A Project Report On

Braille Display

Submitted to the Electronics Engineering Department in partial fulfilment of the requirements for the degree of

Bachelor of Technology

In

ELECTRONICS AND COMMUNICATION ENGINEERING

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

FARIDABAD

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CERTIFICATE

This is to certify that Project Report entitled “Braille Display” which is submitted by Akshay Verma, Ashish Sharma, Sandeep, Sidharth Mehta in partial fulfillment of the requirement for the award of degree B. Tech. in Department of Electronics Engineering of YMCA University of Science and Technology, Faridabad, is a record of the candidates own work carried out by them under my/our supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

DECLARATION

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief. It contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

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ACKNOWLEDGEMENT

It gives us a great sense of pleasure to present the report of the B. Tech Project undertaken during B. Tech. Final Year. We owe special debt of gratitude to complete **Electronics Department** for their constant support and guidance throughout the course of our work. The sincerity, thoroughness and perseverance have been a constant source of inspiration for us. It is only their cognizant efforts that our endeavors have seen light of the day.

We also do not like to miss the opportunity to acknowledge the contribution of all faculty members of the workshop for their kind assistance and cooperation during the development of our project. Last but not the least, we acknowledge our friends for their contribution in the completion of the project.

Contents

Chapter 1

Introduction

Braille is a writing cum reading method used by blind or visually impaired people. In braille script, each character is represented by a unique combination of 6 dots, which form one cell. It has always been a challenge to make braille books for blind people. On an average a page of normal text takes around 4 pages (A. Domale, B. Padalkar, R. Parekh and M. A. Joshi et al, 2013) in braille which often makes braille books quite bulkier which involve a higher production cost. So, to work around this problem we have come up with a solution to make a braille display which can take text input and convert that into braille. There are currently many refreshable braille displays available in the market but all of them face a major problem i.e. high cost, so we propose a design in order to tackle this challenge.

In 1985, there was a paper which proposed the idea of using microcontrollers in the braille displays using mechanical piezoelectric crystals (S. M. Elster, B. L. Zuber and J. L. Trimble et al, 1985). The problem with this was the cost of the piezoelectric crystals. Another braille display was proposed in 2012, which used solenoid valves to form a dot matrix to display the braille characters. The major problem with this was the high-power consumption and the noise that solenoid valves create. There are various solutions proposed like these. Currently, all of the braille displays available in the market use piezoelectric for their working. But the problem remains the same, i.e. the high cost. So, here we propose our solution of a braille display using Atmega328p and stepper motors which can convert any text to braille format.

The Atmega328p is an AVR 8-bit microcontroller manufactured by Microchip. It runs on 1.8V-5.5V power supply. It has

- 32KB Flash Memory with read while write capabilities.
- 1024B EEPROM
- 2KB SRAM
- 23 General Purpose I/O lines
- 6 – channel 10-bit A/D converter
- 3 Timers with compare modes
- Internal/External interrupts

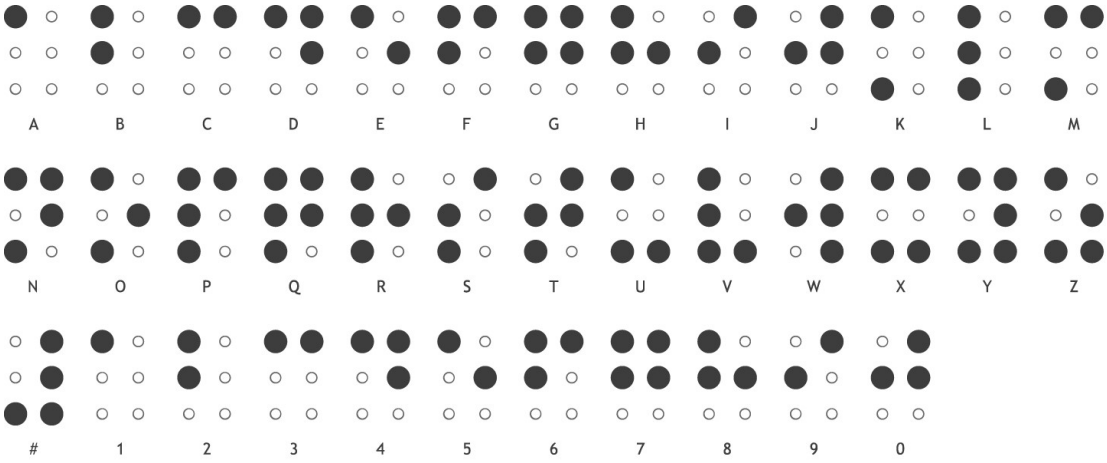
The Atmega328p is a widely used microcontroller and is most popular for its use in Arduino Uno boards.

Chapter 2

Structure and Design

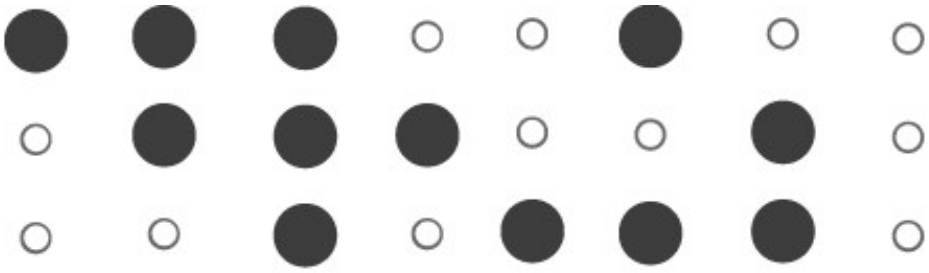
The main point of our proposed work is to cut down the costs and make the device economical and thus available for all. To cut down the cost, we have designed a new and unique way to present all the braille characters.

A braille character is made from a matrix of 3x2 dots. The different alphabets are made by the permutation and combination of these 6 dots.



Braille Characters

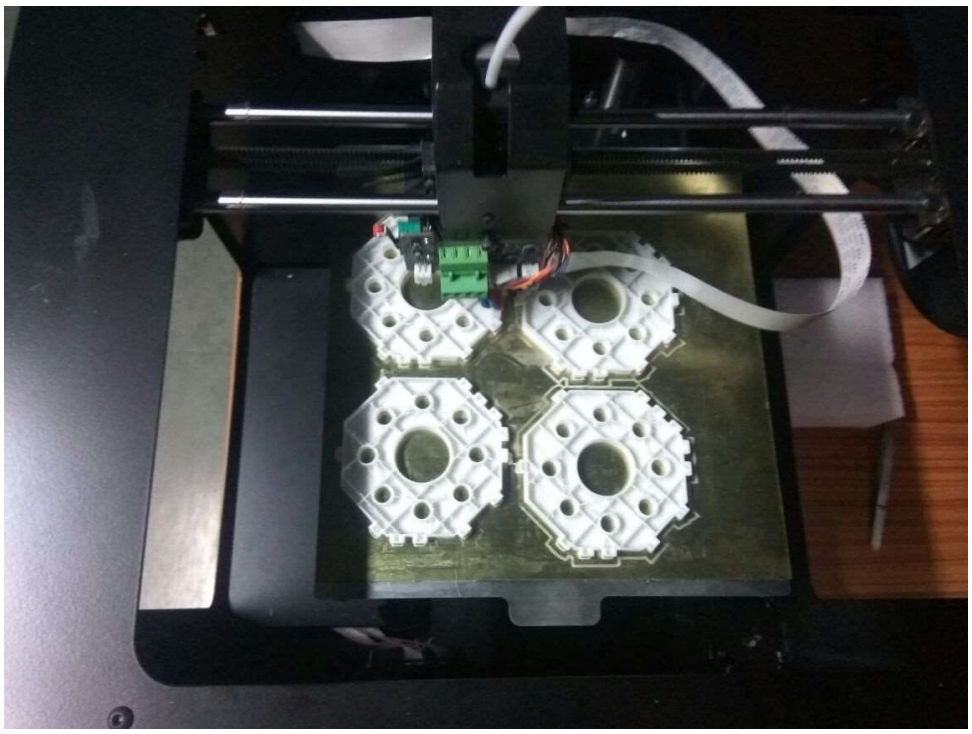
The current solutions use piezoelectric crystals to control each individual dot, which makes them very costly. Our design idea comes from careful analysis of the braille characters. If looked closely, it can be easily seen that each character is made of 2 columns and each column has a total of 8 possible cases.



