

Osikoya’s Method

(Electronic braille box)

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A picture containing indoor, table

Description generated with very high confidence

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**Declaration**

This project is presented in partial fulfilment of the requirements for the degree of Bachelor of Engineering in Computer & Electronic Engineering at Galway-Mayo Institute of Technology.

This project is my own work, except where otherwise accredited. Where the work of others has been used or incorporated during this project, this is acknowledged and referenced.

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**Table of Contents**

[1 Summary 5](#_Toc512530902)

[2 Introduction 6](#_Toc512530903)

[3 A brief overview of braille and how it is taught 7](#_Toc512530904)

[3.1 Statistics of visually impaired users 7](#_Toc512530905)

[3.2 Braille: the language of communication for the visually impaired 7](#_Toc512530906)

[3.3 How Braille is taught 8](#_Toc512530907)

[4 Project Architecture 9](#_Toc512530908)

[5 Agile Project Management 11](#_Toc512530909)

[6 Speech Synthesizer and Recognizer(MOVI) 12](#_Toc512530910)

[7 Solenoids 14](#_Toc512530911)

[7.1 The ULN2803A Chip 15](#_Toc512530912)

[8 Web Server 17](#_Toc512530913)

[8.1 2.4GHZ 17](#_Toc512530914)

[8.2 TCP/IP model suite and HTTP protocol 19](#_Toc512530915)

[8.3 HTML and CSS code 20](#_Toc512530916)

[8.4 HTML & CSS Code 21](#_Toc512530917)

[9 System Integration 21](#_Toc512530918)

[9.1 Overall Power consumption 21](#_Toc512530919)

[9.2 Problem I encountered and how much power it took up all together 21](#_Toc512530920)

[10 Conclusion 23](#_Toc512530921)

[11 References 24](#_Toc512530922)

# Summary

My project is an electronic braille teaching device. The goal of my project is to teach braille to the visually impaired electronically with the help of an assistant by their side to guide them.

I choose my project because of my personal connection to the blind community and simply because I wanted to give back to my community in a different way, and the way I did this was by constructing a braille teacher for the blind community in my locality. Amidst the known technological developments implemented in my area I noticed that not many improvements were being amended to the blind community, premised on the fact that braille was still being taught in rudimentary ways. So, I focused in on this specific area and I wanted to see how I could create something with equal aspects of software and hardware elements that would tend to the needs of visually impaired users.

The scope of my project is implementing Agile tactics to make the execution of my project possible which, involved multiple trials and test to make sure my project worked the way that I envisioned.

My device is composed of an Arduino microcontroller which is interfaced with a speech recognizer and synthesizer. The speech synthesizer allows the user to say a sentence which correlates to one of the letters in the alphabet or numerical system and the synthesizer responds accordingly by activating a six-sequence pattern represented by six D-frame push-pull solenoids, which represent the six-braille cell, to produce an alphabet equivalent. My device is also integrated and networked with serial communications such as Serial terminal and Wi-Fi for added functionality. The details of my project can be viewed via a developed website made using HTML and CSS.

Finally, I would say that the data that I retrieved from the multiple trials and tests that I carried out was satisfactory because overall, it showed that my project was fully functional and could be implemented into a visually impaired person’s learning of braille.

# Introduction

I knew for my second-year project, that I wanted to dedicate my project to enhancements in the blind community. For quite some time, I have had quite a fascination for the sequential language of braille because I was greatly amazed by how the power of braille could communicates ideas and concepts to user with patterns of raised dots. I also wanted to challenge myself in figuring out how I could make the idea I had in my head possible and build my own device in a way that would help visually impaired users in learning braille. I wanted to make sure after the completion of my project, that the device that I would construct would be available for people to utilize and easy to both understand and use.

# A brief overview of braille and how it is taught

## Statistics of visually impaired users

Currently in the world in the diagram below this is the amount of visually impaired people that suffer with the disability [1]. It is said to be that almost 32 percent of this population do not have the amenities nor the funds to learn braille. The vast majority of this population reside in developing countries. When I became aware of this statistic I knew I wanted to make my device because not only would it be educational, but it could potentially target a large audience.

