Project report on

Automatic Paper Crawling Pocket-sized Chargeable Printer with Wireless Connectivity

University of Mumbai

Submitted in partial fulfillment of the requirements of the degree of

Bachelor of Engineering in Electronics Engineering

By

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(2020-21)

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Internal Approval Sheet

CERTIFICATE

This is to certify that the project entitled "**Automatic Paper Crawling Pocket-sized Chargeable Printer with Wireless Connectivity**" is a bonafide work of

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Project Report Approval Sheet

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Examiners:

1._____

2._____

Date:

Place: Airoli, Navi Mumbai.

Declaration

We, declare that this written submission represents our ideas in our own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Nowadays, traditional available printers in the market are very large and bulky also they are wired up to the computer, making them inconvenient to carry from one place to another and hence reduce our productivity. To solve this issue, we propose a mini, smart and wireless printer that is portable and has many features. The proposed printer is small enough to fit into a usual pocket and moves itself and prints letters wirelessly on any size of paper, which means these miniature printers are ideal for printing directly from your laptop, smartphone or tablet. This kind of printer could be just as big as a cup, which is very convenient to carry wherever you go and print efficiently.

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Chapter 1

Introduction

1.1 Introduction

Printer in people's daily life plays a very important role. It can help enterprise personnel Print office documents and business contracts, can help print student graduation thesis, learning materials and so on. A lot of people have been inseparable from it. The birth of mobile technology, it seems that any product is about the mobility and portability, and the printer is also quietly changing, becoming smaller and smaller, and more portable. At home, there is no any successful product like this kind of mini smart printer. There have been two kinds of mini printer in the market. However, first is the ink-jet printer. It can be only used to print receipts. Its function is limited. The second is a kind of dye sublimation printer. However, this kind of printer has high requirements in paper. It is expensive in maintenance. Both of these two kinds of mini printer are limited by the size of paper, which is a big difference from our mini printer. A mobile way is used by our mini printer to print words, that is to say, our printer can move when prints words, so our mini printer can work on any size of paper. In addition, the Wi-fi is used to access the printer system. Once we need to print something, we only need to put our mini printer out from our pocket, and send a file in mobile phone or computer to the printer system to print out. A new printing method used by our pocket printer is different from the traditional ways. When the pocket printer works, the printer itself moves in a straight line on the paper, and the printing head fixed within the printer prints characters. And these two functions - moving and printing work in parallel.

1.2 Drawbacks of present printers

The traditional printer has some disadvantages. As we know, the traditional printer is big, so it is impossible to be carried around. We have to go to somewhere with a printer when we need to print something, which is very inconvenient and inefficient. For another hand, the size of paper for traditional printer is fixed, that is to say, the kinds of paper size we can use are limited. Finally, the traditional printer is more expensive and has a more complex structure, which results in a higher maintenance cost. To solve these problems, a mini smart printer is developed. Our mini smart printer is a new kind of printer that is easily carried, not limited by the size of paper and cheaper than the traditional printer.

1.3 Aim and Objective of the project

The aim of the project is to design an "Automatic Paper Crawling Pocket-sized Chargeable Printer with Wireless Connectivity"in a comprehensible manner in order to help the users just place the printer properly at the top of the page and guarantee an accurate outcome.

- To make the printer small in size

  It will become easy for user to carry the printer from one place to another. It will be possible to carry the printer in bag while travelling. Students studying in colleges requires printer to print their assignments and projects reports hence the small size of printer will benefit an individual to carry it along with them.

- To make it compact structured

  This printer can be brought around with you wherever you go because of their very compact structures and light weight.

- To make it portable

  This will help us to print anytime, anywhere. This Printer will help us to print the professional documents,reports, etc.on-the-go.

- To make it cost effective

  Nowadays people always ponder about the price of an device before buying it but this mini printer will not be more costly. Hence affordable to every individual.

- To make it independent of size of paper

  It will allow us to print on any size of paper.

- To make it accessible via wireless medium

  Wi-fi will be used to access the printer system. Once we need to print something, we only need to put our mini printer out from our pocket, and send a file from a mobile phone or computer via wi-fi to the printer system to printout. No need to plug any wire during use.

- To make it battery operated and rechargeable

  It will come with rechargeable lithium-ion battery which offers dependable performance in a small package.

- To make it move and print the letters parallely

  A mobile way will be used by our mini printer to print words, that is to say, our printer will move when printing words, so our mini printer can work on any size of paper. When the printer works, the printer itself moves in a straight line on the paper and the printing head fixed within the printer prints the characters.

Chapter 2

Review of Literature

2.1 Literature review

The phenomenon that has transformed the way people access technology is the convergence of work and life. Rapid urbanization, gig economy and digitization are macro trends that have not only transformed the office infrastructure but also the way people work. Today many professionals prefer to work from home, with PCs and Printers being at the core of home offices.Modern innovations like wireless and mobile printing have enhanced the experience, making it easy for everyone to access and use high-quality printing for various work, at the office as well as home.Everything today has gone mobile. Thanks to our smartphones, tablets and laptops we can leave our office while staying fully connected by doing work on the go. There is one device that got left behind and seemed to miss the ”mobile revolution train”- The Printer.You can see students, lawyers or entrepreneurs working efficiently outside of their homes of offices but then suddenly struggling to find a place to print. Being students, we worked on our laptops in different places, libraries, classrooms, cafe's, trains and out in the sunshine. We were able to do so because we had everything we needed with us on our phone or laptop. Yet, we always found ourselves struggling to find a place to print once the work was done. Our vision is to change that. The idea is creating a mobile printer that is easy and fun to use, can be taken anywhere, prints from any device (laptop, tablet, smartphone) onto any sized page. Print machines now-a-days are essentially a print head running left and right on a moving piece of paper. We asked ourselves, why not get rid of the entire device, just put the print head on a set of small wheels

and let it run across a piece of paper. By doing so, we allow the printer to really be as little as possible. The printer is entirely fitted for our day to day life. It has a rechargeable battery with an on or off switch, it connects directly to smartphones and to PCs, and it allows the user to print on any size piece of paper.

2.2 Referred sources

1. Technology C How it works - ZINK - Zero Ink. (2005)

ZINK Zero Ink® Technology from ZINK Imaging makes it possible to produce full-color digital images without ink cartridges, ribbons or toner. A new approach to printing, ZINK Imaging's patented technology radically shifts the printing paradigm from ink cartridges or ink ribbons to a totally ink-free system and introduces a new category of devices that allow you to get more out of your digital content. How does Zink work? The key to this process is the patented ZINK Paper®, an advanced composite material with cyan, yellow, and magenta dye crystals embedded inside and a protective polymer overcoat layer outside. Before printing, the embedded dye crystals are clear so ZINK Paper looks like regular white photo paper. The ZINK-enabled device uses heat to activate and colorize these crystals. The printing process is now radically simple. Just add paper®. The result is high-quality, full color, long-lasting, durable, and affordable images.

2. Zable, J.L., Lee, H.C.: An overview of impact printing. J. Res. Dev. (2007)

This paper gives an overview of impact printing and reviews some of the more recent advances made in this printing technology. Matrix and fully-formed-character impact-printing technologies are discussed for both serial printers and line printers. The critical electromechanical subassemblies that are described are the hammer unit, the paper-handling system, the inking system, and the type-element system. The mathematics describing printer performance and the operation of some of the subassemblies are presented. The relative simplicity of the impact printer still allows it to be the most economical form of text printing. Its other advantages are reliability, general insensitivity to environment, and the ability to print on the greatest variety of print media.

3. Introduction to Arduino: A piece of cake by Alan.G.Smith. (2011)

The purpose of this book is to get you started on the road to creating things using microcontrollers. We will discuss only enough electronics for you to make the circuits, and only enough programming for you to get started. The focus will be on your making things. It is my hope that as you go through this book you will be flooded with ideas of things that you can make.