8 possible cases

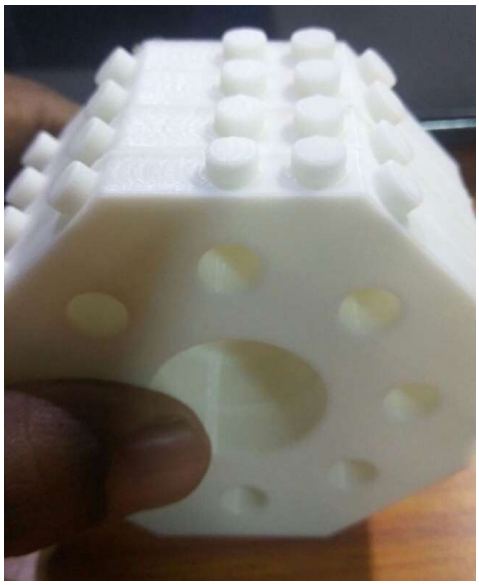
Therefore, to display any character, the problem gets reduced to making combination of these 8 possible cases. To accomplish this task, a part is designed in SolidWorks and then 3-d printed.

Final printed parts



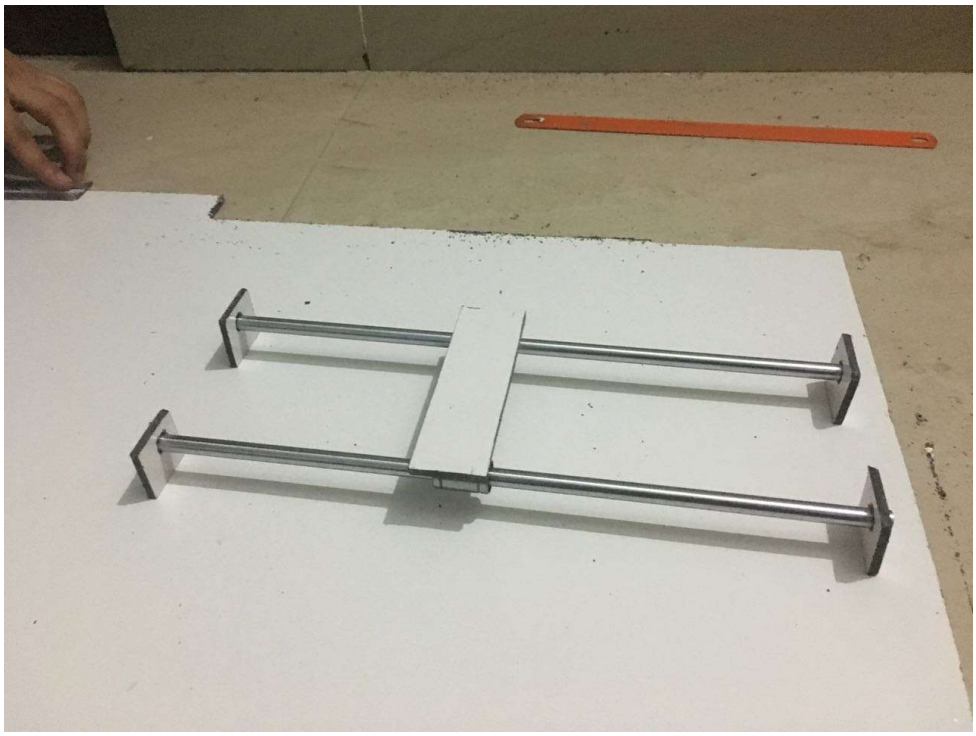
3-d Printing

3-D printed parts

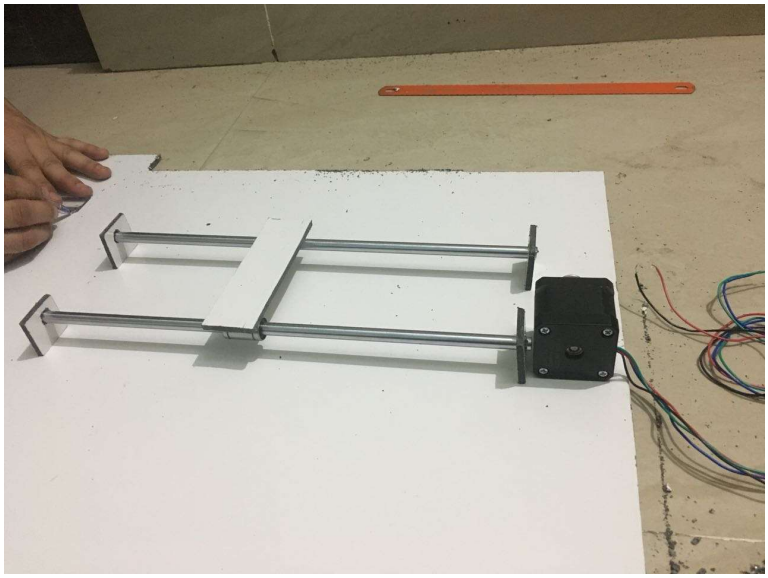


Bearing & Shaft arrangement

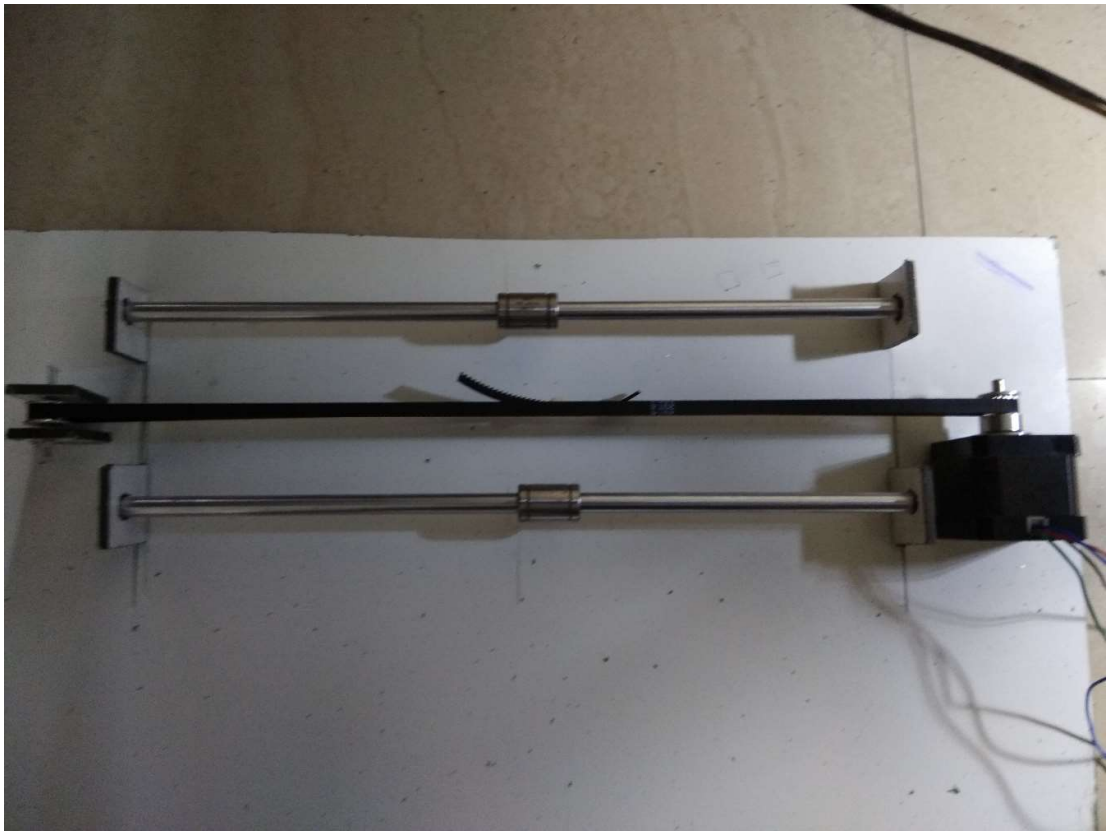