A close up of a logo

Description generated with very high confidence

Figure 1‑1 Pie Chart

## Braille: the language of communication for the visually impaired

Braille is the universal language for blind people. It is how they communicate with the world. The braille alphabet is composed of a six-braille cell which looks like this [2]:

A drawing of a person

Description generated with high confidence

Figure 1‑2 Six braille cell

With the six-braille cell, comes six positions, which identify each braille patterns from one another when the visually impaired user uses braille. The first three positions are on the left-hand side of the six-braille cell and the last three positions on the other. Below is the full Braille alphabet [3]:

A screenshot of a cell phone

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Figure 1‑3 English braille alphabet

## How Braille is taught

To this day braille is still being taught on paper. The process for learning braille can often be long and arduous. In the first few initial weeks the learner is taught to locate the corner of the script they are reading from before they can begin learning braille. Learning braille can often take a long period to comprehend.

# Project Architecture

For my project the development platforms that I am using is the Arduino geunino(R3) and the MOVI speech recognizer and synthesizer (MOVI) by Audeme LLC. The components that I used are interfaced with these Development boards.

[Farnell] data sheet

The Arduino Uno is a microcontroller board based on the ATmega328 chip. The ATmega328 is a microcontroller chip created by Atmel in the mega AVR family. The Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogy inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. Arduino is an open-source electronics platform based on easy-to-use hardware which is the microcontroller and software which is refer to the Arduino IDE (Integrated Development Environment) which runs on your PC which allows you to store and upload code to the microcontroller. Arduino boards can read inputs. Examples of this would be light on a sensor, a finger on a button, or a Twitter message and is then able to turn it into an output like activating a motor, turning on an LED or publishing something online [4].

[link movi website]

The MOVI is an easy to use speech recognizer and voice synthesizer. The MOVI Speech synthesizer is a fundamental part to my project because it is what enables the visually impaired users to communicate with the solenoids and allows them to feel the braille patterns [5].movi

My Architectural diagram below details how my device works. On booting my device, MOVI communicates with Arduino that it is mounted on. It accepts the user’s vocal requests by listening for letters from the Alphabet and numbers. When this is processed, MOVI will then respond telling the user what they had just said. The solenoids are also mounted on an Arduino and respond to what MOVI said with a switch case statement which has the serial

terminal implemented. The assistant will use the serial terminal to type in the letter or number that they heard, and the solenoids will pop up the appropriate pattern. I have also implemented six LEDS as well, these show the braille patterns in case the assistant didn’t pick up what MOVI said.

Also, my Architectural diagram features a WIFI module which is also hosted on the Arduino development platform board. The Wi-Fi Module that I am using is the Esp8266ex. With the Wi-Fi module I made a website detailing what my project is about. The website that I created is coded with the computer coding languages HTML and CSS.

A close up of a logo

Description generated with high confidence

Figure 1‑4 Architecture Diagram

# Agile Project Management

For my project, how I evaluated my successes and progression throughout my project was using Agile Project Management(APM).

APM focuses on outputting quality products by monitoring the development process continuously and carrying trial and tests continuously throughout the life of the project. APM implements scrum as a frame work and is normally carried out in teams of people, who have various roles in the product development process which are scrum master, team member and product owner. Doing an individual project, I had to take on these various roles which were both interesting and challenging.

I choose to use this approach for my project because I knew it would be the best way to examine my project’s development and it would be also a useful tool for monitoring success and failure.

During the formation of my project, I kept and made many product backlogs which were essentially to do lists in agile terminology, of objectives I had to meet in my project. These can be viewed in my log book.

I believe that using APM was indeed very effective because It made me stay on track with my project objectives as I was able to see my project develop in incremental steps by implementing multiple trials and tests.

# Speech Synthesizer and Recognizer(MOVI)

As I had mentioned earlier in my architectural diagram, the MOVI is a fundamental part of my project premised on the fact that it allows for communication between the user and the solenoids to produce a braille pattern.

The MOVI is used with an Arduino board and provides an alternative to buttons, remote controls, or cell phones by letting you use full-sentence voice commands for tasks such as turning devices on and off, entering alarm codes, and carrying on programmed conversations with projects. MOVI is programmed directly from the Arduino IDE and requires no voice samples for training, does not use an Internet connection and is speaker independent.

The MOVI speech synthesizer and recognizer has a built-in microphone with automatic gain control to detect speech up to 10 feet in a quiet environment. Alternatively, an external microphone input is also available and can be used in noisier rooms.

In my project the MOVI is mounted on top of my Arduino in order for it work and carry out its speech recognition and synthesis procedures. The MOVI compatible with selected versions of the Arduino such as the Arduino Uno ​R1 ​and ​R2, ​MEGA2560 ​R1 ​and ​R2, ​Leonardo ​R1 ​and ​R2 Uno ​R3, ​Mega2560 ​R3, ​Leonardo ​R and several other microcontrollers.

