UNIVERSITY OF MUMBAI

DEPARTMENT OF COMPUTER SCIENCE

M.Sc. Computer Science – Semester IV

PSCSP 401 : Robotics

JOURNAL

2022-2023

Seat No. ___________________

मुंबई विद्यापीठ
University of Mumbai
Re-accredited with A++ Grade
(CGPA 3.65) by NAAC (3rd Cycle 2021)

UNIVERSITY OF MUMBAI

DEPARTMENT OF COMPUTER SCIENCE

CERTIFICATE

This is to certify that the work entered in this journal was done in the University Department of Computer Science laboratory by Mr./Ms.____________________________Seat No. ____________ for the course of M.Sc. Computer Science - Semester IV (CBCS) (Revised) during the academic year 2022-2023 in a satisfactory manner.

____________________ ____________________

Subject In-charge **Head of Department**

____

External Examiner

Index

Practical 1

Aim: Making Raspberry pi headless, and reaching it from the network using wifi and SSH..

Components: SD Card -16 Gb, Desktop

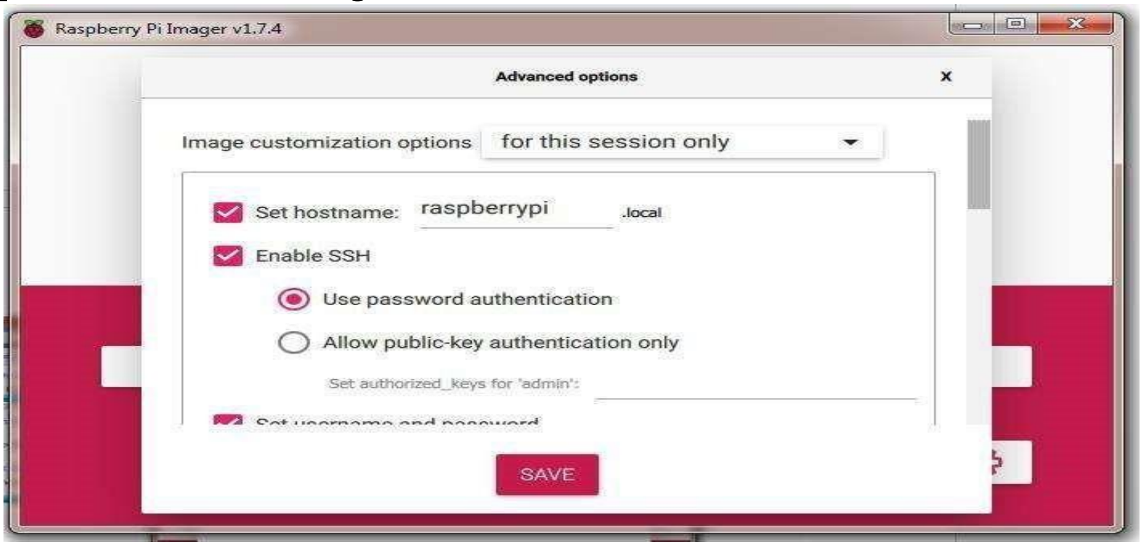
Procedure:

Step I. Go to www.raspberry.com and click on software tab. Download raspberry pi imager for windows. And connect SD card to laptop.

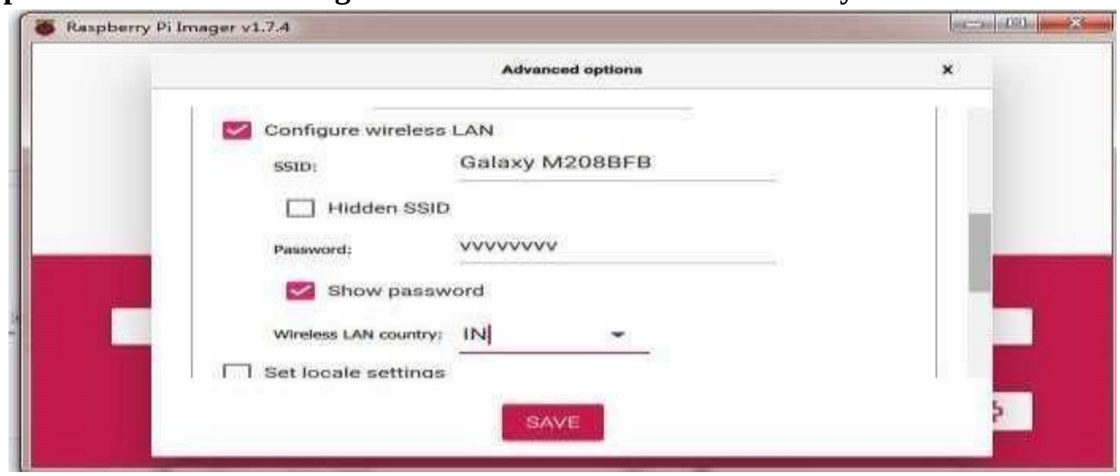
Step II. Select operating system (raspberry pi OS 32-bit)

