VOICE ACTIVATED PORTABLE BRAILLE SYSTEM
FOR
VISUALLY IMPAIRED PEOPLE

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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DHAKA, BANGLADESH
DECEMBER 2019

APPROVAL

This Project/internship titled **"Voice Activated Portable Braille System for Visually Impaired People"**, submitted by Jannatul Ferdousi Sirajum Monira, ID No: 153-15-6605 and Mir Md. Nur-E-Alam, ID No: 153-15-6606 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on December 5, 2019.

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We hereby declare that, this project has been done by us under the supervision of **Fahad Faisal, Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ACKNOWLEDGEMENT

First, we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project/internship successfully.

We really grateful and wish our profound our indebtedness to **Fahad Faisal**, **Assistant Professor**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Electrical Engineering*" to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to **Prof. Dr. Syed Akhter Hossain** and Head**,** Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

Our project named Voice Activated Braille is a portable device that will help blind or visually impaired people to recognize certain written characters without any partial help. This is an Arduino controlled device that will be able to guide blind people. The device mainly works as a guide to the blind people, a different virtual world for the blind people which makes them equally hopeful to the rest of the normal people of the world. we showed blind people can get benefits from the innovative braille techniques and discuss some representative examples to illustrate how this device can be utilized to address the information technology problem of blind and visual impaired people. This device is portable and can avoid partial help for blind people and will help them to read anything without any help as well. Thus, can greatly contribute in reducing the visibility problem of blind people and give them a sort of freedom.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

The braille was invented by Louis Braille in 1821 to help the blind or visually disabled people. Before his invention blind people could only read letters embossed on paper which is slow process of reading. His invention helps blind people to read more quickly and easily which in turn increased the literacy of the blinds. His invented braille system has 6 dots in 2 rows, 3 in each column. The spacing between the dots varies differ from device to device.

When our brain cannot communicate with the eye the brain cannot picture anything, the condition is called blindness. Blindness is the condition of lacking visual perception due to physiological or neurological factors. It is something most people do not like to think about. But the chances of becoming blind probably are greater than realization of someone. In every 5 second a person goes blind and a children goes blind in every minute.

Maximum number of blinds lives in developing countries and among them 60% of the children die roughly in year from the time of when they become blind. Again, as the survivors spend roughly 40 years without sight, so blindness in children accounts for nearly one third of the global economic cost of blindness. We planned to build something for the welfare of visually impaired people of Bangladesh at a very low budget, adaptive and effective solution.

We aim to develop a prototype portable device which can perform basic reading skills of Braille. For this, we will develop a portable device. The device mechanism can be fitted in a six-segment interface and can be used using voice. command. The device and its function will be controlled by Arduino UNO. It will be wireless so that it can be switched on and off from manually.

1.2 Background and Motivation

In Bangladesh the number of blind people is around 750000 and blindness due to cataract is around 600000 and each year another 12000 adds to the list. The children in

poor families goes blind due to lack of Vitamin A. Chances of getting blind increases if the child has diarrhea and nutrition deficiency.

45 million people goes blind with another 135 million people with visual impaired according to the WHO (World Health Organization). Around 17-20 million people goes blind mainly due to debilitating cataracts. Our neighboring country India has the highest number of blindness and the figure is around 9 million, most of the cases goes unoperated.

In some region of Pakistan and whole of Pakistan, survey of blindness prevalence was conducted and the report was 1.0% and 0.8% respectively. In an accompanying survey, 3% of blindness prevalence were recorded for 45 years.

Before this report, no research was carried out in Bangladesh regarding blindness, a country of over 130 million people, which is key reason of reduced vision.[11]. In context of the policy described in the Global World Health Organization initiative for the elimination of evitable blindness by 2020.

For this populous country, a national survey was designed to remedy the lack of blindness and low-vision data for adults. The purpose of this study was to estimate the age and sex prevalence rates of blindness in Bangladesh and visual impairment among adults 30 years of age and older. There are 2 types of braille Grade I, which is for all types of people and another type is Grade II, which is for students.

Therefore, our main motivation is to solve the major problems of a blind or visually impaired person, by building a real-time portable device which will work vocally and perform all the necessary steps for a blind person without any human intervention. If our device is implemented in blind organizations of Bangladesh, it will help the poor, blind people to get rid of the problems cased due to blindness. It will also minimize the hard work of the blind students while studying. This device will also save lots of money for the blind people, as they need not have to buy any Braille-books, supporting instruments, since this device will be affordable and cheap.

1.3   Objectives

When we decided to make a Braille, we set out few goals that we want to accomplish. Achieving the project goals will make this project, all our hard work and our dedication successful.

The following are the objectives of our Braille:

▪ **Build a portable device that will help the blind people to read**: With the help of a portable device, the blind people can read any type of writings freely without any external support.

▪ **A low cost and affordable device for blind people**: The blind people will not have to spend lots of money in order to buy Braille character books or notes. This robot will be affordable and efficient enough for them.

▪ **Make a suitable device for blind students to attend lectures**: For many blind individual braille has been very effective for reading and writing, with a wealth of tangible and intangible advantages.

▪ **Make a suitable device for blind people to move about outdoor:** Before the creation of Braille, the blind people needed external help to move about outdoor. But the refreshable real-time braille will capture any writings from outdoor and guide the blind person automatically outdoors.

CHAPTER 2: TECHNICAL DETAILS

2.1 Existing Solution/Design Alternative

A lot of companies are producing braille, some of them are highlighted in this section.

Dot

Dot is a company in South Korea that claims that the successful braille industry is mainly for transformation. It has created Braille smartwatch that is a resource for the blind for low-cost learning and connectivity. With it, Dot aims to restore fair access to information to a population left behind in the age of digital real-time text.
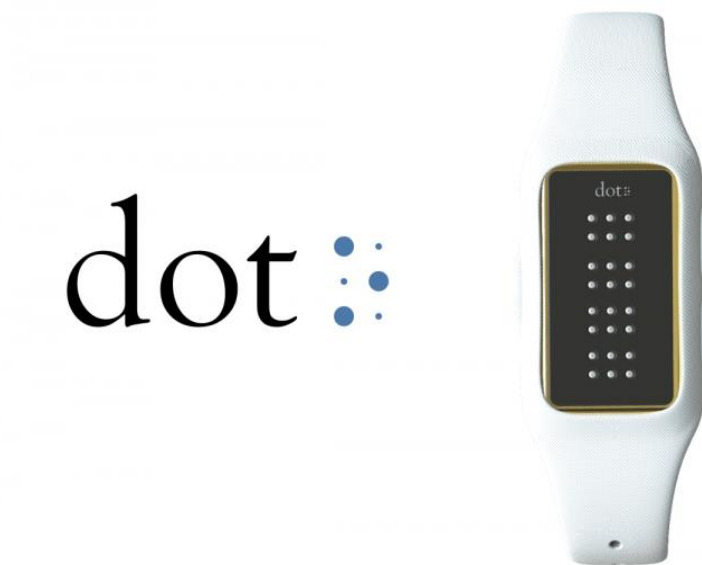
Figure 2.1: A DOT Braille watch

At first glance, the Dot smartwatch appears as one of the watches already in the market. This watch consists of four parts with six dots in each parts and enables user to see four Braille characters at a time. The device can show characters at a frequency of 1 hertz to 100 hertz and has a battery life of 10 hours.

The device gives vibrations when touched on the screen. If it is linked to Bluetooth devices it can display message on in braille language.

As a wearable watch, no one can compete with Dot. Now a days, industries produces hardware in the form of keyboards with containing brille in it and can be connected to computers using USB and has a price of thousands of dollars. In this Body Braille

system, vibrator that are normally used in mobile phones, is used which enables blind people to read braille code using any part of the body. This "Body-Braille" system can be used equally by the sensitivity of various parts of the body such as fingers, palm, ears, head, abdomen, back, arms and legs. Some research says that the human arm and back is the best part of braille response.