4. Verified USB peripherals and SDHC cards. (2012)

Power Usage Notes: Adding peripherals may increase the loading on the power supply to your board and this, in turn, may effect the voltage presented to the Raspberry Pi. If the Raspberry pi's supply voltage falls below a certain value (anecdotally started as around 4.75 V, or it begins to fluctuate, your setup may become unstable. Model B Hardware Revisions and USB Power limits Hardware Revision 1.0: The original Model B board had current limiting polyfuses which limited the power output of each USB port to approximately 100 mA. USB devices using more than 100 mA had to be connected via a powered hub. The Raspberry Pi's PSU was chosen with a power budget of 700 mA of which 200 mA were assigned to the USB ports, so the Raspberry Pi's (poly)fuses were designed only for devices up to 100 mA, and typical 140 mA polyfuses will have as much as 0.6 volt across them when drawing currents near the 100 mA limit. As a consequence the USB ports are only directly suitable for "single current unit" USB devices which, according to USB specifications, are designed to work with just 4.4 Volt. Not only do non single current unit devices draw more current (causing greater Voltage drops, and greater stress on the fuses), they also might require 4.75 Volt to work. Model B Hardware Revision 2.0 and Revision 1.0 with ECN0001 change: This had the polyfuses removed, removing the 100 mA current limitation for each USB port (but leaving the main fuse F3 intact). Users should still ensure their power supply can power the Raspberry Pi and the USB peripherals. Revision 2.0 was released in August 2012. Because the polyfuses have been removed, back feeding of the PI, by applying power via its normal USB output, can damage D 17 if triggered by an over-voltage, and so lead to consequential over-heating. This can be discovered by melts, scorching, smoke or worse.

5. Commodore Business Machines, Inc.: VIC-1525 graphics printer user manual. (1982)

VIC printer is designed to operate through software control. That means you have to make the printer's operation part of a program. For example the VIC-20 has a TYPEWRITER car-

tridge that comes in the VIC SIX-PACK. It's designed to operate the printer by holding down the SHIFT key and pressing the f/1 Yellow function Key. The VIC Printer prints both capital and small letters, numbers, and all the graphic characters available on your computer. It will even print custom made graphics and charts that you design on your VIC-20 or Commodore 64. In addition your printer has a variety of built-in functions of its own. This is because your printer has its own computer inside. The advantages of this internal computer are 1) it automatically resets all its switches to the starting sequence every time you turn the printer on; 2) it contains its own internal memory which means that you can store information to be printed directly in the printer without using up your computer's memory. Your printer is designed to connect directly into your computer through the Serial Port (6-pins). However, you can connect your printer to as many as 5 VIC disk drives by daisy-chaining. Daisy-chaining means connecting 1 peripheral to your computer and any additional peripherals plug into the Serial Port of the last item connected.

6. Zerillo, S.D.: Dot matrix printing device employing a novel image transfer technique to print on single or multiple ply print receiving materials. (1980)

A printer having at least one reciprocally mounted printing member controlled to impact against a printing surface by selective energization of an associated printing driving member. The forward end of the member is guided by a bearing. Ink from a supply source is directed to the printing member near the forward end of the printing member whereby the ink is drawn into the region between the guide hole in the printing member guide bearing and the periphery of the printing member to be moved to the region in front of the forward tip of the printing member whereby activation of the driving member abruptly moves the printing member in the forward printing direction causing the ink deposited upon the tip of the printing member to be urged toward and against the ink receiving medium to transfer the ink to the ink receiving medium. A group of printing members may be used to print in this manner to collectively form characters, symbols, and even graphic patterns.

7. Arduino - introduction. in: arduino.cc. (2005)

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something

online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

8. Raspberry pi .in: wikipedia.org. (2009)

Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. Early on, the Raspberry Pi project leaned towards the promotion of teaching basic computer science in schools and in developing countries. Later, the original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It is now widely used in many areas, such as for weather monitoring, because of its low cost, , and open design. After the release of the second board type, the Raspberry Pi Foundation set up a new entity, named Raspberry Pi Trading, and installed Eben Upton as CEO, with the responsibility of developing technology. The Foundation was rededicated as an educational charity for promoting the teaching of basic computer science in schools and developing countries.

Chapter 3

Components

3.1 Components used

No.	Component Name	Qty
1.	Ardiuno Mega 2560	1
2.	Raspberry pi (version 2014)	1
3.	USB wireless network adapter (BL LW05 5R2)	1
4.	HP-C6602A Ink jet Dot matrix Printing head	1
5.	Omni directional Wheels	4
6.	20V boost converter (MC34063A)	1
7.	ULN2803ANDarlington Transistor Arrays	2
8.	CD4067 16-Channel Analog Multiplexer/Demultiplexer IC	1
9.	1N5819 Schottkey diode	1
10.	Inductor 180uH	1
11.	180 ohm resistor	1
12.	0.22 ohm resistor	1
13.	33k ohm resistor	1
14.	2k ohm resistor	1
15.	Capacitor 100uF	1
16.	Capacitor 1.5nF	1
17.	Capacitor 330nF	1
18.	Led	2
19.	Lego Platform	1

Table 1: Component Table

3.2 Description of components

3.2.1. Ardiuno Mega 2560

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Figure 1: Ardiuno Mega 2560

3.2.2. Raspberry Pi (version 2014)

In this Raspberry Pi (version 2014), the Compute Module packages a BCM2835 with 512 MB RAM and an eMMC ash chip into a module for use as a part of embedded systems. The Foundation provides Debian and Arch Linux ARM distributions for downloading.

Figure 2: Raspberry Pi

3.2.3. USB wireless network adapter (BL-LW05-5R2)

A USB wireless network adapter (BL-LW05-5R2) is used, which supports 802.11 b/g/n wireless network protocol. Its transmission speed is 150 Mbps. In BL- LW05-5R2, the CCA technology is used to automatically avoid the channel interference. It also supports WEP encryption, supports WPA/WPA2, WPA- PSK/ WPA2-PSK and other advanced.

Figure 3: USB wireless network adapter

3.2.4. HP-C6602A Inkjet Dot matrix Printing head

The fast-drying, water-fast, and fade-resistant inks used in the original HP-C6602 ink cartridge make it an ideal solution to handle the printing needs of the banking, retail, hospitality and product identification industries. The high capacity C6602A ink cartridge prints at 96 dots per inch and can print over 7 million characters nonstop making cartridge changes less frequent.

Figure 4: HP-C6602A ink-jet dot matrix adapter

3.2.5. Omni Wheels

Omni wheels or poly wheels, similar to Mecanum wheels, are wheels with small discs (called rollers) around the circumference which are perpendicular to the turning direction. The effect is that the wheel can be driven with full force, but will also slide laterally with great ease.

Figure 5: Omni Wheels

3.2.6. 20V boost converter (MC34063A)

The MC34063A devices are easy-to-use ICs containing all the primary circuitry needed for building simple DC-DC converters. These devices primarily consist of an internal temperature-compensated reference, a comparator, an oscillator, a PWM controller with active current limiting, a driver, and a high-current output switch. Thus, the devices require minimal external components to build converters in the boost, buck, and inverting topologies.

Figure 6: 20V boost converter (MC34063A)

3.2.7. ULN2803 Darlington transistor array

ULN2803 is a High voltage, high current Transistor Array IC used especially with Microcontrollers where we need to drive high power loads. This IC consists of eight NPN Darlington

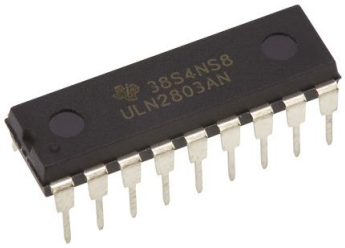

Figure 7: Darlington transistor array

connected transistors with common Clamp diodes for switching the loads connected to the output. This IC is widely used to drive high loads such as Lamps, relays, motors etc. It is usually rated at 50v/500mA.

3.2.8. CD4067 16 channel analog multiplexer/demultiplexer

CMOS analog multiplexers/demultiplexers are digitally controlled analog switches having low ON impedance, low OFF leakage current and internal address de- coding. In addition, the ON resistance is relatively constant over the full input- signal range. The CD4067 is a 16-channel multiplexer with four binary control inputs, A, B, C, D, and an inhibit input, arranged so that any combination of the inputs selects one switch.

Figure 8: Cd4067 16 channel analog multiplexer/demultiplexer

3.2.9. 1N5819 Schottky diode

The 1N5819 is a Schottky diode with a low forward voltage drop and high switching speed. Compared to normal diodes Schottky diodes also have relatively faster switching speeds and hence can be used in high frequency switching circuits.