Step III. Select Storage

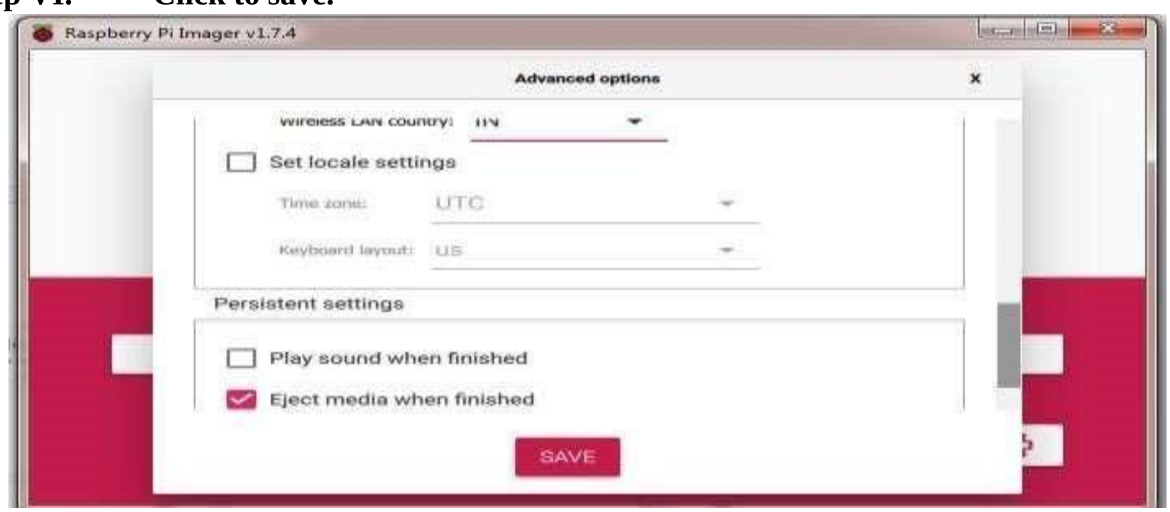
Step IV. **Click on Setting Icon. and set hostname. Click to enable SSH**



Step V. **Click to configure wireless LAN. And select country.**



Step VI. **Click to save.**



Step VII. Click on write.

Step VIII. Click on yes.

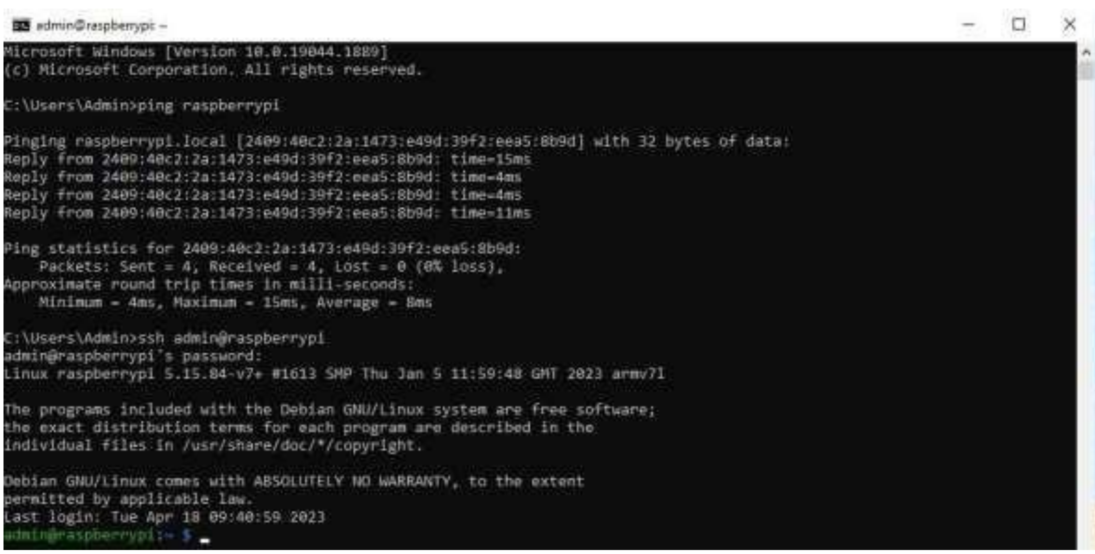
Step IX. Verifying raspberry pi .