Because of the limited space of the Arduino, MOVI comes with a 4GB SD card to save to the library files implemented in the MOVI

The MOVI runs on a A13 chip. the A13 chip is called The Allwinner and is a system-on-chip based on a single-core ARM Cortex A8 processor. It is predominately found on many 7-8-inch budget Android tablets. [6] Allwinner actual site

MOVI is powered through the Arduino board that needs to be powered using an external power supply. The external power supply provides between 7V and 16V and also provides at least 500mA current. During testing, it is recommended to use ​either ​9V ​or ​12V. ​Battery ​packs ​with ​this ​specification ​work ​as ​well. MOVI cannot be powered through a USB power supply or the USB cable of ​the ​Arduino ​board ​as ​the ​voltage ​provided ​is ​less ​than ​6V.

To get audio feedback (including error and system messages), MOVI requires a speaker connected to Audio Out. The speaker can be mono or stereo, but the signal provided by MOVI is mono. The speaker impedance should be 32 ohms, which is the standard impedance for headphones. The output volume can be controlled in software using the MOVI library. For convenience, it is recommended to use active speakers with an ​amplifier ​and ​volume ​control.

With MOVI, you cannot connect 4 ohms or 8 ohms speakers. Especially high-wattage speakers ​require ​an ​amplifier ​and ​might ​damage ​the ​board. For usability reasons or in difficult environmental conditions, a headset microphone should be used. A headset microphone or an alternative electret microphone can be connected to External Microphone in port (MicIn). This audio jack is a stereo jack but only accepts a mono signal. Connecting a device to External MicIn disables the integrated microphone. Also, the signal ​that ​comes ​through ​External ​MicIn ​is ​not ​amplified.

MOVI ​uses ​the ​LED ​as ​an ​indicator ​for ​the ​state ​that ​MOVI ​is ​in. ​if the LED is ​off it ​MOVI ​is ​turned ​off, ​there ​is ​not ​enough ​power ​to operate, ​and/or ​the ​SD ​card ​is ​not ​plugged ​in. if the LED is ​blinking ​faster ​and ​faster it means MOVI ​is ​booting. if the LED is ​blinking ​randomly it means ​MOVI ​is ​writing ​to ​the ​SD-Card. ​This ​happens ​during ​an ​update, training, ​or ​resetting ​to ​defaults. The ​MOVI ​should ​not ​be ​powered ​off ​while ​the ​LED ​is ​blinking randomly and also detailed in the Speech synthesizer manual there is various other functions that notify the user of what state the MOVI device is in.

Training sentences is done is in a textual form over the serial connection to the shield. The shield phonetizes the words in each sentence using a 2 GB English dictionary that knows spelling rules and approximates even for proper names. The phoneme sequences are used to create a temporal model that makes sure that only words are recognized that have been part of the training sentences. A second temporal model favors word sequences that are part of the sentences over sequences that are not by assigning higher probabilities to phoneme sequences that occurred in the trained ​sentences ​over ​those ​that ​didn’t.

Recognition: During recognition, a waveform comes in over the microphone and is broken down into speech and non-speech regions. This is done by an algorithm that monitors the energy of the incoming signal over a short time period and compares it to a threshold. If the pattern looks like speech and speech pauses, it assumes speech, otherwise the signal is ignored. The speech regions of the signal are then passed to a classifier that has been trained on hundreds of adult speakers. It breaks down the waveform into possible phonemes sequences. Using the temporal model created in training, the phoneme sequences are matched to the pre-trained words and word sequences that are part of the training sentences are favored.

A last correction step maps the words to the most likely set (result from poll ()). This second step can be omitted in the library ​by ​using get Result (). The first solution is to uncomment the add Sentence() and train() calls and re-compile and upload after MOVI has learned the sentences. the MOVI API itself as well as another other library potentially included in a sketch also occupy some SRAM which is a type of memory on the Arduino. Another solution therefore is to use the PROGMEM method and the F() macro to store variables in flash memory which takes up less space in the Arduino since it is noted that the Arduino Uno development board is limited by space . [7] manual

# Solenoids

Solenoid's are three-dimensional structures. It is tightly wound around a coil and electricity passes through it to produce special magnetic properties. [8] wikipadia

electromagnetic induction is where voltage or current is produced in a conductor by changing magnetic flux e.g. When a magnet is moved in a solenoid. it works like a bar magnet. An armature which is an element in the component makes it possible to provide a mechanical force to exert some mechanism e.g. Braille sequence

A solenoid can be classified as two types. A solenoid is a type of electromagnet when the purpose is to generate a controlled magnetic field. If the purpose of the solenoid is instead to impede changes in the electric current, a solenoid can be more specifically classified as an inductor rather than an electromagnet.