Advantages:
1. Small and Portable
2. They can be used as wristwatch.

Disadvantages:
1. Very Expensive.
2. It has only 3 braille cells.

Canute

Canute is created by a company named Bristol Braille Technology. It the world first ever multiline digital Braille. It cost same as the price of an iPad.

Figure 2.2: Side view of the Canute Mk8, the word 'Canute' is written in Braille language.

Affordable braille is essential for the blind literacy, education and word but the use of braille has decreased day by day for the last decades due to the technology stagnation. Canute is designed with and by the blind community for the blind by Bristol Braille Technology.

It is the world's first e-reader with multi line having 40 characters per line by 9 lines that will give out it for Perkins typewriter or iPad Pro. It will be distributed over the internet and will be 20 times cheaper than current Electronic Braille systems.

Advantages:

Comparatively cheaper

Disadvantages:

1. Not handy

2. Heavy

Orbit Reader 20

It is one of the expansive braille with a cost of around £349 which in displayed at RNIB Tec share conference organized at Glasgow.

Figure 2.3: Orbit Reader 20

The price of this new device is less than a fifth of the traditional braille displays. This reader was created by Orbit Research and the Transforming Braille Group which is a concern group of sight loss organization from across the world by RNIB. This device was shown in a conference at RNIB Tec share 2016 and will be available worldwide at a price ranging from £349 to £379. This high cost could be a barrier for many blind people.

Learning braille is an important way of increasing literacy skill for blind and partially sighted children. Dr Gina Spagnola, who is an Orbit Research's Founder, said: "We are tremendously excited about the potential of the Orbit Reader 20 to catalyze braille literacy by providing the first affordable solution for refreshable braille."

Advantages:

Compact and portable

Disadvantage:

1. Expensive

2. Complicated to use

2.2   Proposed Solution

The objective for building a Voice Controlled Braille is to help the blind or visually impaired persons to gain a better guidance system. For a developing country like Bangladesh where blindness covers a major part of the population. Here, in this project, we propose to solve various problems regarding the blindness strategy of Bangladesh. In this project we propose to build a portable device which will contribute in creating a better living for the blind people and help them keep pace with the normal world.
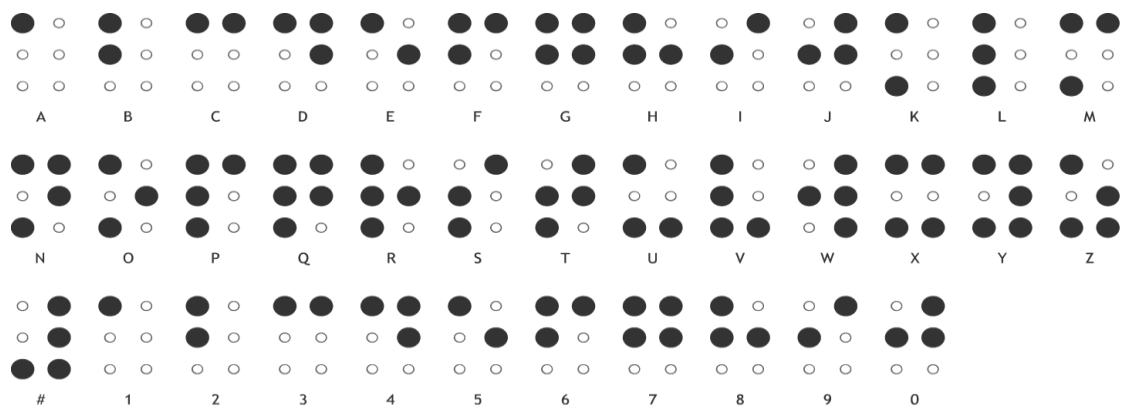

Figure 2.4: Internationally Recognized Braille Characters

This Voice Activated Braille will be a portable device which will be powered on/off manually. Braille pointers were first controlled using servo motor, later we successfully replaced the servo motors by electromagnetic solenoids. The device will have various mechanisms such as tracking various voice through an application on a mobile device and pass them via Bluetooth to the Bluetooth device to display them on braille pointers and provide audio feedback of the command etc. This device will perform its task with the help of Arduino UNO. The Arduino will receive the voice feeds via Bluetooth as input codes. The electromagnetic solenoids used to work as the pointers. The Arduino will take input from the Bluetooth module (the Bluetooth module will receive command from the application installed in the mobile device) and send them to the electromagnetic solenoids. The solenoids will display the words in Braille language and the speakers will give audio feedback of the input command. It will automatically

pickup voice command and converts them to braille language and display them on the braille interface with audio feedback on the speaker. This device will save lots of money and time and will also be very efficient in increasing the courage of blinds of Bangladesh.

2.3   Solution Assessment

Our proposed portable Braille is a device that can be used in guiding the blind people to read without any external help. Our solution is better than existing solutions mainly because our system is portable, less expensive and can be used using voice command. Primarily we proposed to make a portable device. For that we are using Arduino UNO. Original Arduino UNO costs around 4500 TK each. But we can use a Chinese version of Arduino UNO at around 400 TK. We have also used a Chinese Bluetooth module which costs around 300 TK, a SD Card module costs around 120 TK. for voice feedback and a mobile application found on google play store or on any other mobile application website for free.

Since Chinese one costs significantly lesser and since we are making a prototype, we would be buying the Chinese one. To control the Braille pointers, we were using 6 servo motors. The price of them are 280 TK. per piece. Here there is no problem with the weight management as it's very light to carry. The servo motors are controlled by the Arduino. They are directly connected to the controller and a program is uploaded in the controller to use the servos suitably.

The servos rotate and raise the head of the servos to a certain degree which enables to create the formation needed for a single cell of the Braille display. A cell consists of six dots arranged in 2 columns each having 3 dots. The dots of the cell are numbered from 1 to 6. A relay is used to provide power for the servo motors. The servo motors and the Arduino Uno are all arranged inside a plastic-wood casing. There is one big problem while using the servos as the dots of the cells. The size becomes too large for the comfort of the user. Another problem is that it uses too much power to control six servo motors. So, we changed our whole design to make the device smaller.

We used electromagnetic solenoids as the dots of the cell. Each solenoid is used as a single dot. Each of the solenoids cost 750 TK. Arduino Uno is used as the microcontroller to control the movement of each of the dots. 6 MOSFETs are used as the switching components for each of the solenoids each costing only 35 TK.

Figure 2.5: An Electromagnetic Solenoid

A very low current of around 500mA is needed to move the solenoids. A 5V DC supply is used to power up the device. The circuit is implemented on a breadboard.

A platform on top of the breadboard has been used to accommodate the solenoid heads, in other words the dots of the Braille cell. A mobile device is used as the input device for the Braille display. The mobile device will receive voice command using an application installed in it and sends the command to the Arduino UNO via Bluetooth module. The program needed to control the electricity flow through the switching MOSFETs is uploaded in the controller. Whenever an input is given the program converts it into the correspondent Braille formation according to a given conversion chart. The conversion chart includes alphabets, numbers and punctuation marks to convert into Braille language.

The advantage of using the solenoids as the dots is that the size of the device is now significantly smaller so that a single character can be accommodated within the fingertip of a person. As we have been able to reduce the size of the device, the weight has also decreased. The device is very easy to carry around. We just need to connect it to the Bluetooth application installed in the mobile device via Bluetooth. So finally, after assessing our proposed solution we can finally say that it is economical and best possible design we could think of as of now.

Advantages:

1) Cheap.