Step X. Click on continue

Step XI. Check the connection in your mobile hotspot of raspberry pi

Step XII. On cmd prompt execute these command:

a. **ping raspberrypi**
b. **ssh admin@raspberrypi**



Practical 2

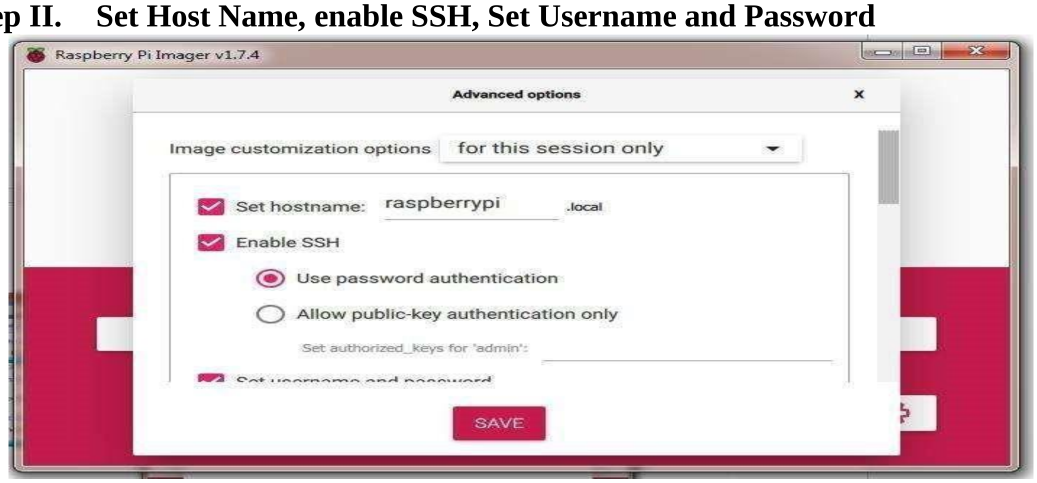
Aim: Using sftp upload files from PC

Software required: FileZilla, GitHub

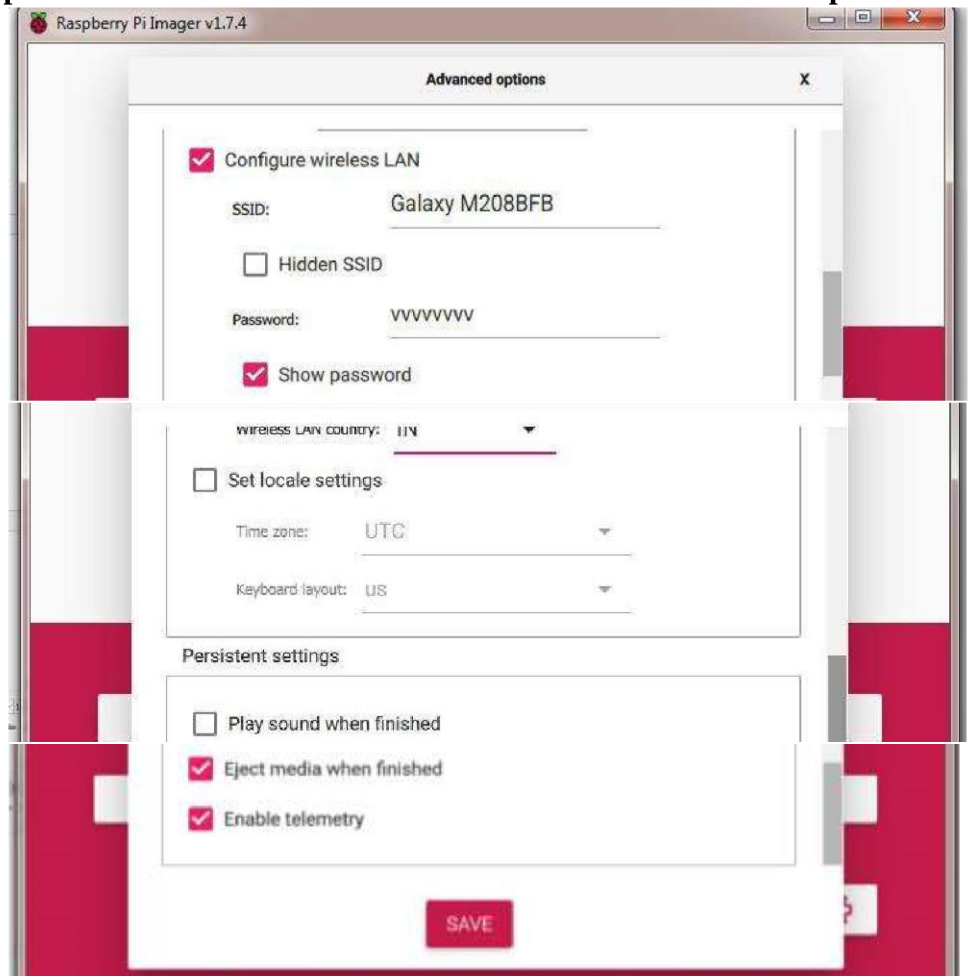
Procedure:

Step I. Install the Raspberry Pi Imager

Step II. Set Host Name, enable SSH, Set Username and Password



Step III. Set SSID and Password of hotspot which is used

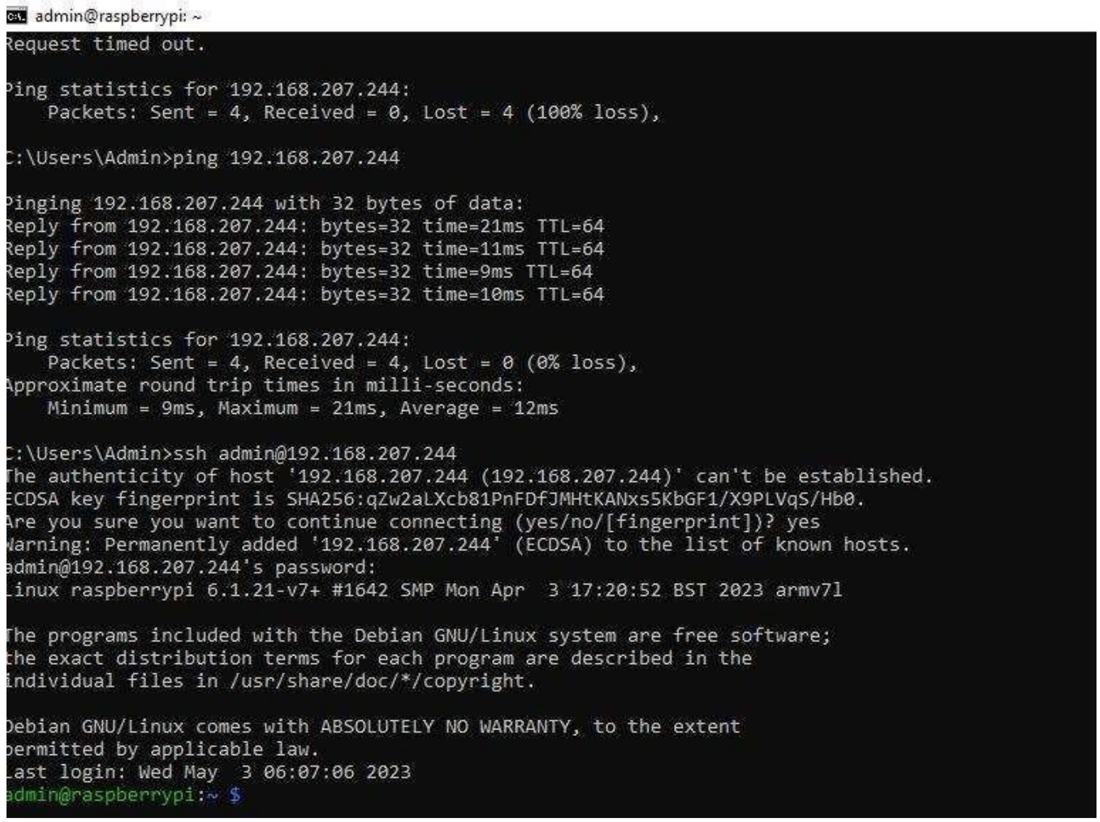


Step IV. Connection Raspberry Pi WIFI and laptop WIFI to mobile device

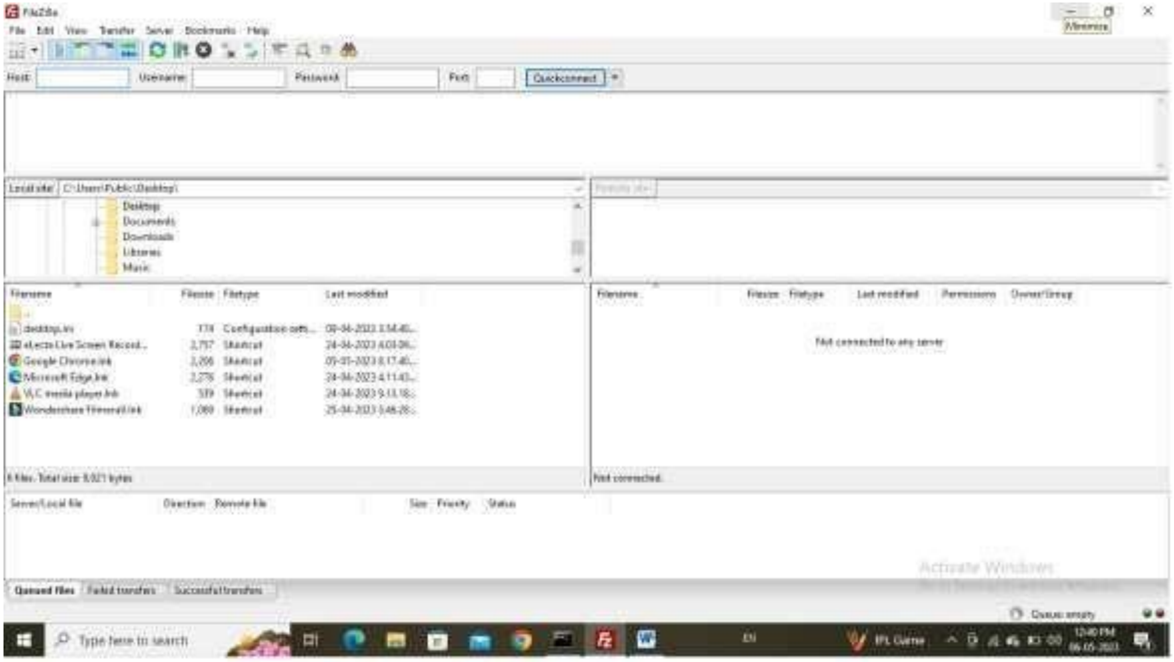
Step V. Open CMD and tyepe following command