[wikipeadia]

The reason why I choose the solenoid components was because I needed it to display refreshable braille sequences as I knew it was a component that could produce a pop-like function.

In the diagram below each one of the solenoids took 6A of current. Solenoid current consumption depends on the active resistance.

Here is how the solenoids are connected in my project:

A circuit board

Description generated with high confidenceA screenshot of a cell phone

Description generated with very high confidence

## The ULN2803A Chip

The ULN2803A device is a 50 V, 500 mA Darlington NPN transistor array. The device consists of eight NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each Darlington pair is 500 mA. The chip contains a clamp diode and its function is to clamp negative current spikes which can be dangerous. The Darlington pairs may be connected in parallel for higher current capability. Use for the ULN283A chip include relay drivers, hammer drivers, lamp drivers, display drivers and logic buffers. The ULN2803A device has a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.

Here is a diagram of the pin out for the chip: A screenshot of a cell phone

Description generated with very high confidence

On the ULN2803A pins 1B to 8C are the NPN darlington pairs and pin is the ground pin to ground the whole chip. Pin 10 serves to act as a common cathode which means the cathode on the pin is negative. The reaction that takes place is electrons from the anode flow to the positive terminal and electrons flow to the cathode

In the functional block diagram, it shows how a Darlington pair chip is constructed. Each Darlington pair of the ULN2803A consists of D NPN transistors

A picture containing object

Description generated with very high confidence

The ULN2803A has a series base resistor to each Darlington pair allowing operation directly with TTL or CMOS operating at supply voltages of 5 V or 3.3 V. The GPIO voltage is converted to base current through the 2.7-kΩ resistor connected between the input and base of the Darlington NPN. The diodes connected between the output and COM pin are used to suppress the kick-back voltage from an inductive load that is excited when the NPN drivers are turned off (stop sinking) and the stored energy in the coils causes a reverse current to flow into the coil supply through the kick-back diode. [reference to Texas instruments]

The reason I decided to use the ULN2803A chip was because it reduced the circuitry needed to connect six solenoids to the Arduino development board.

# Web Server

For my project I integrated a Wi-Fi module because I wanted to develop a webpage where, anyone could view the details of my project. The webpage I developed was created with HTML and CSS.

The Wi-Fi module that I used that made all of this possible was the Wi-Fi module esp8266EX. The Wi-Fi module contains a self-contain Soc integrated TCP/IP protocol stack this means that it gives any microcontroller access to your Wi-Fi network. It also contains a self-calibrated Radio Frequency(RF) balun allowing it to work under all operating conditions. The module operates on 3.3V. Connecting voltages higher than 3.3V e.g. 5V can effectively damage the chip. The Module operates in station mode which means it searches for access points which is called AP and connects to it. Availability of particular station mode depends on wireless-protocol that is used in wireless network. The Wi-Fi module has a hundred percent duty cycle this means the amount of time the device is actually on for and operating and sink an average of 80 mA of current which is a rather high value for such a small module. Below is a schematic of the wifi module and the diffierent pin outs that I used t connect the wifimodle to the arduino.

A close up of a screen

Description generated with very high confidence

## 2.4GHZ

The frequency 2.4GHZ is fundamental component to anything e.g. data being transported wirelessly examples of wireless communication wold be Wi-Fi, Bluetooth, router and radio signals. For anything to be transported wirelessly it is dependent on Radio frequency(RF) oscillations which is the movement of waves through different mediums that it can successfully pass through. The 2.4GHZ frequency is so useful because it is free to use and is unlicensed and this why most devices like cell phone, routers, PCs etc. reside in this region.

RF is made up of electromagnetic waves. They have a distinct orientation in they way that they oscillate thus making the waves polarized. Radio Frequency waves are non-ionising which means it is harmful and the energy it possesses is too low to ionize atoms. This makes them also non-radio-active as radiation is the ionisation of atoms

A close up of a fence

Description generated with very high confidence

The oscillation and wavelength of RF is calculated using the formula down below which is the speed of light over the frequency of that specific waveform and the answer extracted from that formula is given the = to the symbol Gama (see formula below) to represent the wavelength.

A screenshot of a cell phone

Description generated with very high confidence

Signal towers emit and absorb these signals and must match wavelengths but when constructing a signal tower, the height is equivalent to what a quarter of the entire wavelength would be as wavelength are represented by a sine wave are a periodic meaning that they repeat themselves and also because it would be impractical to build such a high tower when there has been techniques implemented to optimize the height of the tower.