2) Portable.

3) Runs on battery, so no harm done to human.

4) User friendly

5) Real-time

6) Give audio feedback

Disadvantages:

1) Will need upgraded workshops in creating more reduced sized device.

2) Complex operating systems for blind people initially.

3) Charging of battery will indirectly pollute the environment.

4) Solenoids need external power supply to run.

2.4   Technical Design: System Level

In our project, we aimed to control the movement of our servo motors using certain codes of arduino UNO. The switching is done through arduino UNO. It is used in various electronics projects and consists of physical circuit that can be programmed and an IDE (Integrated Development Environment) to run on computer to upload code on the board.

Specification of Arduino UNO
The ardunio platform is popular among the newbie on electronics for some quiet good cause. This piece of equipment does not need any external hardware to upload new codes into it, just a USB cable is good enough. This facility is not available in any other circuit boards. In addition to it, this circuit board used a simple version of programming language called C++ which make newbie to learn program easily.

Power (USB / Barrel Jack)
The Arduino can be connected to power source in two ways. One via USB connection and another via external wall power supply.

The USB connection is used to upload code into the Arduino. The recommended voltage is 6-12volts, any greater voltage other than the recommended voltage will destroy the board.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)
Arduino pins are the places where wire is linked in order to build a circuit.
They generally
have ' headers ' of black plastic, allowing a single wire to be connected to the board ri ght onto the board.

- **GND**: GND stands for ground. There are many ground ports on Arduino board of which anyone can be used for ground connection.
- **5V & 3.3V**: As the name suggests, 5V pin supplies 5volts and 3.3V pin supplies 3.3volts which is enough to supply power to most electrical components.

- **Analog**: A0 through A5 on the UNO are Analog In pins. These pins read analog signals and convert them to digital signals.
- **Digital**: 0 through 13 on the UNO are digital pins. These pins are used for digital input and output.
- **PWM**: The sign (~) next to some of the digital pins, 3, 5, 6, 9, 10, and 11 on the UNO are Pulse Width Modulation (PWM) pins. These can be used as digital as well as analog pins.
- **AREF**: This is short for Analog Reference. It is generally not used. It is used to set an external reference voltage, between 0 and 5 Volts, as the maximum for the analog input pins.

Reset Button

The Arduino has a reset button. Pushing the reset button will restart any code that is uploaded on the Arduino. This comes in handy if the code doesn't repeat, and also multiple testing of the code is required.

Power LED Indicator

The power LED indicates that the board is on and ready for the code to be uploaded. If the LED does not turn on there is a strong possibility that there is a problem with the board.

TX RX LEDs

TX stands for transmit, RX stands for receive. These pins are responsible for serial communication. There are two places on the Arduino UNO where TX and RX appear – once on the digital pins 0 and 1, and another time next to the TX and RX indicator LEDs. These blinking LED indicates that transmission of data is going on.

Main IC

Black thing is an IC or an integrated loop with all metal legs. This is considered as Arduino's brains. The key IC on the Arduino differs slightly, but generally from the ATmega IC line on the ATMEL business, from board type to board type. This is important because you might need to learn the IC form before you load a new program from the Arduino code (in accordance with board sort). Usually this information can be found on the top of the IC in writing. Reading the data sheets is often a good idea to understand more about the difference between different ICs.
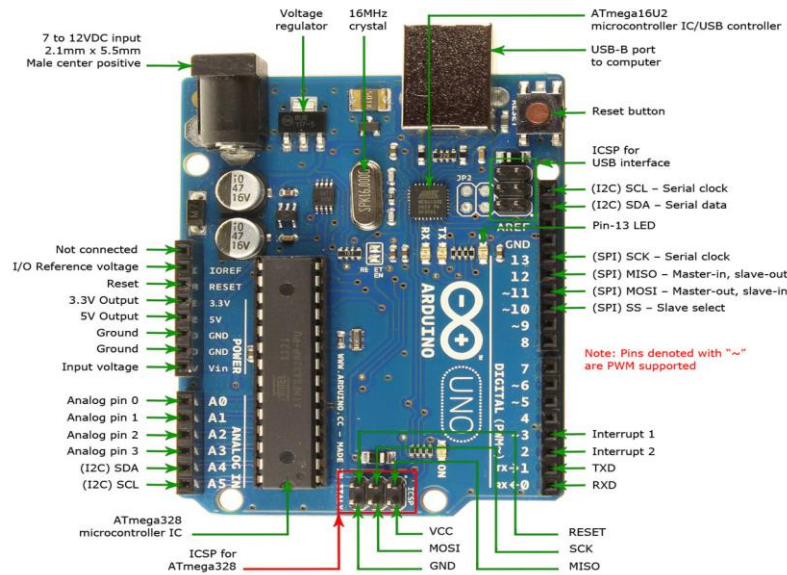
Figure 2.6: Arduino Uno Pin Config

How SD Card module works:

The SD Card Module is used to transfer data to the SD Card and from the SD Card. The pins are compatible with Arduino directly and can also be used with other micro controllers. It can be used as a mass storage and data logging of any project. This module contains SPI interface which makes it compatible type of SD Card which can run on 5 Volts or 3.3 Volts power supply and is compatible with Arduino UNO/Mega. This module has different usage such as data logger and can be used to store audio, video and graphical images. This module helps to overcome the limitation of memory space in Arduino.
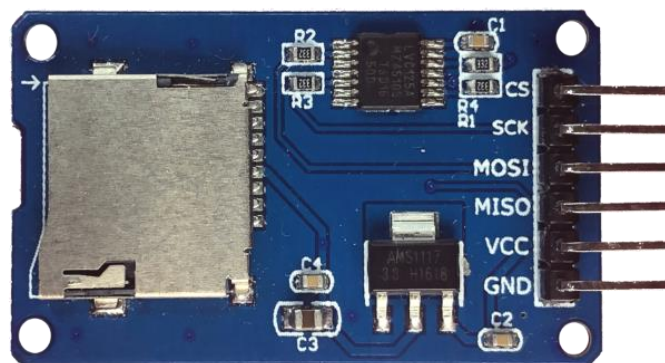
Figure 2.7: SD Card Module

SD Card module wiring table
The **Table 1** below shows how you should wire the SD card module to your Arduino

SD card module	Wiring to Arduino Uno	Wiring to Arduino Mega
VCC	3.3V or 5V (check module's datasheet)	3.3V or 5V (check module's datasheet)
CS	4	53
MOSI	11	51
CLK	13	52
MISO	12	50
GND	GND	GND

Table 1: SD Card module wiring table

How Bluetooth module (HC-05) Works:

Bluetooth serial modules allow all serial enabled devices to transfer data between them.

1. **Key/EN:** It is used to switch the module between command mode and data mode. If it is set to high, then the module will work in command mode but by default it works in data mode. The baud rate in command mode is 38400 bps and in data mode 9600 bps.

HC-05 module has two modes,

1. **Data mode:** It enables data to be passed between the devices.
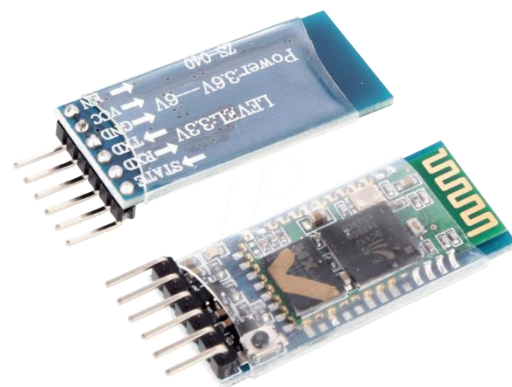
Figure 2.8: Bluetooth module (HC-05)

2. **Command mode:** It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.