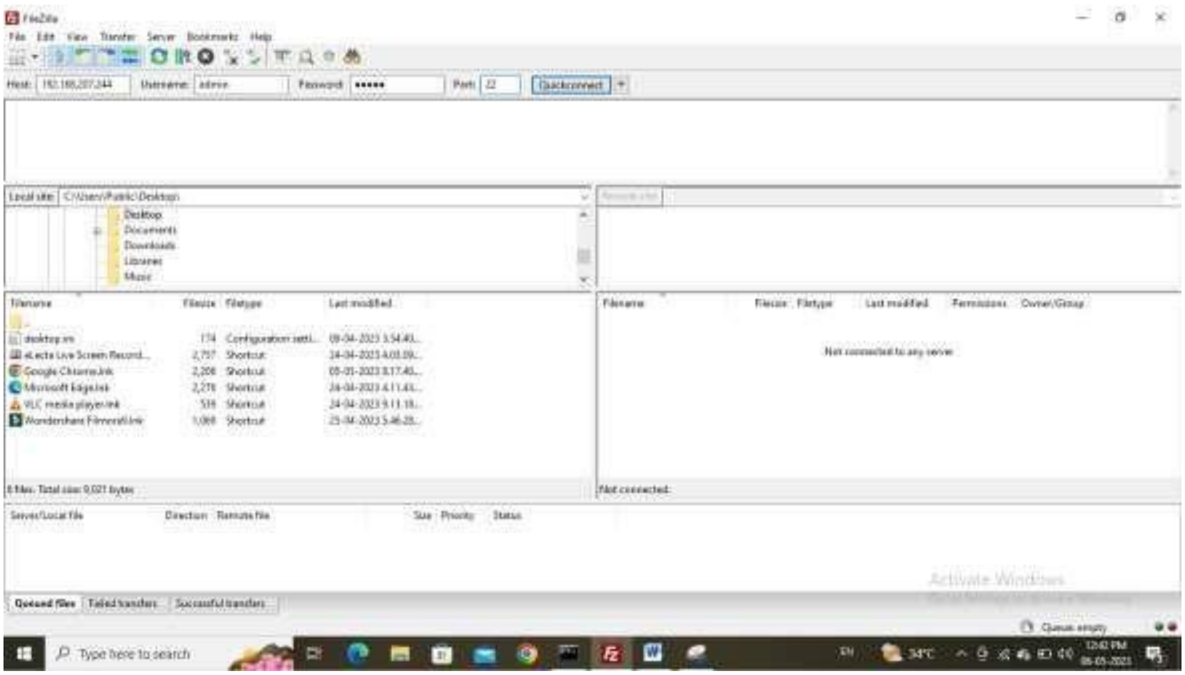
a. **ping raspberrypi or ping 162.168.207.244**

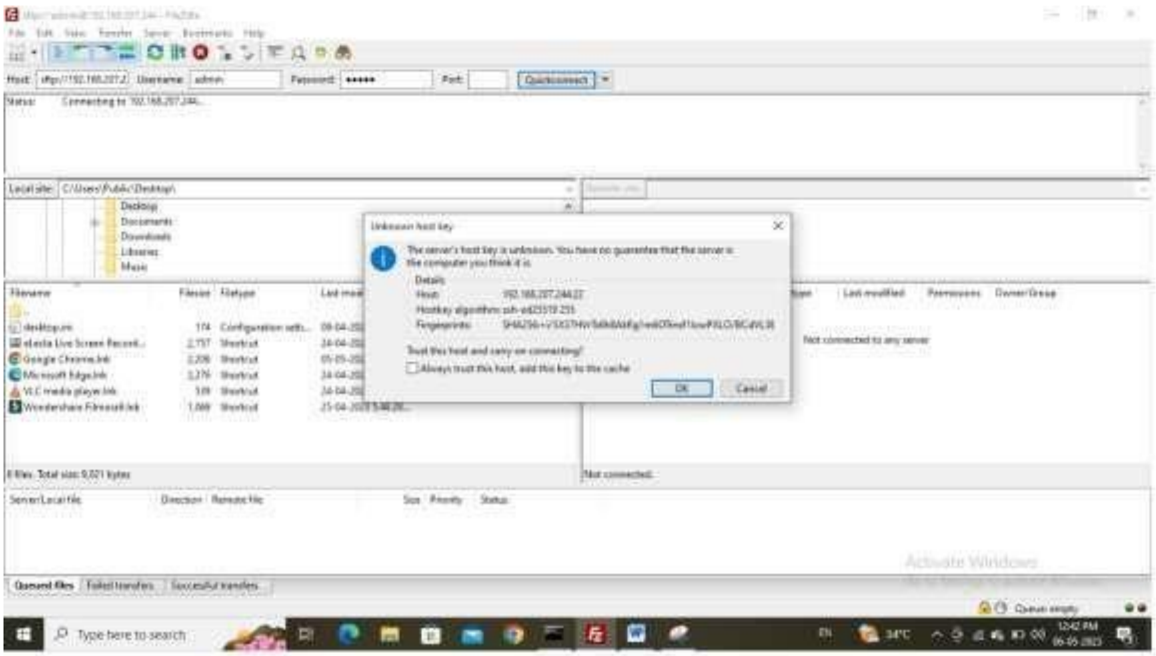
b. **ssh admin@ raspberrypi or ssh admin@ 162.168.207.244 and type password of Admin**