802.11g. 802.11g is a Wi-Fi standard developed by the IEEE for transmitting data over a wireless network. It operates on a 2.4 GHz bandwidth and supports data transfer rates up to 54 Mbps.

When hosting my website Wi-Fi module developed on the Arduino with the on my phone the antenna in my phone will pick up the signal because it is a directional antenna, which means it can transmit and receive RF signals and also block unwanted signals, and then the wireless communications between my phone and the Wi-Fi module will begin.

//Wi-Fi code implement here

## TCP/IP model suite and HTTP protocol

What makes the wireless transfer of data possible is the TCP/IP model and the HTTP which I will explain in further depth and how it correlates to my project

* TCP/IP Model suite:

The TCP/IP Model suite is One of the most widely used. It is stands for the Transmission Control Protocol/Internet Protocol (TCP/IP). Also, a generic protocol model used in describing network communications known as the Open System Interconnection (OSI) model is useful for comparing and contrasting different protocols.

TCP/IP is a suite of communication protocols used to interconnect network devices on the internet. TCP/IP can also be used as a communications protocol in a private network (an intranet or an extranet).

TCP/IP Model suite is made up of four layers which are the following:

1. The Data link Layer

Which can also be referred to the network access layer transport packets to get the IP address

1. Internet Layer

In this layer each of the packets get addressed and get prepped for IP address transport

1. Transport Layer

On this layer the data is divided into packets

1. Application Layer

Webpage side of things data is accessed using the http and FTP protocols e.g. requesting and downloading information

A screenshot of a cell phone

Description generated with very high confidence

* HTTP:

Stands for Hypertext transfer protocol and is found on the application layer of the TCP/IP model suite. HTTP it transfers hypertext from the web server to your web browser, so u can view it in your web browser. It is used by web browser and web servers to communicate.

## HTML and CSS code

For the internet of things side of my project, I choose to use Wi-Fi as my form of wireless communication. For this mode I made a webpage using HTML and CSS detailing what my project was about.

HTML is a mark-up language which defines content and stands for Hyper Text Mark-up Language and it is framework of what my website is built on because it allows me to display my paragraphs and different headings on my website while CSS is responsible for making the website aesthetically pleasing. How I went about creating my website was using the following tags in HTML which were <head> <body> <p> tags to create viewable content to the user that would be viewing my website.

# System Integration

System integration was one of the parts of my project that I would say that I worked tirelessly on. Although, I could not get my project fully integrated I was able to display my components to their full potential individually but also showcasing them by bringing together as a whole fully functioning project.

## Overall Power consumption

All together my project takes 1.6A of current to make it function this is solely because of the solenoids and how they take up to 500ma of current each.

## Problems I encountered and how much power it took up all together

* The problem I encountered with integrating my project was integrating the Wi-Fi code and the solenoid code. This was because when I tried to integrate the two pieces of code together it became messy and ultimately didn’t function when I tried to run the sketch.
* Another problem I experienced was power problems with the solenoids and MOVI, when I tried mount the solenoids on the MOVI it appeared than not enough current was being sent to the solenoids and therefore that meant the solenoids would not perform their functions. So, to solve this problem I implemented another Arduino and the solenoids then worked independently on their own whilst still being a main part of my project.

# Conclusion

The outcome of my project was that it was fully functional, meaning that a visually impaired user could use it to receive feedback from MOVI with the help of an assistant by their side. Although, my project didn’t fully reach what I had envisioned, I was very proud that I was able to develop it to the stage of where it was still functional and ready for use.

In the future I would like to further expand on my project by making it autonomous to the visually impaired user. This way they wouldn’t need an assistant as a medium for communication to access the braille patterns. Also, in the future I hope to make my project more interactive by adding different sensors and different forms of serial communications to it.

# References

Some example references are given here. For example, the section in your report on your servo motors should have a sentence that includes [1] in it, referring to reference [1] here.

* [1] Arduino, “Arduino description”, arduino.cc, 2018.
* [3] Texas Instruments, “TLL logic”,TLL datasheet, 2018.
* Texas Instruments, “ULN2803a”, TLL datasheet, 2018.
* [4] Stack Overflow, “Is there a connect solenoids successfully to a speech synthesizer?”, stackoverflow.com, 2018.
* . 2018) *Arduino Datatsheet,*Available at: *http://www.farnell.ie* (Accessed: 20th April 2018).
* (Texas, n.d.)Texas Instruments (2017) *ULN2803A Darlington Transistor Arrays,*Available at: *https://www.ti.com* (Accessed: 6th april 2018).