2. **VCC:** 5 Volt or 3.3 Volt power supply is connected to this Pin.

3. **GND:** This pin is used as ground of module.

4. **TXD:** Transmission of Data.

5. **RXD:** Receiving of data serially.

6. **State:** It shows if the module is connected or not.

HC-05 module Information

- This module has a red LED which shows the connection state and the on/off state. When it is connected to device it blinks slowly but if the device is not connected it blinks frequently.
- This module works on both 3.3 Volts and 5 Volts. A regulator inside controls the voltage.
- Since Bluetooth has 3.3 Volts for RX/TX, and 3.3 Volts can be sensed on the microcontroller, the communication of HC-05 is not necessary to be modified. Nevertheless, we must change the transmission voltage level from the HC-05 module to RX.

How Electro-magnetic Solenoids Work

A solenoid is just an electromagnet specially designed. A solenoid consists usually of a coil and of a moving iron core, known as the armature. It works like this. A magnetic field is installed around the cable when streams through a cable.

When they create a coil with many wire twists, this magnetic field becomes stronger several times, circulating around the body and its core in the shape of a doughnut. The center moves to increase the stream connection by closing the air gap between the cores, when the coil of the solenoid is powered by current. Normally a spring load is added to the traveling center to allow the core to withdraw when the current is off.

An electromechanical relay is a solenoid used between electrical leads to make or break mechanical contact. A low input voltage regulates a potentially large power via the relay contacts in the solenoid. Power switches and electromechanical control

components are included in implementations. A relay performs a similar function to the transistor of power but, if necessary, can change extremely large currents. Transistors, though, have a much shorter time than relays.

A voice coil consists of a coil that moves in a magnetic field produced by a permanent magnet and intensified by an iron core. The force on the coil is directly proportional to the current in the coil. The coil is usually attached to a movable load such as the diaphragm of an audio speaker, the spool of a hydraulic proportional valve, or the read-write head of a computer disk drive. The linear response and bidirectional capability make voice coils more attractive than solenoids for control applications.
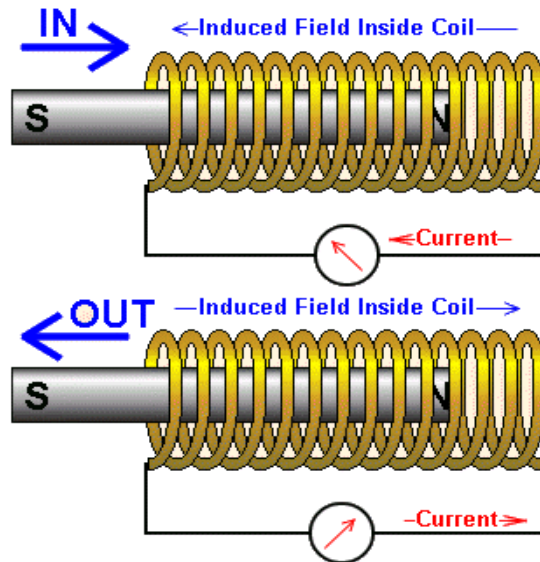
Figure 2.9: Internal Structure of Electromagnetic Solenoid

Most generally, the goal of this project is to develop a braille typewriter prototype which will promote success in the blind community in all levels of education and the workforce. The device itself will be mechatronic based and shall accommodate an easy writing experience or the blind in an ergonomic, portable, and inexpensive manner.

The feasibility of this writing device shall be shaped by the input of potential blind users, which will be obtained in the form of a survey. Once a successful prototype has been fabricated, dissemination of the device in the United States will be explored via numerous companies that offer products to blind users.

MOSFETs working as Switches

Here we used n-type MOSFET, model number
IRF540 SWD-00006

The N-channel, Enhancement-mode
MOSFET (e-MOSFET) works employing
a positive input voltage and has a
greatly high input resistance
(nearly unbounded) making it conceivable to

Figure 2.10: MOSFET IRF540 SWD-00006

interface with about any rationale gate or driver competent of creating a positive yield.

 Due to this excellent resistance to input (Gate),
we can easily contrast several different
MOSFETS together until we reach the current
management capacities required. By connecting
a variety of MOSFETS in parallel, we can
switch high currents or high voltage loads,
making both components and board space costly
and unworkable. In order to overcome this
problem, transistors or power FETs are required

Figure 2.11: Internal Structure of n-type MOSFET

The main differences between field effect transistors, depletion mode only for JFETs
and improvement modes and depletion mode are two. There are two main differences
between field effect transistors. We should be using the MOSFET enhancement mode
as a switch in this tutorial, since these transistors need positive gate voltage to turn on,
and null voltages to turn "off," so that they are easy to understand and effectively
communicate as switches with logical gates.
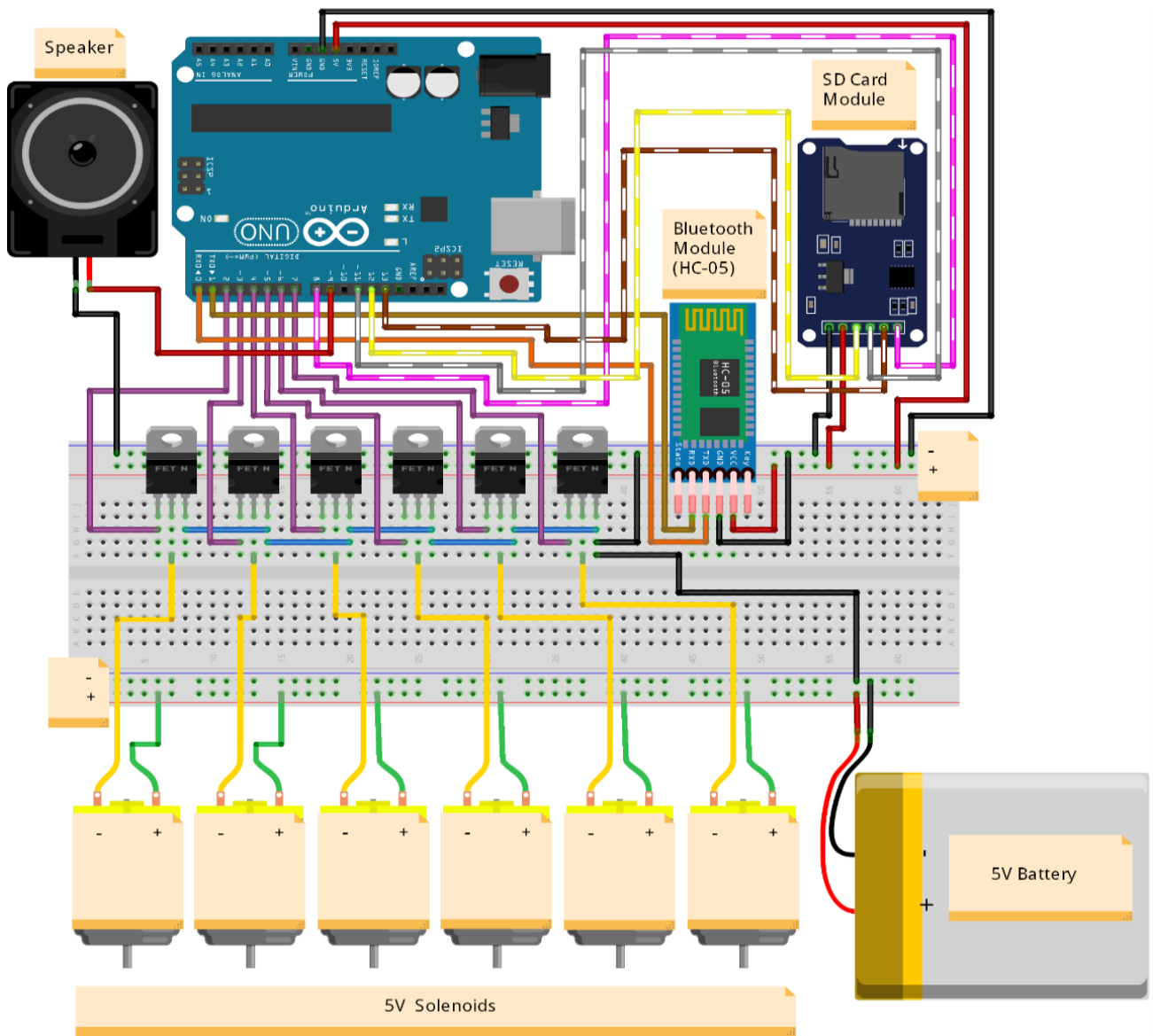
Figure 2.12: System level design