Figure 9: 1N5819 Schottky diode

3.2.10. Lego Platform

Fixing Printing head, Arduino mega 2560, raspberry pi and all other parts on the Lego platform in an integrated way so that it all fits on it to form a mini structure.

Figure 10: Lego Platform

Chapter 4

Hardware system design

The pocket printer should work in a mobile way, so to control the printing head and the movement of the printer is needed. The printer can communicate with a mobile phone or a computer in a wireless way. As for the key component which is used for printing, ink jet printing head should be chosen carefully.

4.1 Block diagram

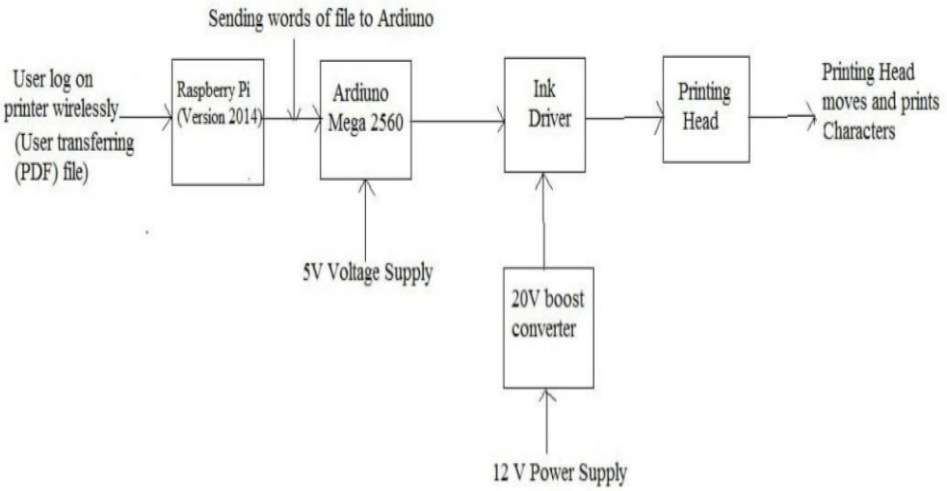

Figure 11: Block diagram of Printer

Figure 11. shows the basic block diagram for the mini printer. To print any file with a mini printer first a user has to log on to the printer wirelessly. After logging onto the printer, the user has to select the pdf file to print and transfer it to Raspberry pi via USB wireless network adapter. The pdf file is sent to the Raspberry pi. The Raspberry pi reads the pdf file and converts it to a plain text file using a linux command "pdftotext" and it sends the characters of the text file to Arduino Mega 2560. As Arduino Mega 2560 receives the characters of text files from Raspberry pi, it will generate the control signals. These control signals will be given to the Ink Driver. The Arduino Mega 2560 is provided with a 5 V power supply. The Ink driver receives the control signals from Arduino Mega 2560 and then it transmits these control signals to the printing head and it also transmits the power from a 20 V boost converter to the printing head. As the printing head gets the signals from the Ink driver it moves and prints the characters parallely on the paper.

4.2 Circuit diagram

The whole circuit which is shown in the Figure 12. consists of four parts:

1. Arduino connections
2. Supply voltage management
3. 20 V boost converter
4. Ink driver

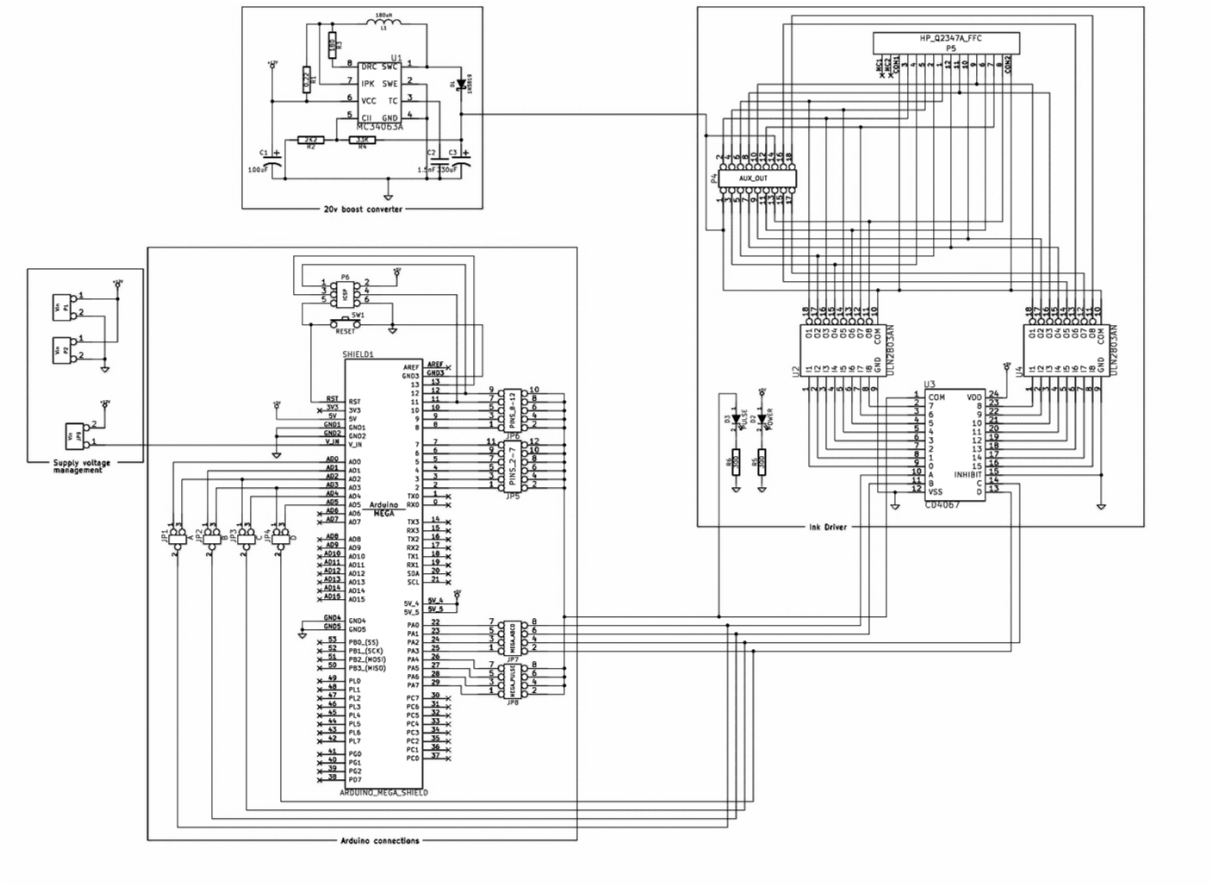

Figure 12: Circuit diagram of Printer

1. Arduino connections

Arduino connections part is the control component. It consists of an Arduino board and a Raspberry Pi. Control signals will be generated by the Arduino board to control the printing head to print words and control the movement of the printer. The Raspberry Pi is used to send characters of the file users want to print to the Arduino.