Assembly-



Base

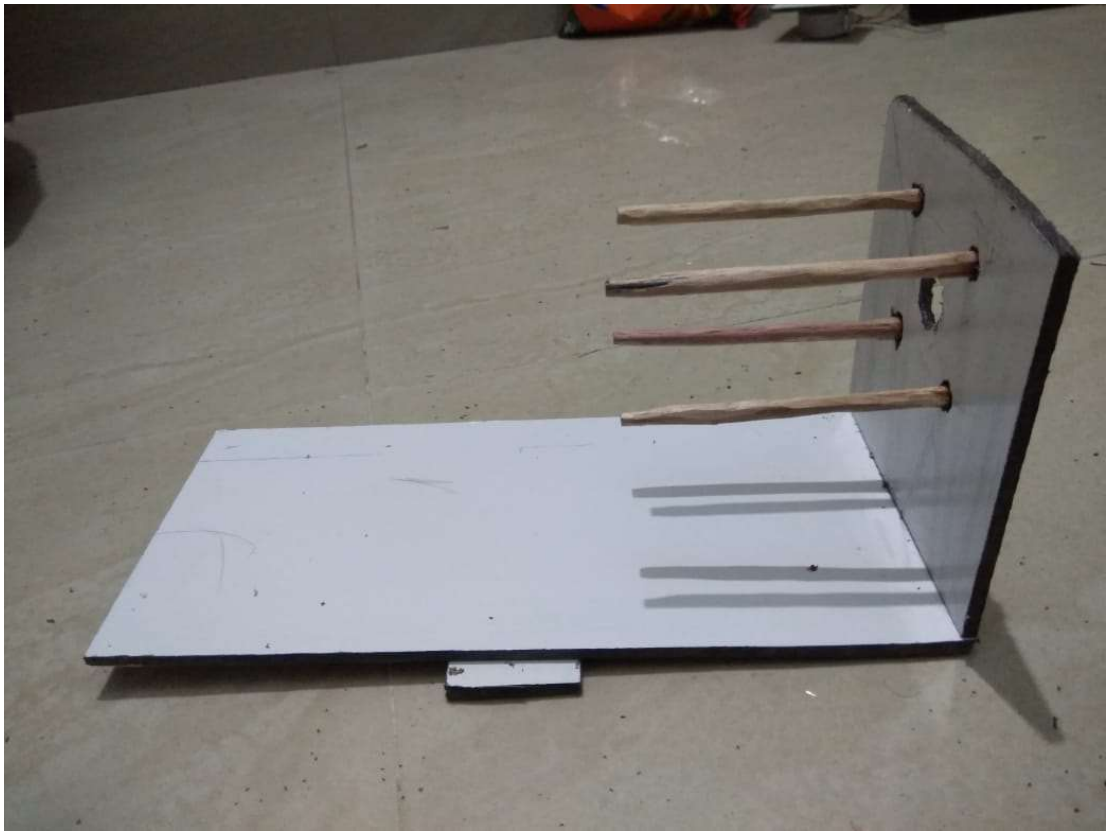


Base Assembly

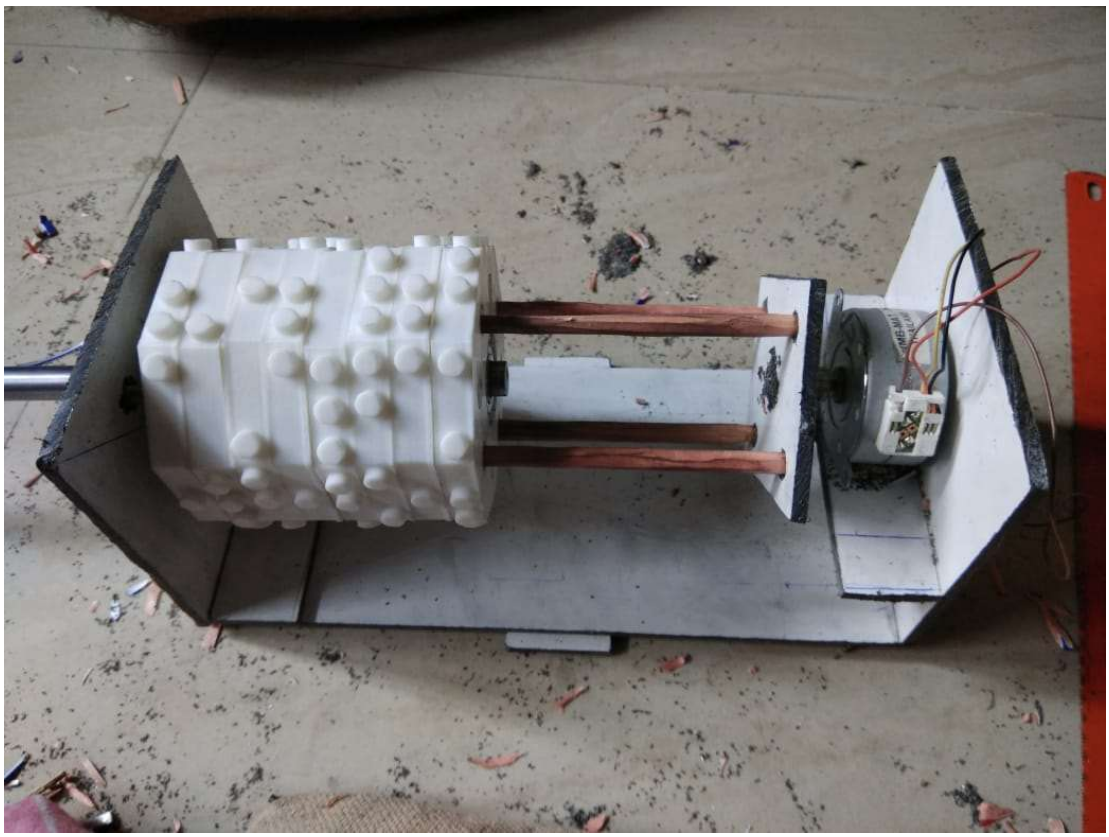


Motor and Pulley Assembly

Pulley

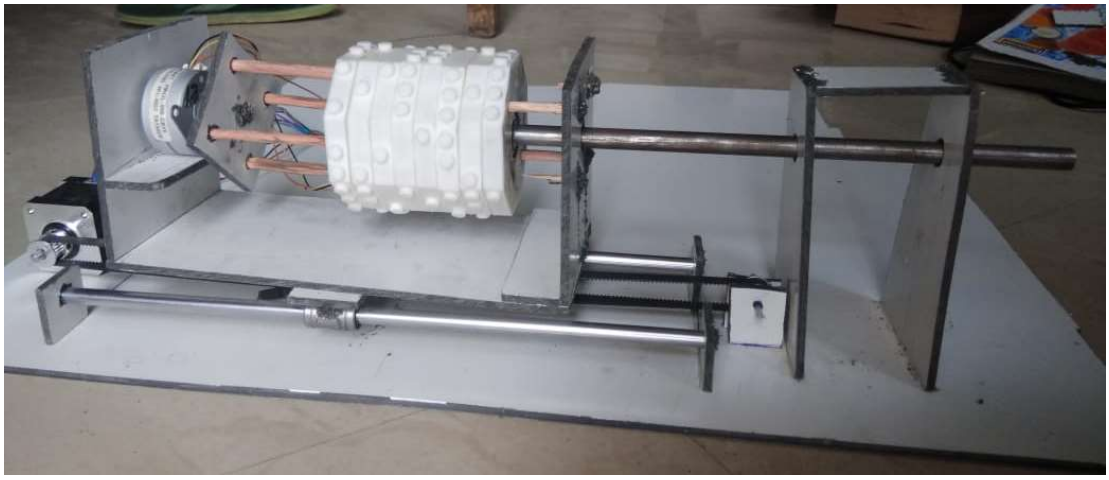


Main Frame

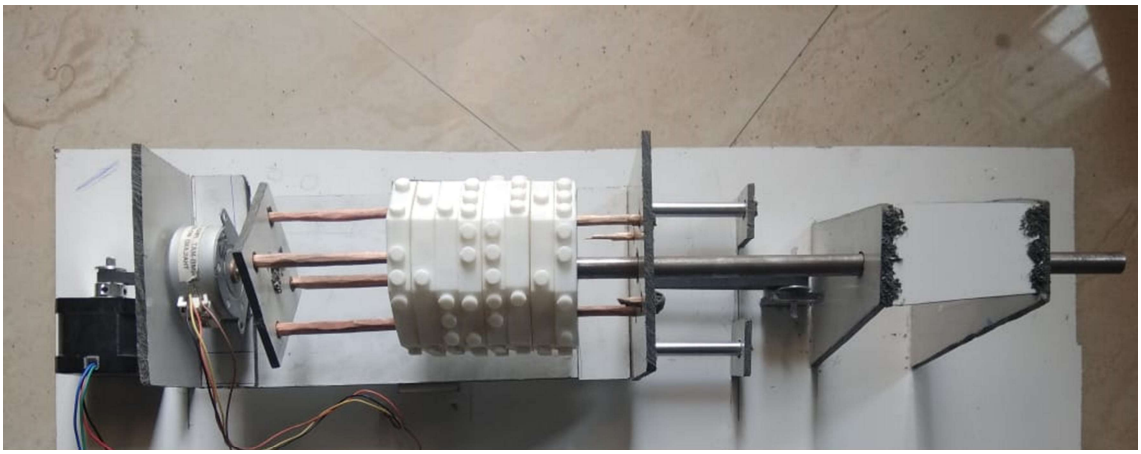


Main Frame complete assembly

Final Assembly: -



Front View



Top View

Chapter 3

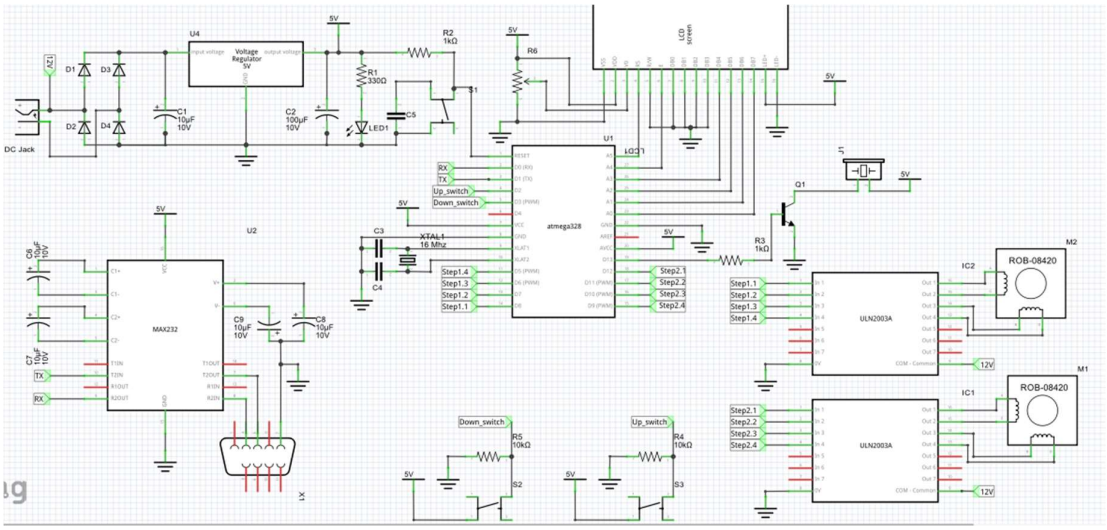
PCB Layout and Design

The electronic circuit contains the following: -

1. Driving circuit for the stepper motors.
2. A 16x2 character LCD
3. Buzzer for indication
4. Power Supply Section (12V to 5V conversion)
5. UART to RS-232 converter section
6. Atmega328p microcontroller

Schematic: -

A schematic tells about the interconnection of various components. It doesn't exactly tell how the will be placed on the PCB, for that PCB layout is used. The schematic tells about the connections only.