2.5   Technical Design: Module Level
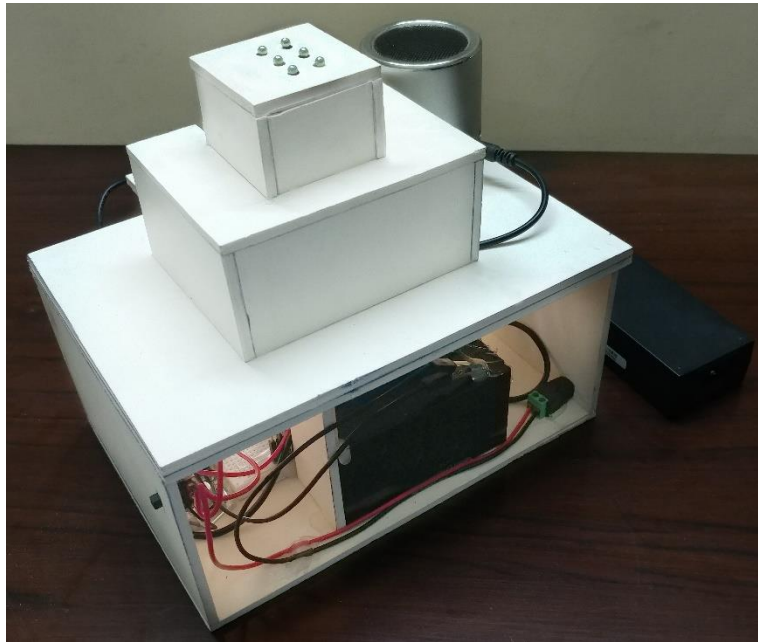
Figure 2.13: Outer Casing of Portable Braille

The force required to emboss a single pin of braille had to be obtained first, because it dictates the entire design of the refreshable display. For example, mechanical levers must be the correct length to provide the appropriate advantage so as to emboss the paper, while electromechanical means must be able to produce enough force to emboss the paper.

Melda Saner, a mechanical engineering PhD student, obtained the force data in an experiment by mounting a slate and paper on a load cell and simply embossing the paper with a stylus. The load cell used was a Loadstar Load Cell, rated up to 50 pounds outputting data at 500 Hz. For a single braille pin, the force gradually increases as the stylus applies increasing pressure on the paper.

Figure 2.14: Top view of the refreshable display

At a certain peak force (represented by the purple stars on the graph) the paper is punctured, resulting in lower resistive forces by the paper as the stylus travels to the pin well in the slate. When the stylus reaches the slate a sharp force peak is produced, as the user is not able to react immediately to embossing the paper. Averaging these force peaks, the mean force required to emboss braille paper was found to be 9.38 N. Standard weight paper was found to have a peak embossing force of about seven newtons.

Ergonomics and Pin Formation The American National Standard for Human Factors Engineering recommends an upper depression force limit of 1.5 N and a key displacement travel between 2 and 4 mm. When considering the user interface, which is going to have keys somehow interacting with embossing pins, the displacement range is not concerning, as 2-4 millimeters will allow for full pin formation in addition to extra pin travel that may be necessary.

However, the force recommendation of 1.5 N is problematic, as it is significantly lower than the force required to create a braille pin, as explained above. If braille embossing is performed without significant mechanical advantage, user injury may occur.

In order to move a metal pin inside the magnetic field. This actuating pin could be fitted with the appropriate dimensioned tip in order to create the raised braille pins when the solenoids are used to actuate the pin. In the figure shown is a US Patent 6,086,272, which takes advantages of this actuating action to form braille pins. Solenoid actuation offers the advantage of being relatively compact, and easy to design around. However, weight, cost, and having a power source for the electromechanical element are all concerns.
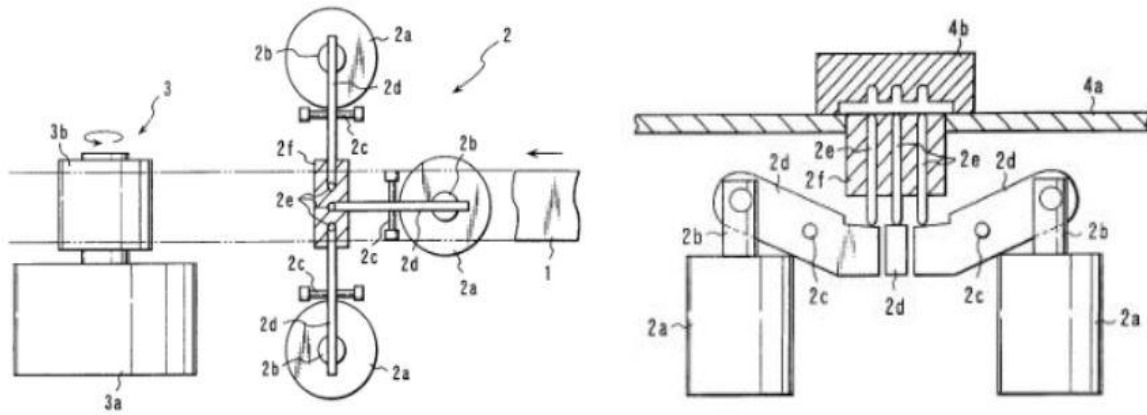
Figure 2.15: Internal Structure of Solenoid formations for Braille Characters

2.6　Skills

The required skill for doing this project is very simple

- basic IDE (Arduino software) programming skills.

- Six segment Braille language alphabets.

- basic circuit connection knowledge.

- a good knowledge about Arduino controllers.

- basic electrical parts assembling skills.

- Braille language vocabulary.

CHAPTER 3: WORKING SHEETS

3.1 Financial Plan

Equipment	Price
Arduino UNO	830 tk.
Bluetooth Module	299 tk.
SD Card Module	120 tk.
Solenoids	4520 tk.
Jumper	60 tk.
Breadboard	80 tk.
Connector	15 tk.
MOSFETS	210 tk.
Total	**6134 tk.**

Table 2: List of equipment, model number and price

3.2 Feasibility Study

The feasibility and design of this writing device was shaped by the input of potential blind users and the staff at the National Braille Press and National Federation of Blind. The refreshable display itself is a mere 50mm x 44.5mm x 21.75mm at maximum dimensions. Variable tolerance actuation allows the refreshable display to form between one and six braille pins in a single motion, facilitating rapid braille transcription.

This is accomplished using one actuator and an array of six blocking devices engaged by the user, in contrast to most braille transcribing devices that utilize six actuators (one per braille pin location), drastically reducing size, cost and weight. The device is capable of forming high quality braille pins consistent with pins formed by the slate and stylus transcribing method. FEA analysis was conducted to verify the

robustness of the design. Manufacturing costs were kept to a minimum by constructing the device with only five unique parts. Finally, future design recommendations for refreshable display translation from cell to cell of braille and refreshable display translation from row to row of braille cells are presented.