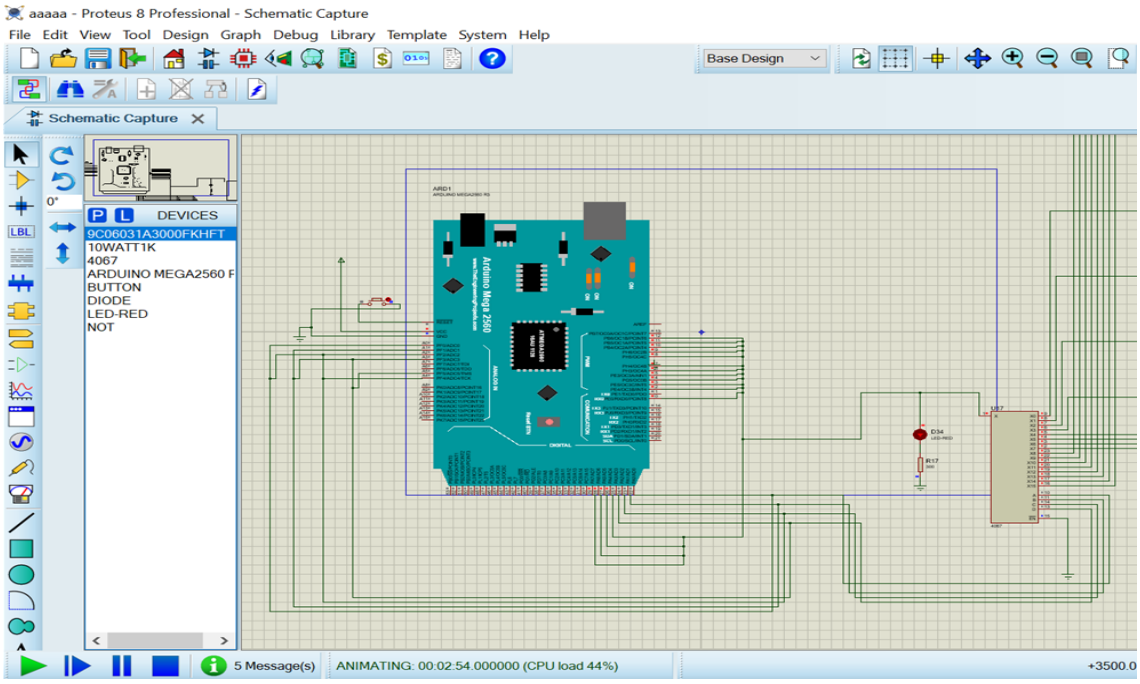

Figure 13: Arduino Mega 2560 circuit

2. Supply voltage management

Supply voltage management part supplies power for the control component. Because the working powers of the control component and the printing head are different, we need different power providers. The Supply voltage management part is used to provide the control component with 5 V power.

3. 20V boost converter

20 V boost converter is for another power provider. It is used to provide stable power at 20 V for the printing head. To protect the circuit, we make it to be a separate component.

4. Ink driver

Ink driver is an important transmission component. It is used to transmit the control signals from the control component to the printing head and transmit the power from the 20 V boost converter to the printing head. There are totally 16 output ports to receive the control signals, which are corresponding to the ports on the printing head.

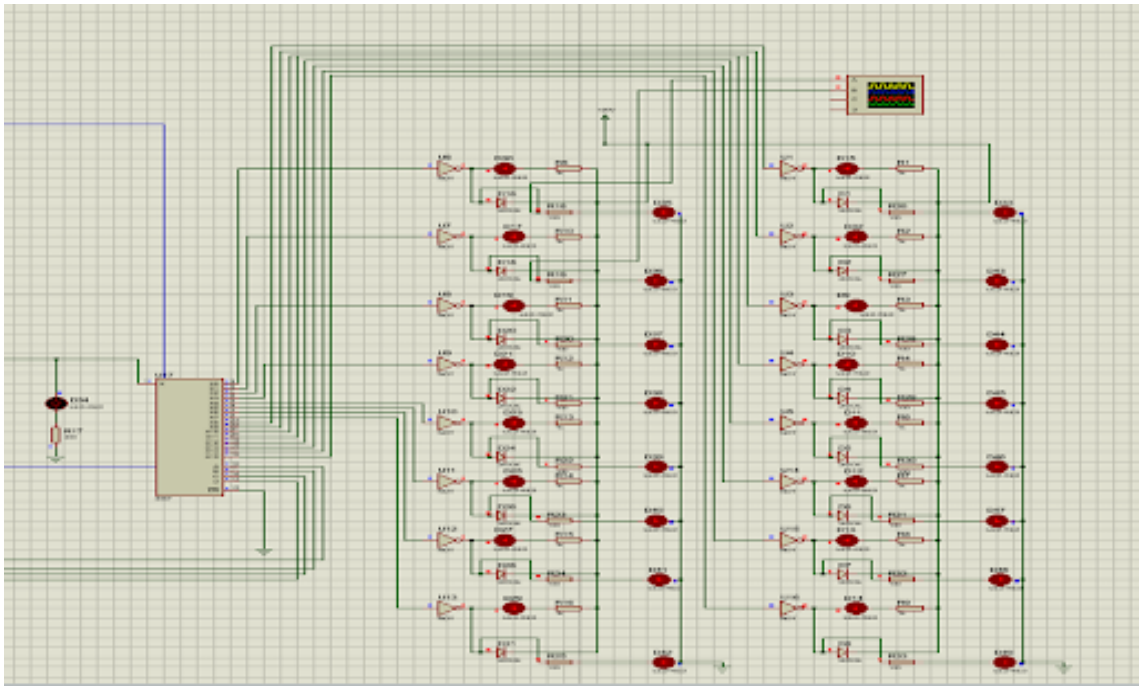

Figure 14: Ink driver circuit

4.3 Control component

The pocket printer should work in a mobile way, so to control the printing head and the movement of the printer is needed. The control component consists of two parts: an Arduino board and a Raspberry Pi. Control signals will be generated by the Arduino board to control the printing head to print words and control the movement of printer. Arduino Mega 2560 is chosen in this system. The Arduino Mega 2560 is a microcontroller board based on the ATmega 2560 (datasheet). It has 54 digital input/output pins (of which 15 can be used as PWM outputs). 16 of the output pins will be used to generate control signals for the printing head. The Raspberry Pi is used for transferring characters of users file to Arduino. In addition, the Raspberry Pi is also used for the wireless communication. In this Raspberry Pi (version 2014), the Compute Module packages a BCM2835 with 512 MB RAM and an eMMC ash chip into a module for use as a part of embedded systems. The Foundation provides Debian and Arch Linux ARM distributions for downloading.

4.4 Communication component

The printer can communicate with a mobile phone or a computer in a wireless way. A USB wireless network adapter (BL-LW05-5R2) is used, which supports 802.11 b/g/n wireless net-

work protocol. Its transmission speed is 150 Mbps, which is enough for communication between the printer and the mobile phone (or the computer). In BL-LW05-5R2, the use of CCA technology to automatically avoid the channel interference and make full use of the advantages of the channel, to ensure that the use of wireless networks will not affect the neighbors. Besides, it also supports WEP encryption, supports WPA/WPA2, WPA-PSK/ WPA2-PSK and other advanced encryption and security mechanism. Wireless network provides a much more convenient way in the communication between the pocket printer and the mobile phone (or the computer).

4.5 Printing head

In this system, ink jet printing head is chosen as the actuator. And the HP-C6602A is chosen, because this kind of printing head satisfies the printing requirements, and it is easier to control and cheaper than other printing heads. HP-C6602A is a dot matrix printing head. Dot matrix printing is a type of computer printing which uses a print head that moves back and forth, or in an up and down motion on the page and prints by impacting and striking an ink-soaked cloth ribbon against the paper, much like the printing mechanism on a typewriter. However, unlike a typewriter or daisy wheel printer, letters are drawn out of a dot matrix, and thus, varied font sand arbitrary graphics can be produced. The advantage of dot matrix is that they can produce graphical images in addition to text; however the text is generally of poorer quality than impact printers that use letterforms.

4.6 Moving platform

To make a perfect product, all of these parts should be put on a moving platform including Arduino, raspberry pi, supply voltage management, 20 V boost converter, and Ink driver. And all of these parts should be integrated to minimize our product. At present, in terms of testing and efficiency, we just use Lego to make a simple platform. And we fix our printing head under the platform and our voltage management and integrated part on the platform. With four wheels making a crisscross pattern, our printer could move in a straight line on the paper driven by the Arduino and print letters clearly. This is the main difference between our pocket printer and other printers in the shopping mall.