Schematic of Braille Display

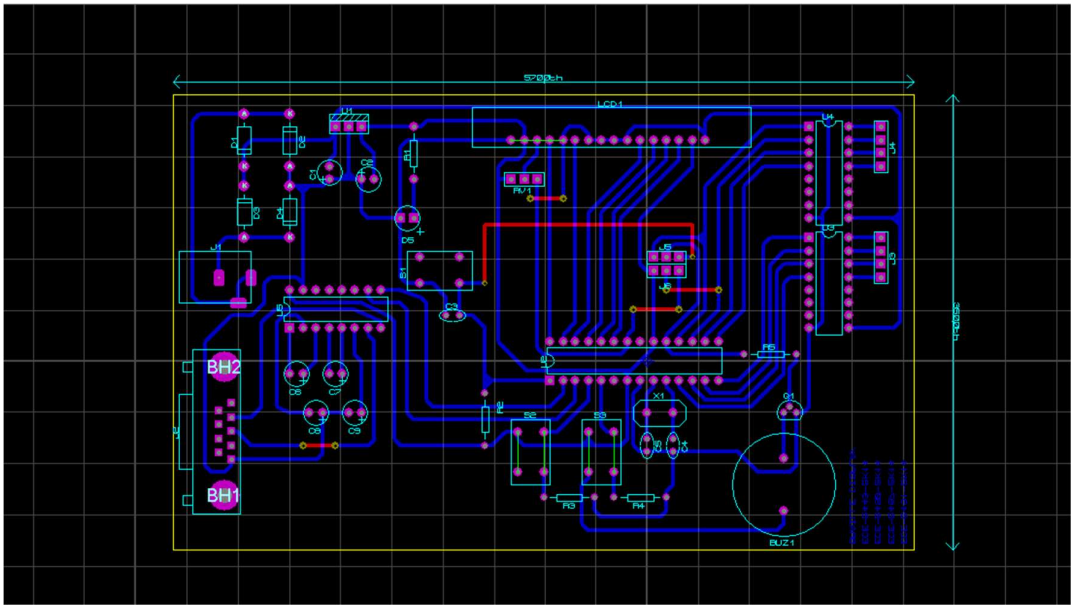
The schematic can be divided in following sections: -

1. Power Supply – The power supply section is converting 12V down to 5V using a 7805 voltage regulator. A bridge rectifier is applied at input side, which makes sure the correct polarity of voltage goes forward even is DC Jack is connected in opposite direction. A simple capacitor filter is used for filtration and a LED indicates the status of power. It glows when power is available.
2. Atmega328p microcontroller – The Atmega328p is the main brain of all of the device. It is responsible for controlling the motors and the operation of the LCD.

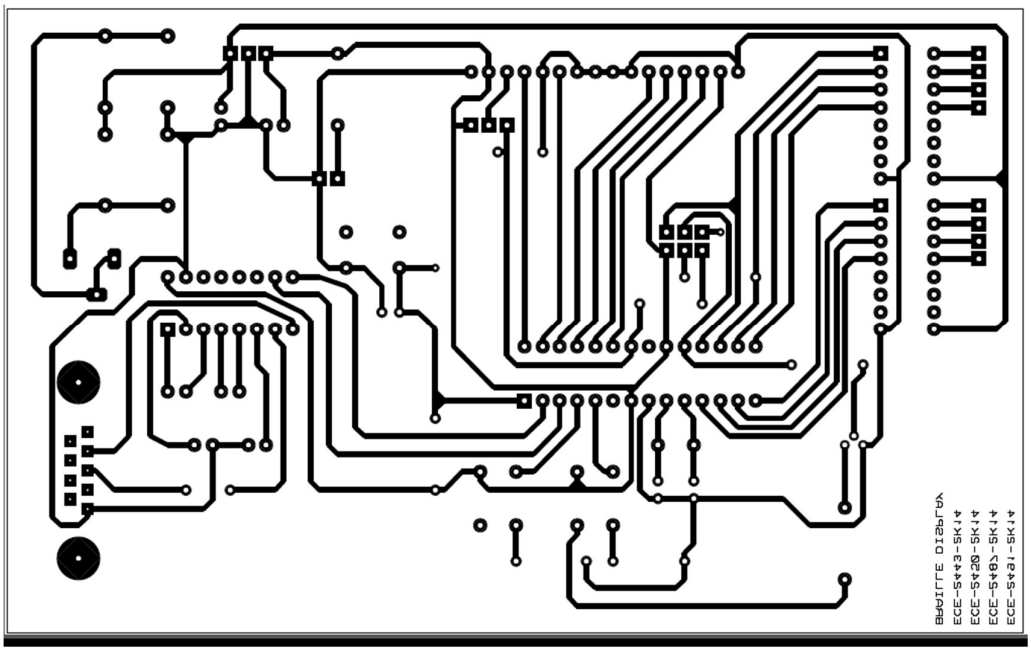
3. UART to RS-232 converter – This section is responsible for converting the incoming data coming from the PC in UART format so that the microcontroller can read the data. This section uses a MAX-232 IC which converts UART to RS-232 and vice versa.
4. Stepper motor driving section – As the name suggests, this section is responsible for driving the stepper motors. ULN2003A IC is used for this purpose which is being controlled by the microcontroller.
5. LCD Display section – The 16x2 LCD is used to display the output data and also used for debugging purposes.

PCB Layout: -

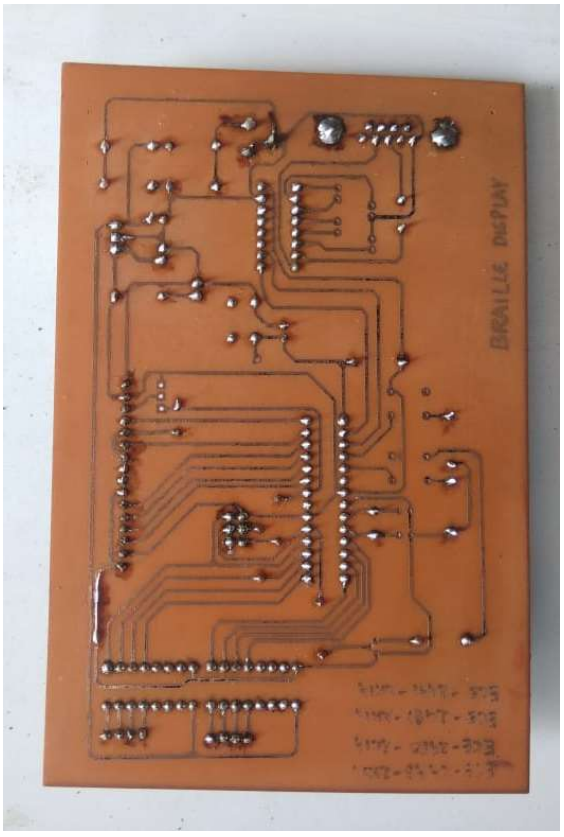
The PCB layout gives the information about how the components will be placed on the PCB. It is designed using Proteus Software.