Low Cost

The final device must be economically competitive with existing portable braille's on the market today, which denotes the design of a device that is easily manufacturable. As the Jot-A-Dot and Next Generation Perkins Braille are priced at $340 and $650 respectively, there is significant room for improvement over existing devices. It should be noted that the cost of designing the prototype may be slightly higher than these figures, as mass production and manufacturing techniques will ensure the lowering of production costs. Once a final design is selected it will be subject to economic and manufacturing analyses.

Portability

The final device shall be small, readily available for transport by blind individuals in their typical carrying cases, the size of which will be determined by the survey of the blind. This size requirement shall not impede on the ability of the device to produce braille characters on a standard sized sheet of braille paper, which is cited as either 8.5''x11'' or 11.5''x11''. Mechanical Design Specifications The mechanical design challenges of this project can be separated into three distinct components: braille pin formation, user interface, and refreshable display translation from cell to cell of braille as well as refreshable display translation from row to row of braille cells.

Dot Formation

The refreshable display of the device shall be capable of forming high quality braille pins in a consistent and repeatable manner. The pins themselves should meet the American Library of Congress specifications for depth, being fully formed to a depth of half a millimeter. The ability of the refreshable display to form the correct depth pins should not be compromised within the expected life of the product. As a benchmark, it is desirable that the braille pins formed by the device be of comparable quality to those formed by the slate and stylus transcription method.

User Interface

The refreshable display must connect the user interface in such a way that allows for an ergonomic and enjoyable reading experience, not exceeding recommended ergonomic constraints while still being small enough so that the device remains sufficiently compact. Additional keys may be required to allow refreshable display translation from row to row and cell to cell.

Repeatability

The device must allow the refreshable display to form braille pins on adjacent braille cells in a consistent and repeatable manner. This entails the accurate horizontal translation of the refreshable display. The ability of the refreshable display to move from cell to cell in an accurate manner should not be compromised within the expected life of the product.

The device must allow the refreshable display to form multiple lines of braille text on a sheet of paper. This shall be accomplished in a repeatable manner, so that the spacing between rows of braille cells meets the specifications set out by American Library of Congress. The ability of the refreshable display to move from row to row in an accurate manner should not be compromised within the expected life of the product.

Sensory Feedback Systems

As blind individuals do not have a visual feedback system to signify the completion of a certain action, such as the refreshable display reaching the end of a row or a keyboard key being fully depressed, the device shall have sensory feedback systems that are not based on sight. This will ensure easy operation of the device for blind individuals and expedite the braille transcribing process.

The project is feasible in most aspects, the cost of making one unit of this device will not exceed BDT 2,500. So, it's really cheap and effective device. If any investor or any government agency likes the idea of this project and wills to fund for researching, it can also be done with more developments.

If an organization wants to adopt the idea of this prototype and wants to sell it in the market then the cost for making each unit will reduce, since the trial and error step will

be omitted. So overall the price will reduce even more which will attract customers to buy this product and the profit for each unit sold will also increase.

The components used to build this prototype are cheap. So, the cost of maintenance will not be very high. It will be very easy for maintenance.

CHAPTER 4: PROJECT SUMMARY

4.1 Problem Faced and Solutions

We had to learn about the different combinations of braille alphabets and then we develop a braille cell using servo. This cell was our first prototype. There two major issues with this prototype, first it was too big and second it had to be powered from external source.

For the second prototype our aim was to bring the cell display to a size not more than that of our figure tip. Another aim was to provide the power from a battery so that it becomes portable.

To achieve the desired size, we tried base magnets and some suspended bard electromagnets but we failed and found that the base magnets were too strong and it attracts the suspended magnets regardless being the same poles. Then did some research and worked on the solenoids and Arduino. Initially we made 6 electromagnetic solenoids but found that these were not smooth enough and needs a lot of power so we bought six 5-volt solenoid to fix this issue. Then another problem aroused regarding switching the solenoids independently. To avoid this issue, we used tiny n-type MOSFETS to control the switching of each solenoids independently.

After testing several times, we found a major issue regarding the power consumption of the electromagnetic solenoids along with the MOSFETS. Each solenoid consumes 900mAh current and gradually the current decrease but in our local market we couldn't find any small suitable power source which can provide such current perfectly. So, to avoid this problem we bought two batteries and connected them in series using diodes so that it can provide sufficient current.

After fixing these issues, another problem came up regarding sending voice command to the Arduino for the braille to work. We bought different type of voice recognition modules but each module has their own problem like one could only recognize and work on 3 commands at a time only, another on 7 commands only i.e. the module could only store those number of commands in their memory and work on them. This became a huge problem because the braille cannot work on those limited number of commands,

we have to send different types of command to the Arduino to work. After spending a huge amount of time on researching about a probable solution to this problem we came up with an ingenious solution of connecting our device with a Bluetooth module and using a third party app to send voice command to the module connected the braille via Bluetooth connection. This solution made us overcome the voice command limitation problem.

4.2 Conclusion

Our project goal was to create a portable Braille device that would be able to display one alphabet of Braille using electromagnetic solenoids. The device we created is much feasible to the modern world. We went through much trial and error solving several issues in making the device perfect.

The device mainly works as a guide to the blind people, a different virtual world for the blind people which makes them equally hopeful to the rest of the normal people of the world. We tried to show blind people that how creative Braille methods can be used to demonstrate and how this tool can be used to solve the blind or visually impaired people's information technology issue.

This Real-time Device has many difficult points to cover as it supports precise registration in any arbitrary, indoor or outdoor environment. The braille machine often requires compact or mobile devices that are secure and unobtrusive to go anywhere. To deal with density, occlusion and general situation sensitivity problems, new visualization algorithms are required. Several visual applications ideas and models were produced. Nevertheless, the practical testing and evaluation of quantified changes in the visual application was missing. This evidence is necessary in order for this new technology to be expensive and difficult to implement. Further research is needed in basic visual problems and optical illusions resulting from the fusion between real and digital. Experimental results must inform and verify braille device implementations and simulation approaches. According to the demonstration of our device, blindness might come to an end someday which will make the world a better place.

4.3 Future work: Initial Description

In our project we have mainly assembled parts and accessories and researched about our system and created a single cell of the refreshable Braille display. But our target is to complete our portable Braille by interfacing all the parts using electromagnetic equipment's and program them so that it would be able to give a multiple Braille alphabets output. This is our primary target. If we can successfully complete our primary task then we might look to add some more features to our system. For example, A video feeding source will help the Braille display to capture certain writings from outdoor sources. So, depending on our progress we will modify our work accordingly. Our minimum target will be to complete the primary task i.e. video feed by our portable Braille device.