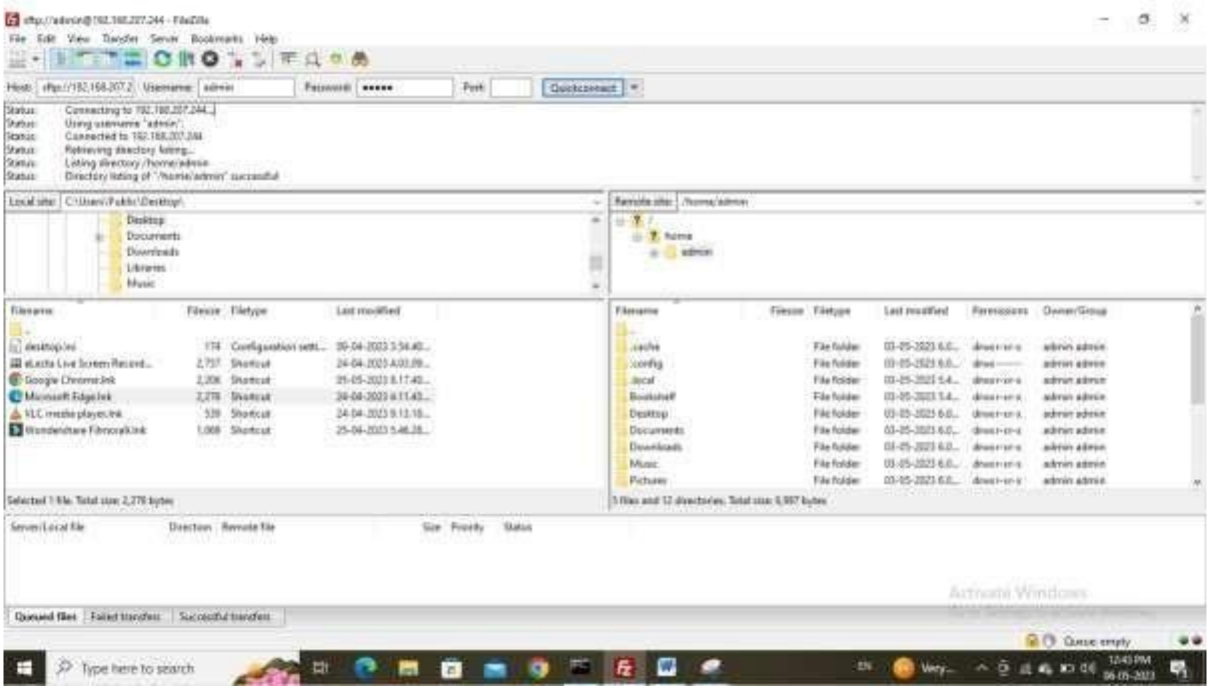


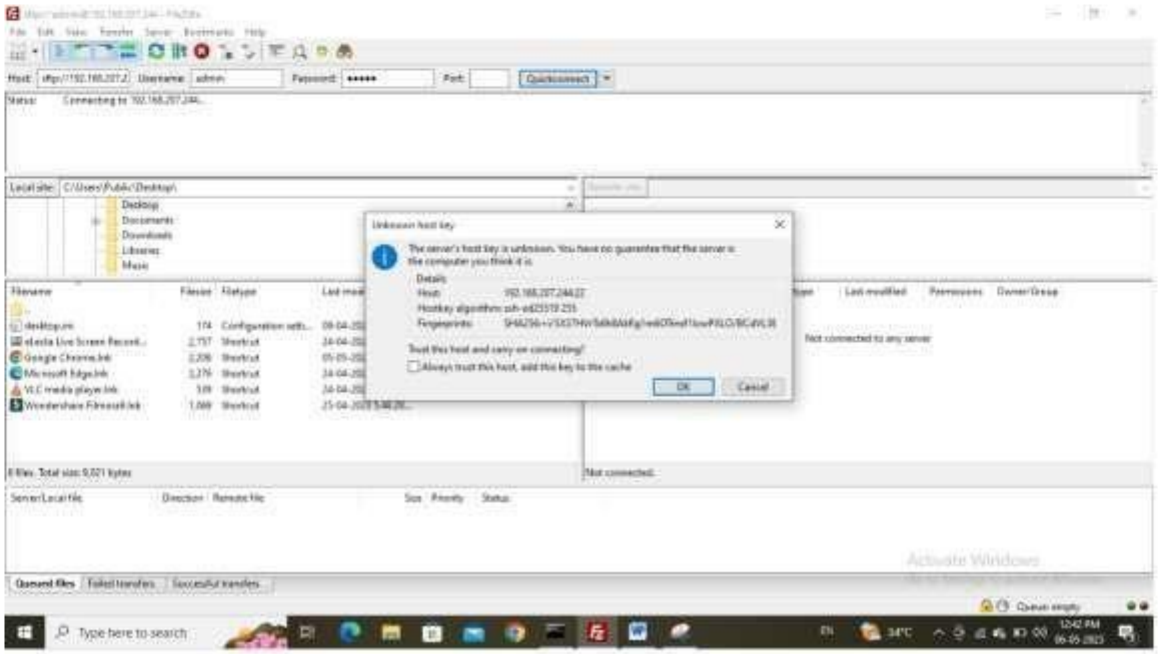