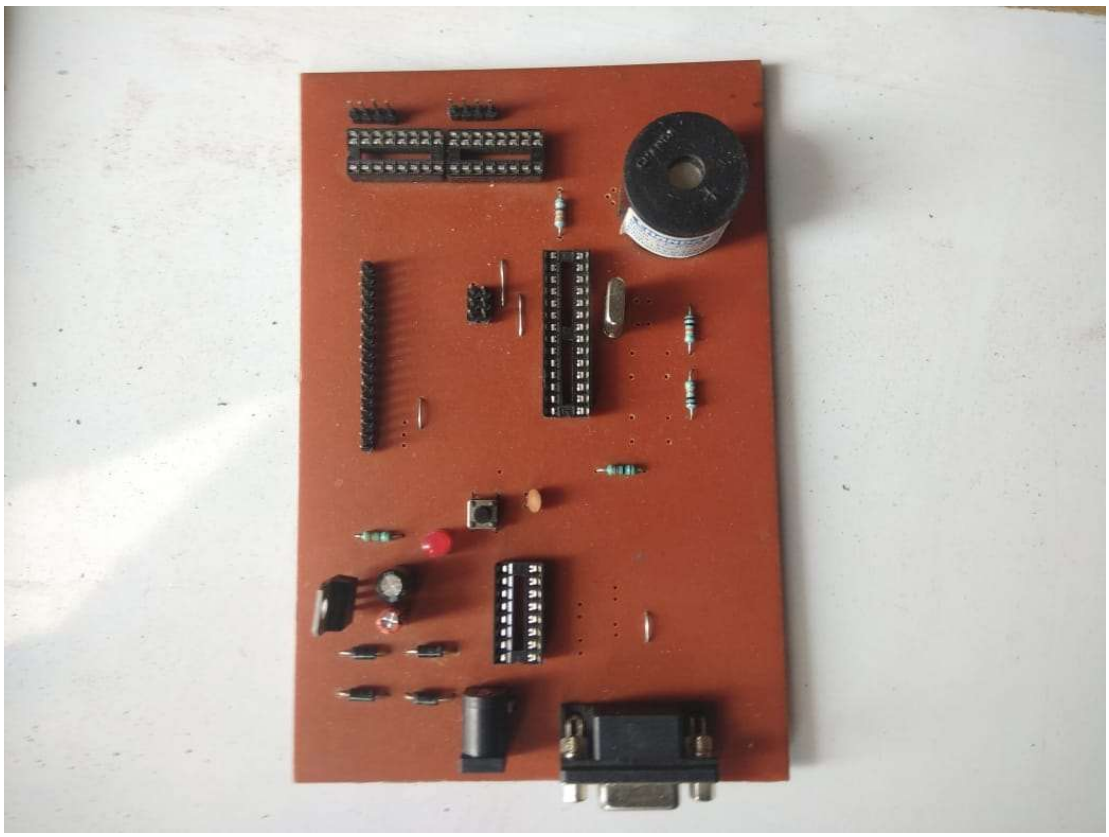
PCB Layout



Bottom Layer of PCB



PCB Bottom Layer



PCB Top Side

Chapter 4

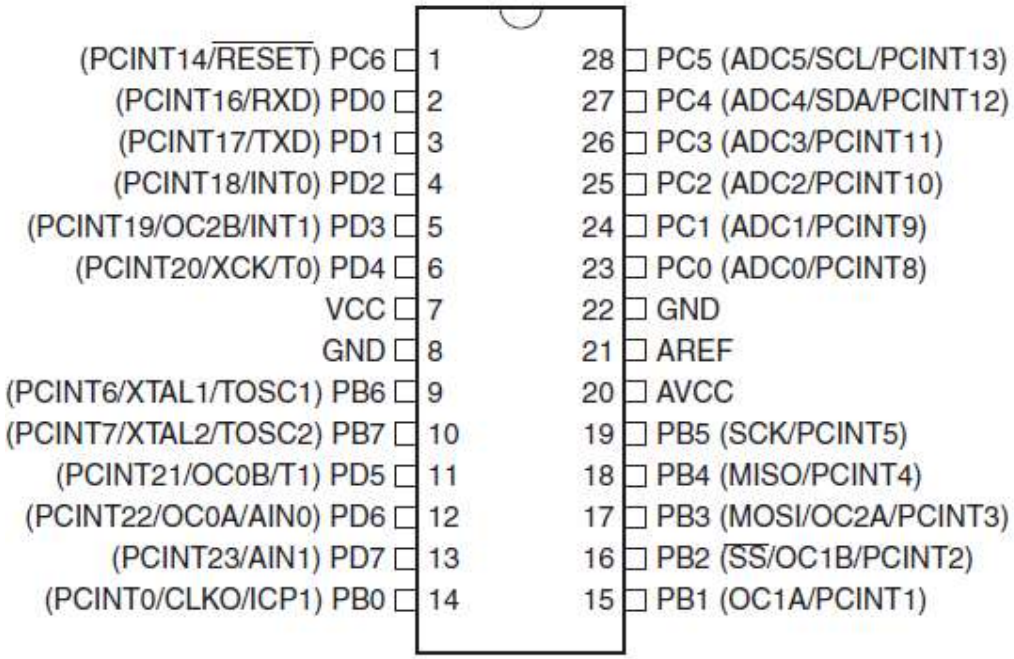
Electronic Components

Atmega328p microcontroller: -

The high-performance Microchip picoPower 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

Pinout: -



Atmega328p Pinout

Pin Description: -

Pin Number	Description	Function
1	PC6	Reset
2	PD0	Digital Pin (RX)
3	PD1	Digital Pin (TX)
4	PD2	Digital Pin
5	PD3	Digital Pin (PWM)
6	PD4	Digital Pin
7	Vcc	Positive Voltage (Power)
8	GND	Ground
9	XTAL 1	Crystal Oscillator
10	XTAL 2	Crystal Oscillator
11	PD5	Digital Pin (PWM)
12	PD6	Digital Pin (PWM)
13	PD7	Digital Pin
14	PB0	Digital Pin
15	PB1	Digital Pin (PWM)
16	PB2	Digital Pin (PWM)
17	PB3	Digital Pin (PWM)
18	PB4	Digital Pin
19	PB5	Digital Pin
20	AVCC	Positive voltage for ADC (power)
21	AREF	Reference Voltage
22	GND	Ground
23	PC0	Analog Input
24	PC1	Analog Input
25	PC2	Analog Input
26	PC3	Analog Input
27	PC4	Analog Input
28	PC5	Analog Input

Features: -

Name	Value
Program Memory Type	Flash
Program Memory Size(KB)	32
CPU Speed	20
SRAM Bytes	2048
Data EEPROM	1024
Digital Communication Peripheral	1-UART,2-SPI,1-I2C
Capture/Compare/PWM Peripheral	1 Input Capture, 1 CCP, 1 PWM
Timers	2 x 8-bit, 1 x 16 bit
Number of Comparators	1
Temperature Range (C)	-40 to 85
Operating Voltage Range	1.8V to 5.5V
Pin Count	32
Low Power	Yes

ULN2003A IC: -

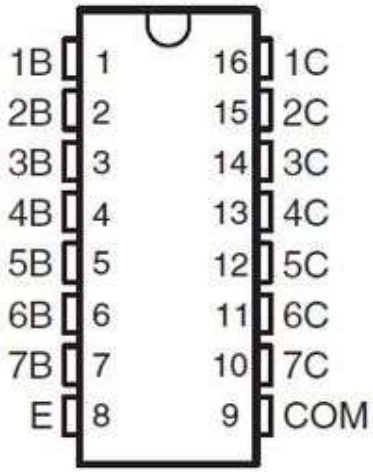
The ULN2003A is an array of seven NPN Darlington transistors capable of 500 mA, 50 V output. It features common-cathode flyback diodes for switching inductive loads. It can come in PDIP, SOIC, SOP or TSSOP packaging.

The ULN2003 is known for its high-current, high-voltage capacity. The drivers can be paralleled for even higher current output. Even further, stacking one chip on top of another, both electrically and physically, has been done. Generally, it can also be used for interfacing with a stepper motor, where the motor requires high ratings which cannot be provided by other interfacing devices.

Main specifications:

- 500 mA rated collector current (single output)
- 50 V output (there is a version that supports 100 V output)
- Includes output flyback diodes
- Inputs compatible with TTL and 5-V CMOS logic

Pinout: -



Pinout of ULN2003A

Pin Description:

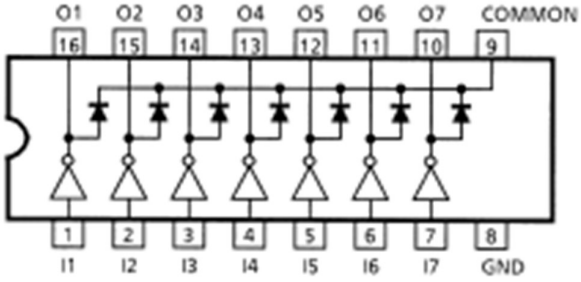
1B-7B are the inputs.