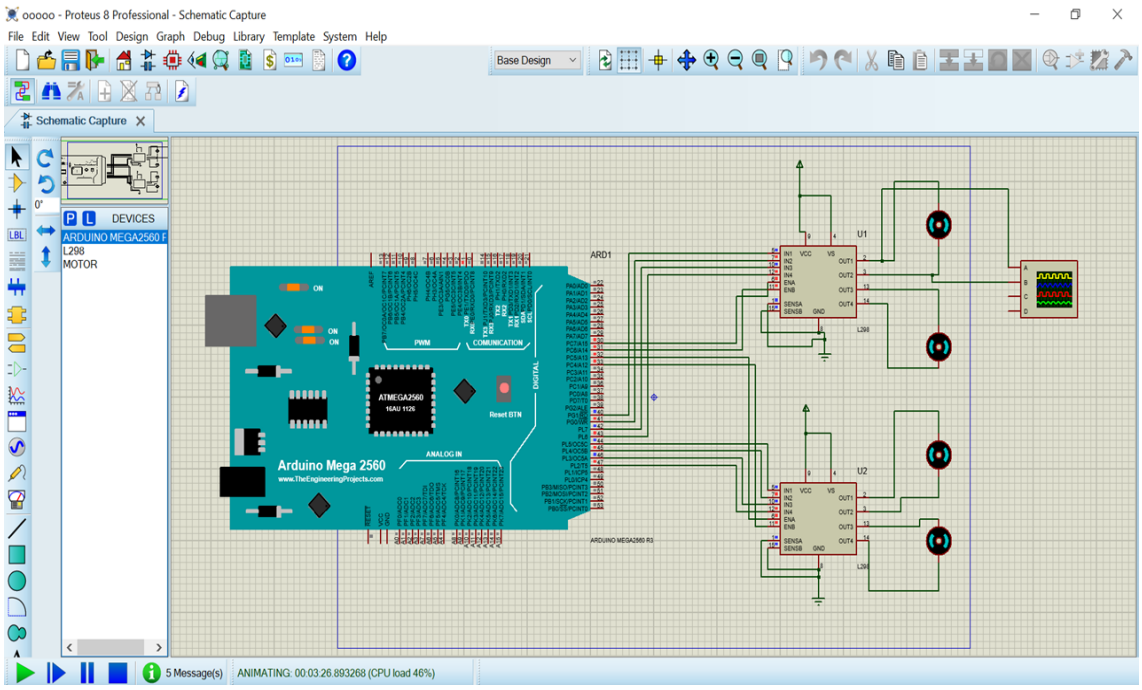

Figure 15: Printer moving circuit

4.7 Flow chart of the printer

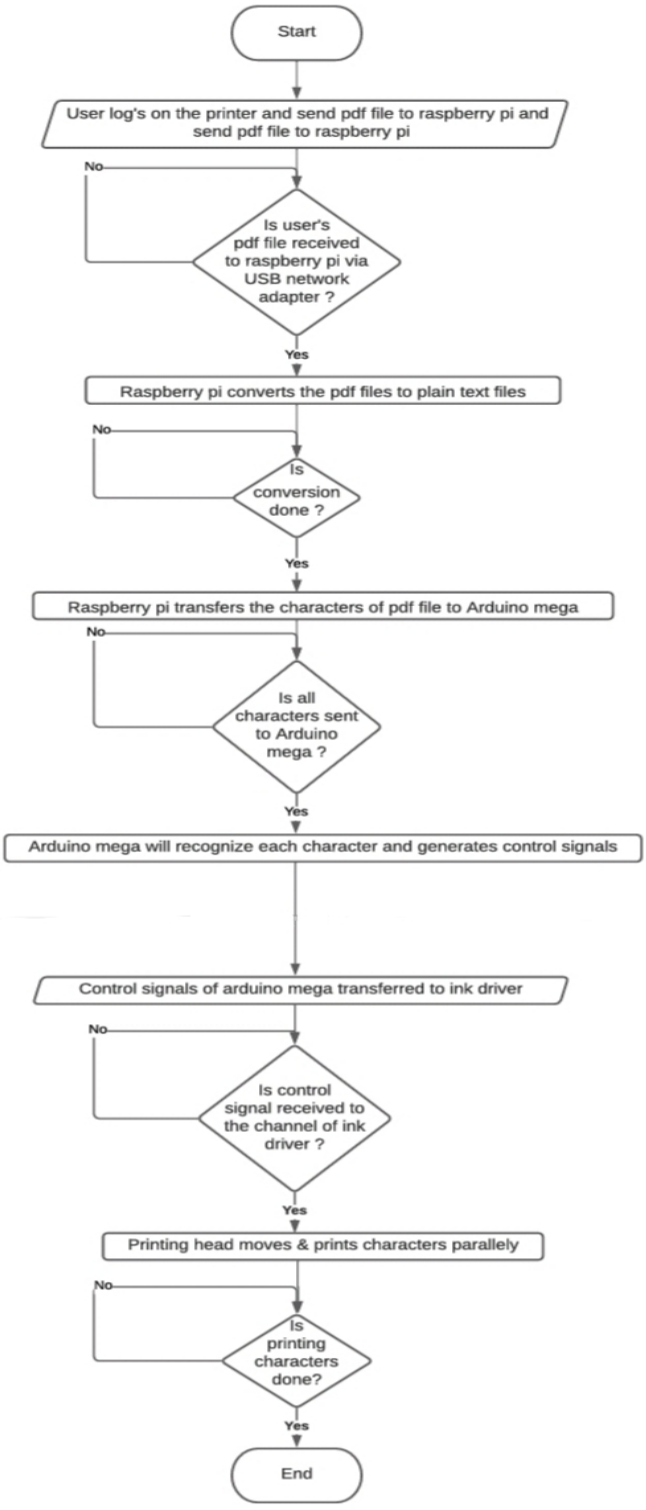

Figure 16: Flowchart

Chapter 5

Software system design

5.1 Description

In order to implement the function of a pocket printer; we need to design a robust software system. With this designed software system pocket printer could receive characters from the file which the user wants to print, and then it controls the printing head to spray ink and moves on the paper. The following Figure 17. shows the flow diagram of pocket printer software system design. We will see the software system design step by step.

5.2 Flow Diagram

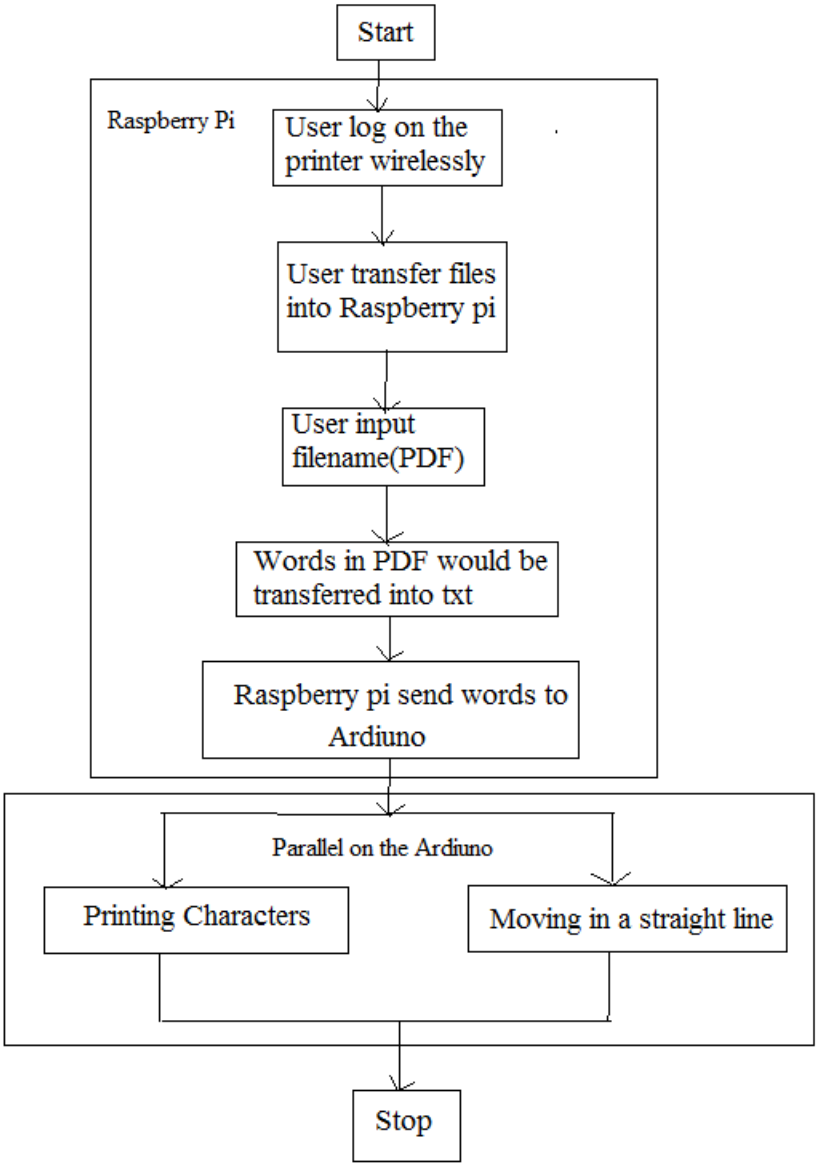

Figure 17: Flow diagram of software system Design

5.3 Steps

5.3.1 Step 1: A shell script needs to be implemented on the Raspberry Pi

Shell script is like an application which users could click and run to print their files. In the meanwhile, in order to print PDF files, an important Linux command C pdftotext needs to be used when we write and implement this shell script. This command is an open source command-line utility for converting PDF files to plain text files.