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APPENDIX A

DATASHEET

Arduino UNO
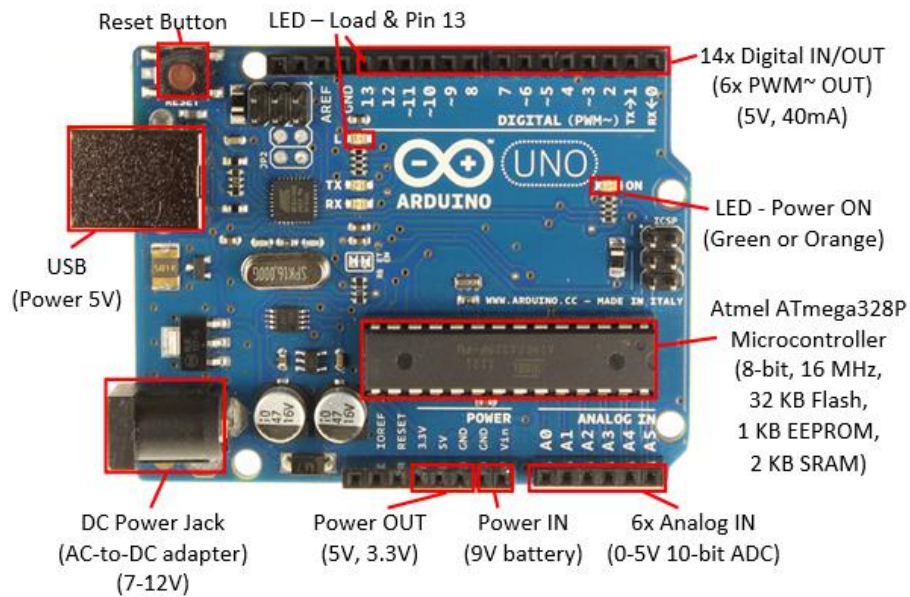
Data Sheet of Arduino UNO:

Microcontroller	ATUNO328
Operating Voltage	6V
Input Voltage (recommended)	6 - 12 V
Input Voltage (Limits)	6 - 20 V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC current per I/O Pin	40mA
DC current for 3.3V Pin	50mA
Flash memory	32 KB (ATUNO328) bootloader uses 0.5KB
SRAM	2 KB (ATUNO328)
EEPROM	1 KB (ATUNO328)
Clock Speed	16MHz

APPENDIX B

Electromagnetic Solenoid

SD Card Module

SD card module	Wiring to Arduino Uno	Wiring to Arduino Mega
VCC	3.3V or 5V (check module's datasheet)	3.3V or 5V (check module's datasheet)
CS	4	53
MOSI	11	51
CLK	13	52
MISO	12	50
GND	GND	GND

Bluetooth Module
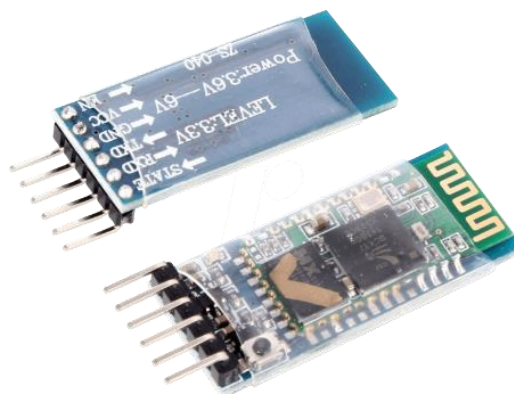
MOSFET IRF 540

N – CHANNEL 100V – 00.50Ω – 30A – TO-220/TO-220FI POWER MOSFET

TYPE	V DSS	R DS(on)	I D
I RF540	100 V	< 0.077 Ω	30A
I RF540F I	100 V	< 0.077 Ω	16A

- TYPICAL R$_{DS(on)}$ = 0.050 Ω
- AVALANCHE RUGGED TECHNOLOGY
- 100% AVALANCHE TESTED
- REPETITIVE AVALANCHE DATA AT 100°C
- LOW GATE CHARGE
- HIGH CURRENT CAPABILITY
- 175°C OPERATING TEMPERATURE
- APPLICATION ORIENTED CHARACTERIZATION

APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- SOLENOID AND RELAY DRIVERS
- DC-DC & DC-AC CONVERTER
- AUTOMOTIVE ENVIRONMENT (INJECTION, ABS, AIR-BAG, LAMP DRIVERS Etc.)

TO-220   TO-220FI

INTERNAL SCHEMATIC DIAGRAM
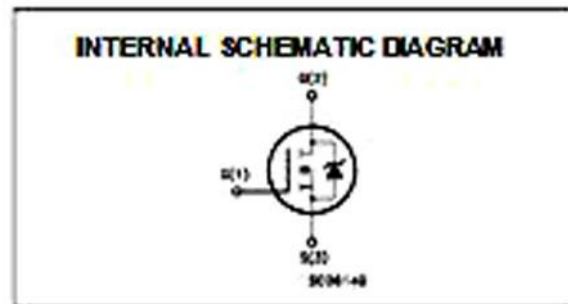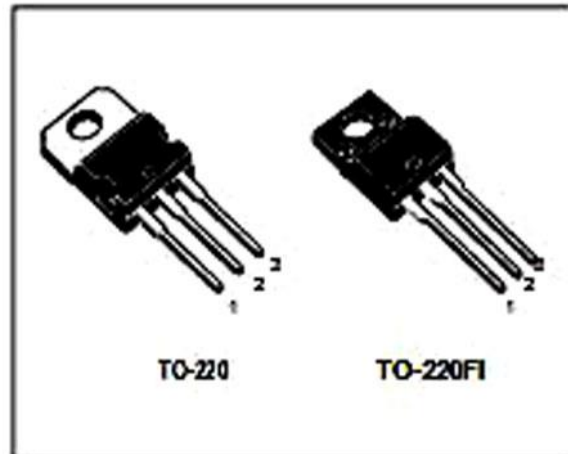
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value		Unit
		IRF540	IRF 540FI	
V$_{DS}$	Drain-source Voltage (V$_{GS}$ = 0)	100		V
V$_{DGR}$	Drain-gate Voltage (R$_{GS}$ = 20 kΩ)	100		V
V$_{GS}$	Gate-source Voltage	±20		V
I$_D$	Drain Current (continuous) at T$_C$ = 25 °C	30	17	A
I$_D$	Drain Current (continuous) at T$_C$ = 100 °C	21	12	A
I$_{DM}$(•)	Drain Current (pulsed)	120	120	A
P$_C$	Total Dissipation at T$_C$ = 25 °C	150	45	W
	Derating Factor	1	0.3	W/°C
V$_{ISO}$	Insulation Withstand Voltage (DC)	-	2000	V
T$_{stg}$	Storage Temperature	-65 to 175		°C
T$_J$	Max. Operating Junction Temperature	175		°C