1C-7C are the outputs.

E is Ground.

Com is VCC (Common)

Internal Schematic: -



Internal Schematic of ULN2003A

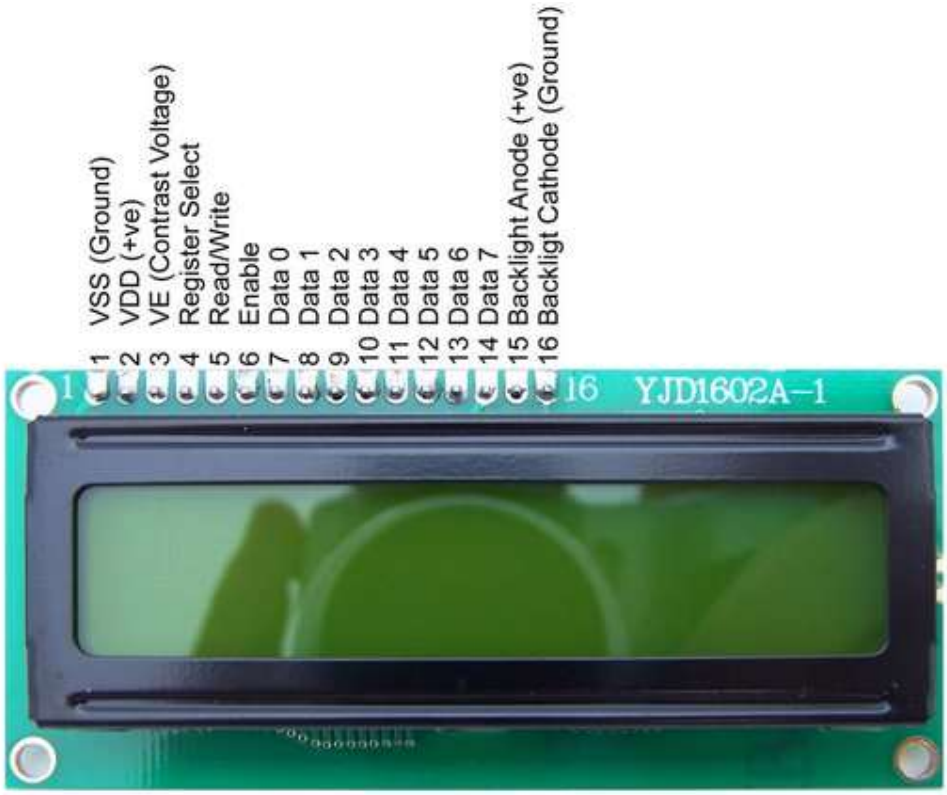
16x2 Character LCD: -

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

Pinout: -



Pinout of 16x2 character LCD

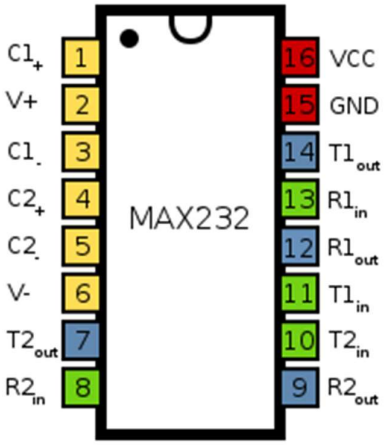
Pin Description: -

- VSS - Ground
- VCC - (+5V)
- VE - Contrast adjustment
- RS - Register Select
- RW - Read/Write
- EN - Clock (Enable)
- D0 - Data Bit 0
- D1 - Data Bit 1
- D2 - Data Bit 2
- D3 - Data Bit 3
- D4 - Data Bit 4
- D5 - Data Bit 5
- D6 - Data Bit 6
- D7 - Data Bit 7
- BLA - Backlight Anode (+)
- BLK - Backlight Cathode (-)

MAX 232 IC: -

The MAX232 is an integrated circuit first created in 1987 by Maxim Integrated Products that converts signals from a TIA-232 (RS-232) serial port to signals suitable for use in TTL-compatible digital logic circuits. The MAX232 is a dual transmitter / dual receiver that typically is used to convert the RX, TX, CTS, RTS signals.

Pinout: -



Pinout of MAX232

Pin Description: -

Max232 has 16 pins. It requires four external capacitors for its proper configuration. Capacitors can range between 8 uf to 10 uf and are of up to 16 volts. Pin names with functions are listed below.

PIN 1(C1+) Connect positive leg of a capacitor to it.
PIN 2(Vs+) Connect positive leg of a capacitor to it, and make negative leg of same capacitor ground.
PIN 3(C1-) Connect negative leg of a capacitor to it, whose positive leg is connected to Pin#1.
PIN 4(C2+) Connect positive leg of a capacitor to it.
PIN 5(C2-) Connect negative leg of a capacitor to it, whose positive leg is connected to Pin#4.
PIN 6(Vs-) Connect negative leg of a capacitor to it and apply 5 volts to positive leg of the same capacitor.

PIN 7(T2OUT) - Outputs the converted TTL signal in RS-232 form. TTL signal is received from Microcontroller etc at T2IN Pin. Connect this pin to Pin#2 of DB-9 serial port of your PC. Pin#2 of DB-9 port is Rxd(Rxd means This pin receives Transmitted Signal(data)).

PIN 8(R2IN) - This Pin receives RS-232 signal as input and outputs the converted signal in TTL form on pin R2OUT. Connect this pin to Txd pin of DB9 Port. Pin#3 of DB-9 port is Txd(Txd means This pin transmits data).

PIN 9(R2OUT) - Outputs the converted signal in TTL form. Signal is recevied from Pc at R1In Pin. Connect this pin to your module(TTL) Rxd pin which receives the signal.

PIN 10(T2IN**)** - Receives the transmitted signal from microcontroller(TTL Level) etc and outputs the converted RS-232 signal on T2OUT pin. Signal is transmitted from txd pin of microcontroller serial port. Connect this pin to your module Txd pin.

PIN 11(T1IN) - Works same as T1IN.

PIN 12(R1OUT) - Works same as R2OUT.

PIN 13(R1IN) - Works same as R2IN.

PIN 14(T1OUT) - Works same as T2OUT.

PIN 15(GND) - Ground this pin.

PIN 16(vcc) - Apply 5 volts to this pin.