Shell Script:

```
1 ! /bin/bash
2 echo –n “Enter your filename (PDF):”
3 user input the file they want to print
4 read filename
5 pdftotext filename output.txt
6 python transfer.py
```

5.3.2 Step 2: Serial Communication

After that to send the converted plain texts to Ardiuno a serial communication is established between python and Arduino Mega 2560. We have used Python 3.7 version i.e Spyder to execute Python code. To establish serial communication between Ardiuno mega 2560 and Python we have installed the Pyserial module in Python to send the characters from text file to Ardiuno serially. Following is the Python Code executed in Spyder.

Code for Serial communication in python i.e. transfer.py code

```
import serial
import time
arduino=serial.Serial('COM3',9600)
time.sleep(2)
f=open("demo.txt", "r")
while 1:
line=f.readline()
if not line:
break
for letter in line:
arduino.write(b 'letter')
print(letter)
time.sleep(1)
f.close()
```

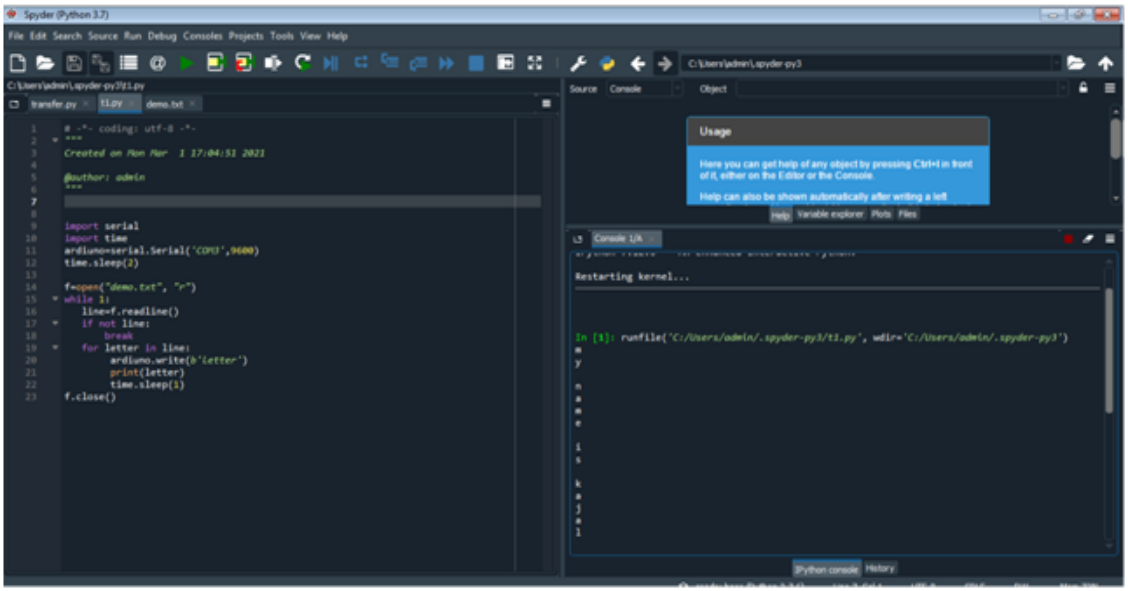

Figure 18: Serial communication code implemented on spyder

Ardiuno Mega 2560 Code

```
void setup() {
// put your setup code here, to run once:
pinMode(13,OUTPUT);
digitalWrite(13,LOW);
Serial.begin(9600);
}
void loop()
{
// put your main code here, to run repeatedly:
if(Serial.available()¿0)
{
if(Serial.read()==’s’)
{
digitalWrite(13,HIGH);
Serial.println(”Letter is s and Led is on”);
delay(2000); }
}
else
{
digitalWrite(13,LOW);
```

}

}

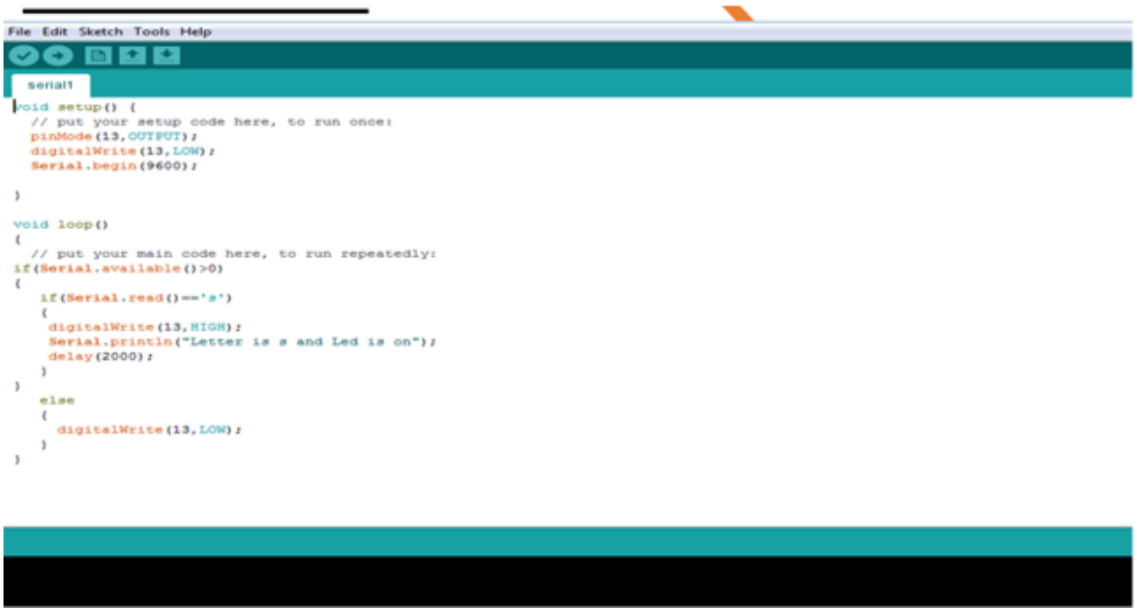

Figure 19: Arduino Mega 2560 code for receiving the characters from python implemented on Arduino IDE

5.3.3 Step 3

Next to control the Printing head, a library needs to be created which tends to contain various words we would use to express in our daily life. And a matrix called font is used to contain these characters whose ASCII are between 32 and 96. Each character is represented with a matrix which has ten rows and 18 columns. And in every row, the first two codes 0b stand for control signal, the next two codes 00 mean low voltage level, the following two codes 00 are stored and the remaining 12 codes are used to control whether the printing head will spray ink or not (1 represents spraying ink and 0 represents not). An example is shown in the following Figure 20. which stands for the character E and F. Then Arduino Mega is initialized on pin 2 and its frequency is set to be 9600. And after that, if there are characters in the buffer of Arduino which means Arduino receives the words transferred from the raspberry pi, Ardiuno will judge which character it is and use the function “spray letter” to print these words. Following that, if these characters are recognized to be lowercase letters, they need to be transformed into uppercase letters, because our character library only has letters whose ASCII are between 32 and 96. Next we need to focus on how to realize the function of “spray letter”. In these function, it firstly uses ASCII of letters we want to print to find its beginning row in the matrix “font”. Then it uses a loop function for ten times (each letter is represented by a matrix with ten rows) and uses

the function “spray ink” to print each row of the letter. Finally, this pocket printer could print a complete letter we want to print.

