card storage:

Depending on the size of the image to text conversion library, we might need to add an SD card to supplement the 256kB program memory storage available on the microcontroller.

2.4: Input unit:

This unit will be responsible for taking the input from the user and relaying the information back to the processing unit.

2.4.1: Power Button Input:

We will have a power button so that the system will be able to be powered on and off.

2.4.2: Next Button Input:

We will have a button to control when we want the next string of characters to be displayed. We need this because we will have a limited number of characters for the prototype.

2.4.3: Capture Button Input:

We will need to have a button that will be a signal for the device to take a new picture of the desired text.

2.5: Braille Display Unit:

This unit will be responsible for displaying the braille for the user to read the converted text. We will need it to be able to properly display the correct dots that the image processing unit has determined.

2.5.1: Braille display metal plate:

This portion will consist of 24 solenoids for the braille letters, and 2 more solenoids for to keep track of the status of the power and next state.

2.5.2: Status indicator (Single solenoid):

Our device needs a status indicator to indicate that the device is either powered on or off. Since our user base largely comprises people who are visually impaired, we cannot use an LED as a status indicator. Instead, we are moving ahead with a single solenoid pin that will indicate if the device is powered on or off. If the solenoid is up, it means that the device is powered on and the user can proceed to press the capture button and get the braille text.

2.6 Risk Analysis:

We believe that the Braille Display Unit poses the biggest risk to the successful completion of this project since all other units are fairly standard units for any senior design project. The reason we selected this unit is because the availability of parts is a major concern as we need 6 miniature push type solenoids per braille character that we intend to display. Hence, scaling the solution to full sentences is a major issue for us. The price aside, the availability of the parts is another concern that can affect this project. Once we acquire the parts, we will need to assemble it together in the machine shop in order to make effective use of it in our project.

3 Safety and Ethics

One safety issue that can arise while working on this project is that spilling water or other liquids on the device could cause a short circuit and ruin the components. This is a risk because our project idea is to be used at places like restaurants where everyone would have a drink on the table. We believe that finding a rubber casing for the device will make it safer to use for this scenario.

Another potential safety concern related to the use of a battery in this device. The first issue would be that the battery could leak. A battery leak could be harmful to the user because, for example, lithium ion batteries may release harmful gasses that can potentially harm people[2]. One solution is for us to use batteries that are leak resistant. The next issue that could come from the battery, is that we could electrocute ourselves while working on the project. This is a persistent concern when working with electronics and circuits. One good precaution to take to avoid this from happening is to make sure the system is powered down before you attempt to change something. Also, we will be having some sort of surge protection to protect our device from voltage fluctuations.

One ethical issue we see with this project is that there are similar projects that are being worked on[2]. While there are other projects that our attempting to help the blind to be able to read better, our project is meant as a portable solution for public places. We intend to develop this project idea in a unique manner, and will strive to make our design exactly how we have stated.

References:

[1] National Federation of the Blind, 'The Braille Literacy Crisis in America', 2009. [Online]: https://www.nfb.org/images/nfb/documents/pdf/braille_literacy_report_web.pdf

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[3] wearable-technologies.com, 'Dot Braille Smartwatch for the Visually Impaired', 2018. [Online]: https://www.wearable-technologies.com/2018/10/the-dot-braille-smartwatch-lets-the-visually-impaired-people-see-the-world-from-a-different-angle/