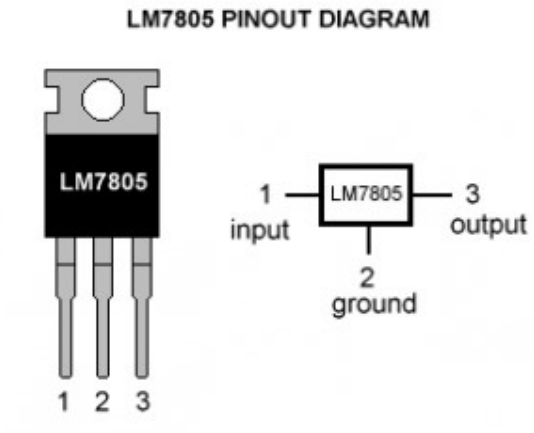
7805 Voltage Regulator: -

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

7805 IC Rating

- Input voltage range 7V- 35V
- Current rating $I_{c=}$ 1A
- Output voltage range V_{Max} = 5.2V ,V_{Min} = 4.8V

Pinout: -



Pinout of 7805

Pin Description: -

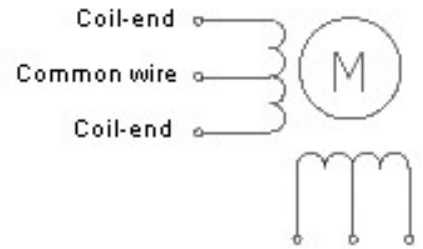
Pin No.	Pin	Function	Description
1	INPUT	Input voltage (7V-35V)	In this pin of the IC positive unregulated voltage is given in regulation.
2	GROUND	Ground (0V)	In this pin where the ground is given. This pin is neutral for equally the input and output.
3	OUTPUT	Regulated output; 5V (4.8V-5.2V)	The output of the regulated 5V volt is taken out at this pin of the IC regulator.

Stepper Motor: -

A stepper motor or step motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed.

There are two basic winding arrangements for the electromagnetic coils in a two phase stepper motor: bipolar and unipolar.

- Unipolar motors: - A unipolar stepper motor has one winding with center tap per phase. Each section of windings is switched on for each direction of magnetic field. Since in this arrangement a magnetic pole can be reversed without switching the direction of current, the commutation circuit can be made very simple (e.g., a single transistor) for each winding. Typically, given a phase, the center tap of each winding is made common: giving three leads per phase and six leads for a typical two phase motor. Often, these two phase commons are internally joined, so the motor has only five leads.
  A micro controller or stepper motor controller can be used to activate the drive transistors in the right order, and this ease of operation makes unipolar motors popular with hobbyists; they are probably the cheapest way to get precise angular movements.



Unipolar Stepper motor

- Bipolar Motors: - Bipolar motors have a single winding per phase. The current in a winding needs to be reversed in order to reverse a magnetic pole, so the driving circuit must be more complicated, typically with an H-bridge arrangement (however there are several off-the-shelf driver chips available to make this a simple affair). There are two leads per phase, none are common.

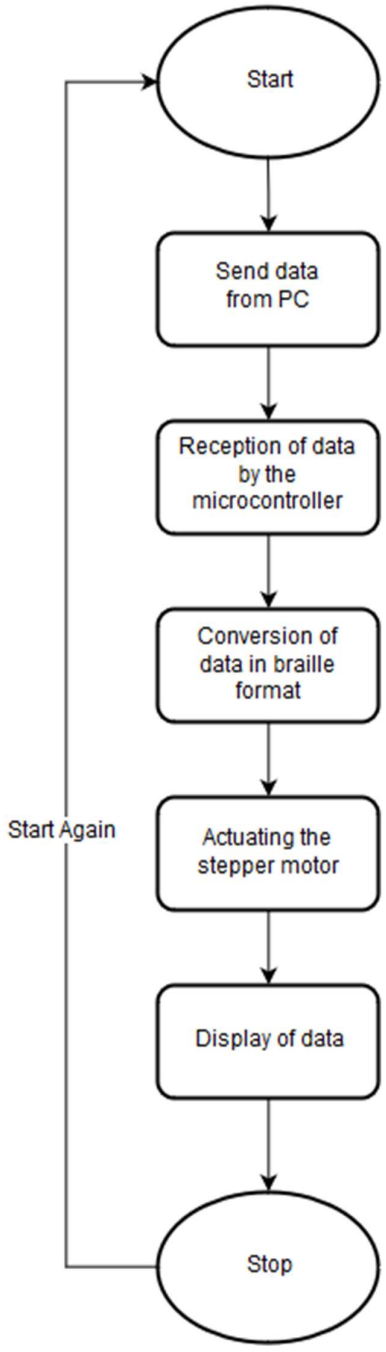
Chapter 5

Working

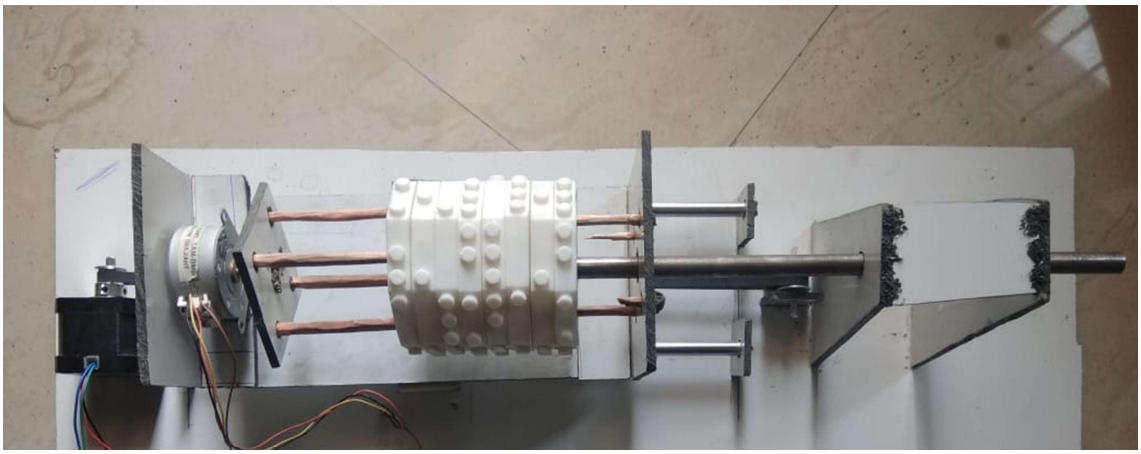
The working of the device can be divided in following segments: -

1. Data acquisition – The data i.e. the text which needs to be displayed in braille is sent by the PC to the microcontroller. The data is transmitted using a USB to RS232 cable. The PCB has a RS232 header and a MAX232 IC is connected with it. The data is converted in UART format by the MAX232 and is then sent to the microcontroller for further processing.
2. Conversion of data to braille format – The microcontroller converts the received data in braille format. After conversion, this data is used to drive the stepper motor which are working as actuators. The combination of stepper motor and the 3-d printed part is used to display the braille characters.
3. Display of characters using the stepper motor – The stepper motor are rotated according to fixed pattern. The stepper controlling the rotation is rotated 45° each turn and the stepper motor controlling the base's movement is rotated enough to move the base 1cm.
4. Extra Options – The 16x2 Character LCD, the buzzer, the Up and Down Switch are all extra options available. They are used to present the user with notifications and indications.

Block Diagram: -



RESULTS



Final assembly

Through the use of proposed solution, the cost of a Braille Display can be reduced by significant amount. The total cost in making this was around 5,500 INR which is significantly lower than the solutions available in the market (around 1000 US$). In mass production, this cost can be reduced even further helping the blind people in their learnings.

Future Aspects

The device proposed is in initial stages of development and lots of work has to be done on it. Some of the areas where this product can be improved are: -

- Addition of image to text converter using OCR (Optical Recognition Technology).
- Availability of blind e-books which can be downloaded and used on one such machine.
- Compatibility with other platforms like Android, Ios, Mac, Linux etc.
- We want all the people to have access to the knowledge in the books. In future, our goal is to bring these devices to each and every blind person. Devices like these can be set up in public libraries and in University Campus.
- Addition of text to speech converter that can be used to hear the books.
- A voice recognition-based system using which anyone can access all the features of the device.

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