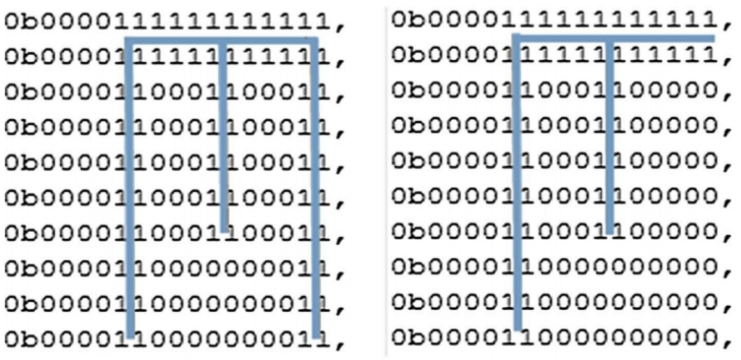

Figure 20: Character E and F representing with matrices

Furthermore, we should pay attention to realizing the function of “spray ink”. From existing information, our printing head is an ink printing head. If we want this printing head to spray ink, pulse signals should be given to the corresponding channels of this printing head. And each letter is actually controlled by 12 channels (2 of 14 channels are stored). Then pulse signals are given to the corresponding channels based on the digits from the right to the left of each letter’s matrix row. If Arduino reads 1, then pulse is given to that channel, or it will not receive the pulse signal. One example is displaying in Figure 21. In which we just use Row 3 to demonstrate our idea.

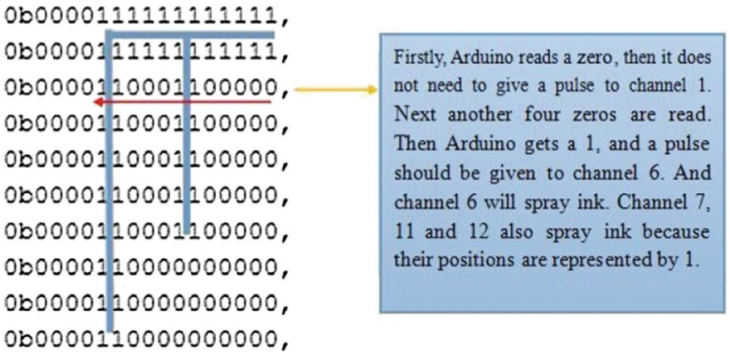

Figure 21: Ardiuno reads the matrix of letter F and calls the Function Spray ink

Code:

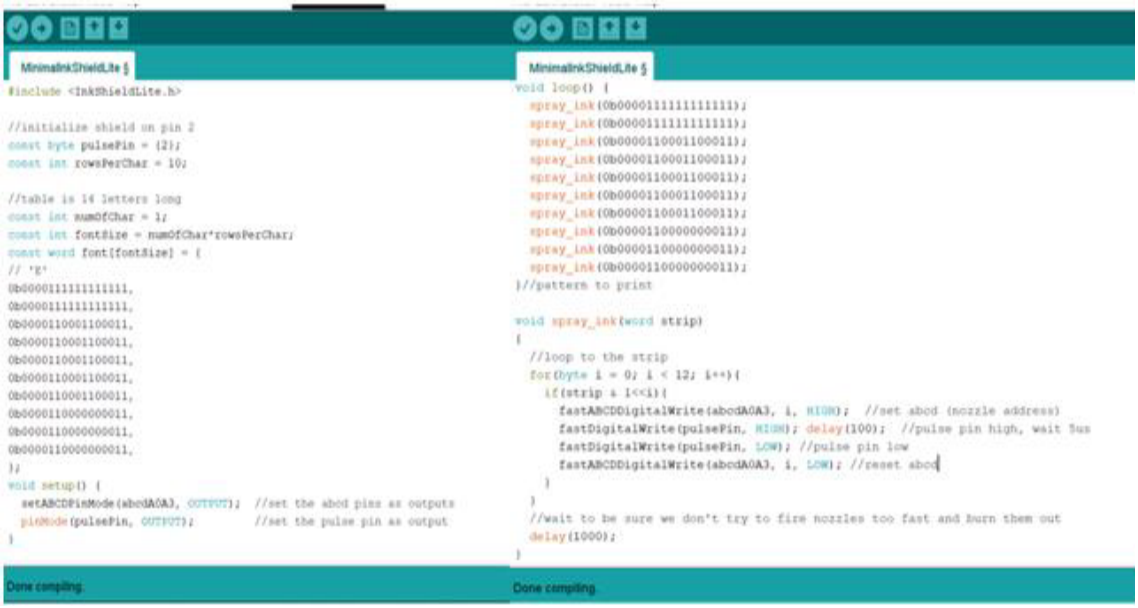

Figure 22: Arduino code for spray ink is implemented on the Arduino IDE

5.3.4 Step 4

Next step to move the printer on paper. Unlike general Printers, they all need paper to move forward. Our printer needs itself to move in a straight line. So the function of moving needs to be implemented in the Arduino. L298 driver IC is used to control two parallel wheels. Hence need 2 drivers IC to control four omni wheels.

Code For Moving

Figure 23: Arduino Code for moving is implemented on Arduino IDE

5.3.5 Step 5

At last to work Printing and Moving function in parallel on the Arduino, The Arduino Task Scheduler is used to Schedule printing and moving tasks Automatically. The Ardiuno task scheduler is like a library and provides some useful functions to us to schedule different tasks on the Arduino. Firstly, Sch.init() and Sch.start() are put into the function setup(), and then Sch. dispatchTasks() is located in the function loop(). In these two steps, Sch.init(), Sch.start() and Sch.dispatchTasks() are the functions offered by that project. And then, the implementations of function printing and moving are added at the end of codes. Finally, Sch.addTask() is called between Sch.init() and Sch.start() to add tasks into the task scheduler, like the following example in the Example code for task schedule. With this library and these useful functions, Arduino could schedule the printing function and moving function through adjusting different parameters and use the most appropriate parameters to make these two tasks work perfectly in parallel. And all of these things will make our printing more clear, neatly and wirelessly.

Example code for task Schedule

```
1 void setup(){
2 //code...
3 Sch.init();
4 //Add printing task.
5 //Starts at the 0th ms, and runs every 1 ms
6 Sch.addTask(printing, 0, 1, 1);
//Add moving tasks.
8 //Starts at the 1th ms, and runs every 2 ms
9 Sch.addTask(moving, 1, 2, 1);
10 Sch.start();}
```

Chapter 6

Results

The circuits are tested in the Proteus 8 Professional software. The process of testing the circuits is divided into four parts: Arduino Mega 2560 circuit, 20 V boost converter circuit, Ink driver circuit and printer moving circuit.

6.1 Arduino Mega 2560 circuit

This circuit is to test whether Arduino Mega 2560 could give the control signals to the Ink driver. The codes are implemented and the output is seen on the digital oscilloscope in Proteus.

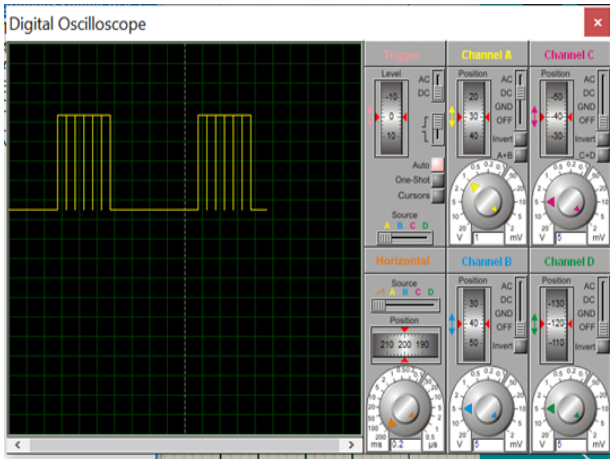

Figure 24: Testing results of Arduino Mega 2560 circuit

6.2 20 V boost converter circuit

This circuit is to test whether the 20 V boost converter is able to supply the boosted 20 V power from 12 V input supply. 20 V boosted output voltage is observed on the digital oscilloscope.

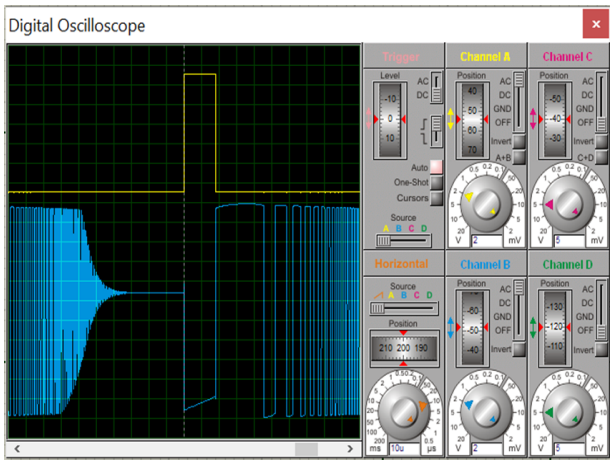

Figure 25: Testing results of 20 V boost converter circuit

6.3 Ink driver

This circuit is to test whether the corresponding ports of the ink driver are receiving the control signals from the Arduino Mega 2560. Two ports out of 16 are connected to the digital oscilloscope and the output waveforms are observed.