CODES

```
#include <SoftwareSerial.h>
#include <SD.h>
#include <TMRpcm.h>

#define SD_ChipSelectPin 8
TMRpcm tmrpcm;

SoftwareSerial BT(0, 1);
String readvoice;

void setup() {
 BT.begin(9600);
 Serial.begin(9600);
  pinMode(2, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(4, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(6, OUTPUT);
  pinMode(7, OUTPUT);
  pinMode(10, OUTPUT);
  tmrpcm.speakerPin = 9;

  if
(!SD.begin(SD_ChipSelectPin)) {

   return;
 }
 tmrpcm.setVolume(6);
}
void loop() {
 while (BT.available()){
 delay(10);
 char c = BT.read();
 readvoice += c;
 }
 if (readvoice.length() > 0) {
  Serial.println(readvoice);

 if(readvoice == "*a#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("a.wav");
```

```
digitalWrite(2, HIGH);

  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
 }
 else if (readvoice == "*b#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("b.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, HIGH);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
 }
 else if ( readvoice == "*c#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("c.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, HIGH);
 }
 else if (readvoice == "*d#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
```

```
digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("d.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, HIGH);
  digitalWrite (7, HIGH);
 }
 else if (readvoice == "*e#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("e.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, HIGH);
  digitalWrite (7, LOW);
 }
 else if (readvoice == "*f#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("f.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, HIGH);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, HIGH);
 }
 else if (readvoice == "*g#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
```

```
digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("g.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, HIGH);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, HIGH);
  digitalWrite (7, HIGH);
}
 else if (readvoice == "*h#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("h.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, HIGH);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, HIGH);
  digitalWrite (7, LOW);
}
 else if (readvoice == "*i#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("i.wav");
  digitalWrite(2, LOW);
  digitalWrite (3, HIGH);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, HIGH);
}
 else if (readvoice == "*j#")
 {
  digitalWrite(2, LOW);

  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("j.wav");
  digitalWrite(2, LOW);
  digitalWrite (3, HIGH);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, HIGH);
  digitalWrite (7, HIGH);
}
 else if (readvoice == "*k#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("k.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, LOW);
  digitalWrite(4,HIGH);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
}
 else if (readvoice == "*l#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("l.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, HIGH);
  digitalWrite(4,HIGH);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
}
 else if (readvoice == "*m#")
 {

  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("m.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, LOW);
  digitalWrite(4,HIGH);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, HIGH);
}
 else if (readvoice == "*n#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("n.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, LOW);
  digitalWrite(4,HIGH);
  digitalWrite(5,LOW);
  digitalWrite(6, HIGH);
  digitalWrite (7, HIGH);
}
 else if (readvoice == "*o#")
 {
  digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("o.wav");
  digitalWrite(2, HIGH);
  digitalWrite (3, LOW);
  digitalWrite(4,HIGH);
  digitalWrite(5,LOW);
  digitalWrite(6, HIGH);
```

```cpp
    digitalWrite (7, LOW);
  }
  else if (readvoice == "*p#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
    tmrpcm.play("p.wav");
    digitalWrite(2, HIGH);
    digitalWrite (3, HIGH);
    digitalWrite(4,HIGH);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, HIGH);
  }
  else if (readvoice == "*q#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
    tmrpcm.play("q.wav");
    digitalWrite(2, HIGH);
    digitalWrite (3, HIGH);
    digitalWrite(4,HIGH);
    digitalWrite(5,LOW);
    digitalWrite(6, HIGH);
    digitalWrite (7, HIGH);
  }
  else if (readvoice == "*r#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
    tmrpcm.play("r.wav");
    digitalWrite(2, HIGH);
    digitalWrite (3, HIGH);
    digitalWrite(4,HIGH);
    digitalWrite(5,LOW);

    digitalWrite(6, HIGH);
    digitalWrite (7, LOW);
  }
  else if (readvoice == "*s#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
    tmrpcm.play("s.wav");
    digitalWrite(2, LOW);
    digitalWrite (3, HIGH);
    digitalWrite(4,HIGH);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, HIGH);
  }
  else if (readvoice == "*t#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
    tmrpcm.play("t.wav");
    digitalWrite(2, LOW);
    digitalWrite (3, HIGH);
    digitalWrite(4,HIGH);
    digitalWrite(5,LOW);
    digitalWrite(6, HIGH);
    digitalWrite (7, HIGH);
  }
  else if (readvoice == "*u#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
    tmrpcm.play("u.wav");
    digitalWrite(2, HIGH);
    digitalWrite (3, LOW);
    digitalWrite(4,HIGH);

    digitalWrite(5,HIGH);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
  }
  else if (readvoice == "*v#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
    tmrpcm.play("v.wav");
    digitalWrite(2, HIGH);
    digitalWrite (3, HIGH);
    digitalWrite(4,HIGH);
    digitalWrite(5,HIGH);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
  }
  else if (readvoice == "*w#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
    tmrpcm.play("w.wav");
    digitalWrite(2, LOW);
    digitalWrite (3, HIGH);
    digitalWrite(4,LOW);
    digitalWrite(5,HIGH);
    digitalWrite(6, HIGH);
    digitalWrite (7, HIGH);
  }
  else if (readvoice == "*x#")
  {
    digitalWrite(2, LOW);
    digitalWrite (3, LOW);
    digitalWrite(4,LOW);
    digitalWrite(5,LOW);
    digitalWrite(6, LOW);
    digitalWrite (7, LOW);
    delay(200);
```

```
tmrpcm.play("x.wav");
digitalWrite(2, HIGH);
digitalWrite (3, LOW);
digitalWrite(4,HIGH);
digitalWrite(5,HIGH);
digitalWrite(6, LOW);
digitalWrite (7, HIGH);
}
else if (readvoice == "*y#")
{
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
delay(200);
tmrpcm.play("y.wav");
digitalWrite(2, HIGH);
digitalWrite (3, LOW);
digitalWrite(4,HIGH);
digitalWrite(5,HIGH);
digitalWrite(6, HIGH);
digitalWrite (7, HIGH);
}
else if (readvoice == "*z#")
{
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
delay(200);
tmrpcm.play("z.wav");
digitalWrite(2, HIGH);
digitalWrite (3, LOW);
digitalWrite(4,HIGH);
digitalWrite(5,HIGH);
digitalWrite(6, HIGH);
digitalWrite (7, LOW);
}
else if (readvoice == "*0#")
{
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);

delay(200);
tmrpcm.play("0.wav");
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,HIGH);
digitalWrite(5,HIGH);
digitalWrite(6, HIGH);
digitalWrite (7, LOW);
}
else if (readvoice == "*1#")
{
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
delay(200);
tmrpcm.play("1.wav");
digitalWrite(2, LOW);
digitalWrite (3, HIGH);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
}
else if (readvoice == "*2#")
{
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
delay(200);
tmrpcm.play("2.wav");
digitalWrite(2, LOW);
digitalWrite (3, HIGH);
digitalWrite(4,HIGH);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
}
else if (readvoice == "*3#")
{
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);

digitalWrite (7, LOW);
delay(200);
tmrpcm.play("3.wav");
digitalWrite(2, LOW);
digitalWrite (3, HIGH);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, HIGH);
digitalWrite (7, LOW);
}
else if (readvoice == "*4#")
{
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
delay(200);
tmrpcm.play("4.wav");
digitalWrite(2, LOW);
digitalWrite (3, HIGH);
digitalWrite(4,LOW);
digitalWrite(5,HIGH);
digitalWrite(6, HIGH);
digitalWrite (7, LOW);
}
else if (readvoice == "*5#")
{
digitalWrite(2, LOW);
digitalWrite (3, LOW);
digitalWrite(4,LOW);
digitalWrite(5,LOW);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
delay(200);
tmrpcm.play("5.wav");
digitalWrite(2, LOW);
digitalWrite (3, HIGH);
digitalWrite(4,LOW);
digitalWrite(5,HIGH);
digitalWrite(6, LOW);
digitalWrite (7, LOW);
}
else if (readvoice == "*6#")
{
digitalWrite(2, LOW);
```

```
  digitalWrite (3, LOW);                    digitalWrite(2, LOW);
  digitalWrite(4,LOW);                       digitalWrite (3, LOW);
  digitalWrite(5,LOW);                       digitalWrite(4,LOW);
  digitalWrite(6, LOW);                      digitalWrite(5,LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("6.wav");
  digitalWrite(2, LOW);
  digitalWrite (3, HIGH);
  digitalWrite(4,HIGH);
  digitalWrite(5,LOW);
  digitalWrite(6, HIGH);
  digitalWrite (7, LOW);
}
 else if (readvoice == "*7#")
{
digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("7.wav");
  digitalWrite(2, LOW);
  digitalWrite (3, HIGH);
  digitalWrite(4,HIGH);
  digitalWrite(5,HIGH);
  digitalWrite(6, HIGH);
  digitalWrite (7, LOW);
}
 else if (readvoice == "*8#")
{
digitalWrite(2, LOW);
  digitalWrite (3, LOW);
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
  delay(200);
  tmrpcm.play("8.wav");
  digitalWrite(2, LOW);
  digitalWrite (3, HIGH);
  digitalWrite(4,HIGH);
  digitalWrite(5,HIGH);
  digitalWrite(6, LOW);
  digitalWrite (7, LOW);
}
 else if (readvoice == "*9#")
{
```

```
  tmrpcm.play("9.wav");
```

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