6.4 Printing Moving circuit

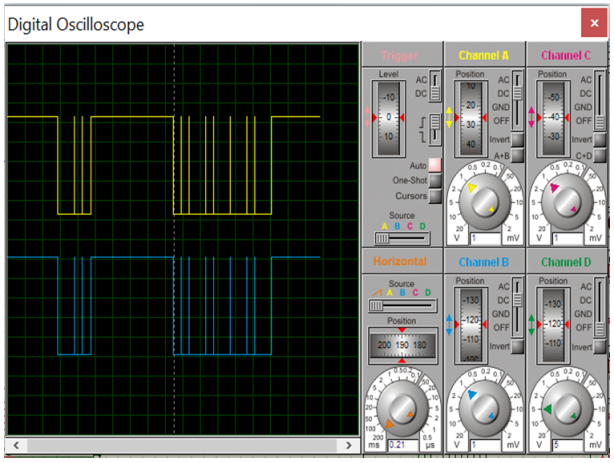

Figure 26: Testing results of Ink driver circuit

This circuit is to test whether the Arduino is able to control the motor driver to move on the paper. Output waveforms across the motor are observed on the digital oscilloscope.

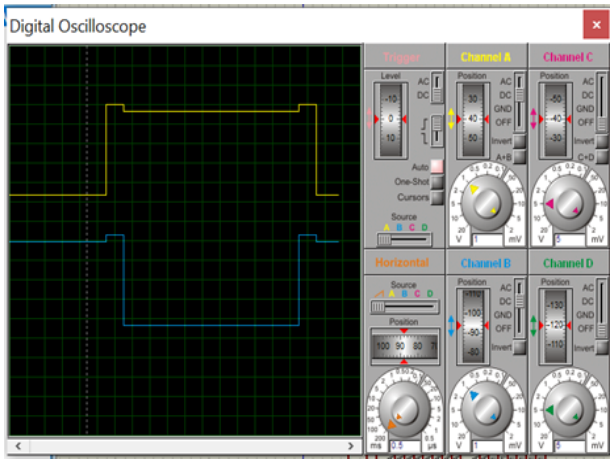

Figure 27: Testing results of printer moving circuit

6.5 Hardware implementation

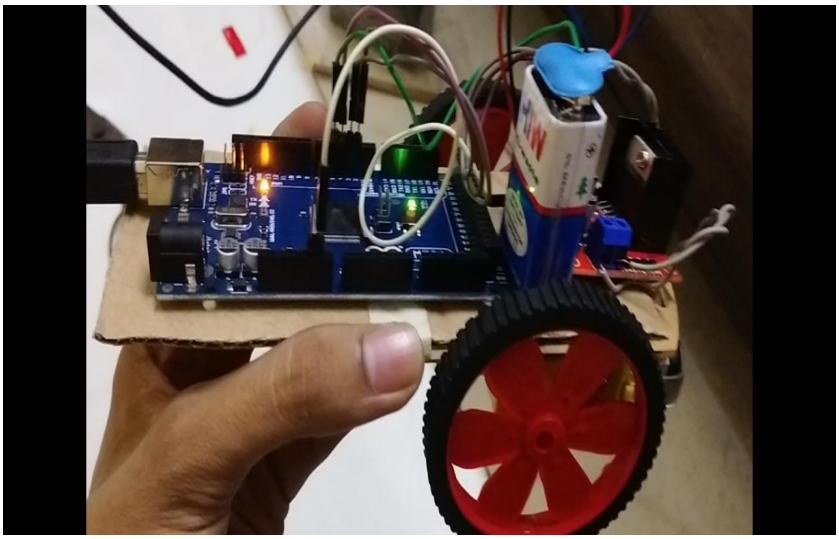

Figure 28: Printer moving on ground

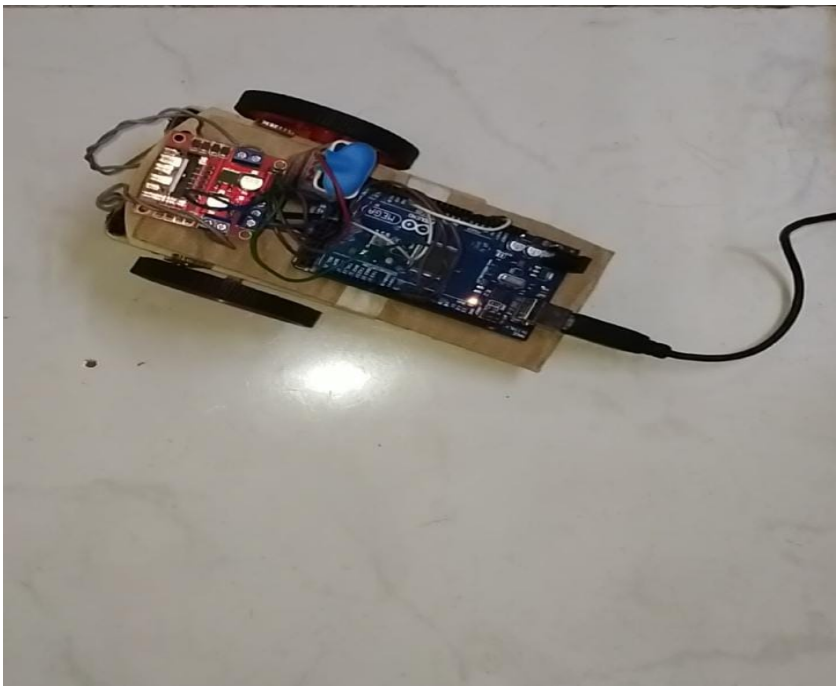

Figure 29: Mini Printer

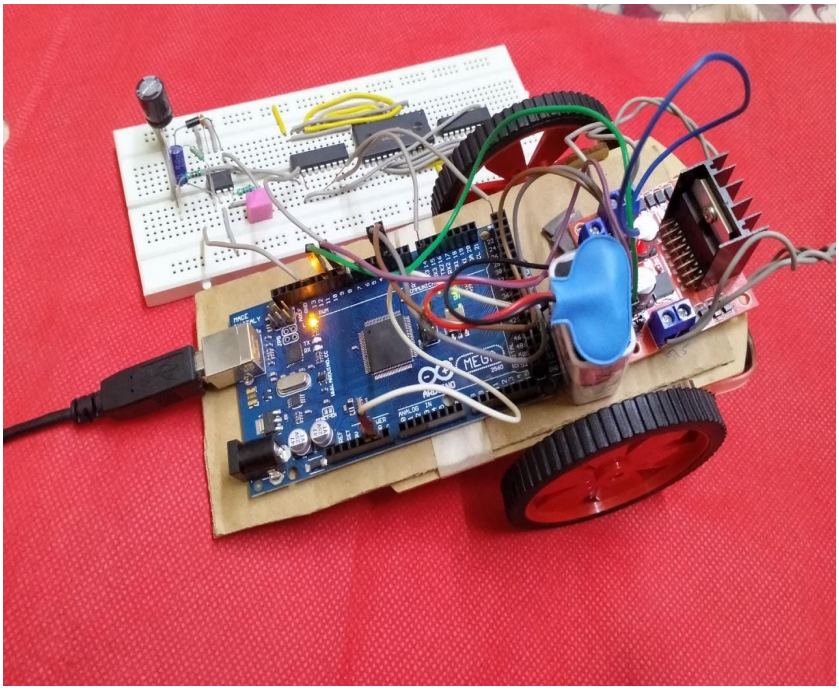

Figure 30: Printer circuit connections

Chapter 7

Conclusion

We tend to conclude that our printer could print as clearly as other inkjet printers and it is very different from traditional printers. Our printer could print wirelessly on the different paper with various sizes and the volume of our printer could be smaller than any other printers in the market. In the near future, with the improvement of integration of our printer, we would make it become a printer which can be really put in your pocket.

References

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