Step VI. Download the FileZilla (Client)

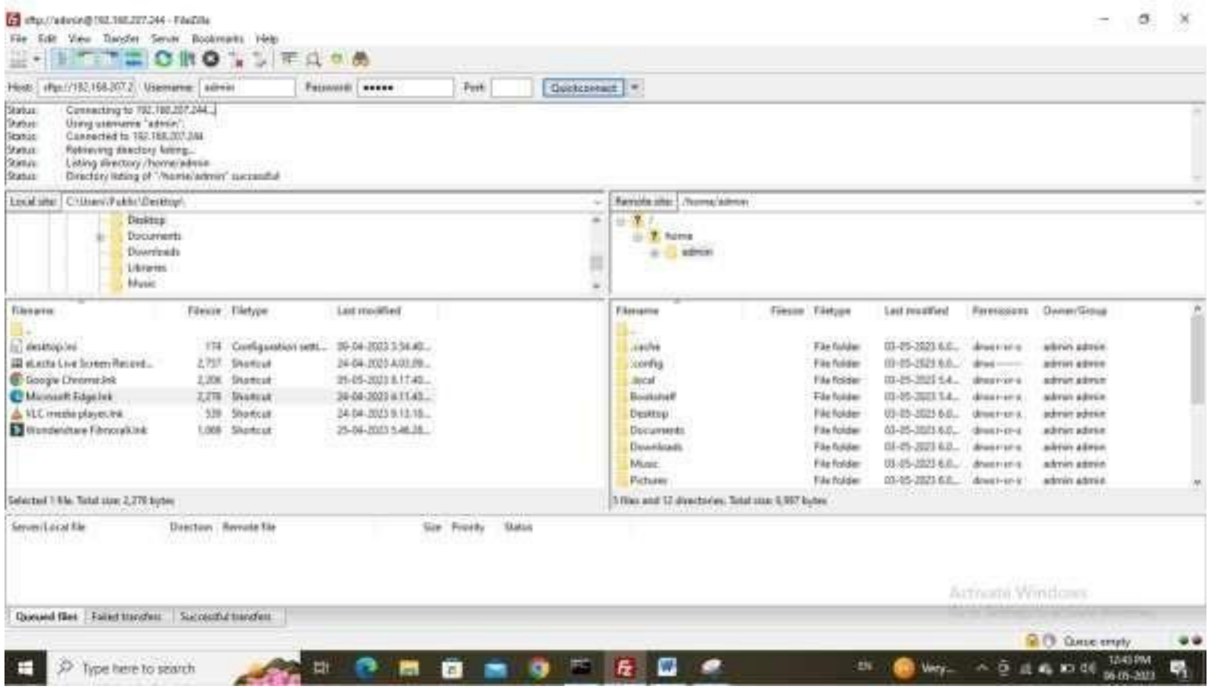


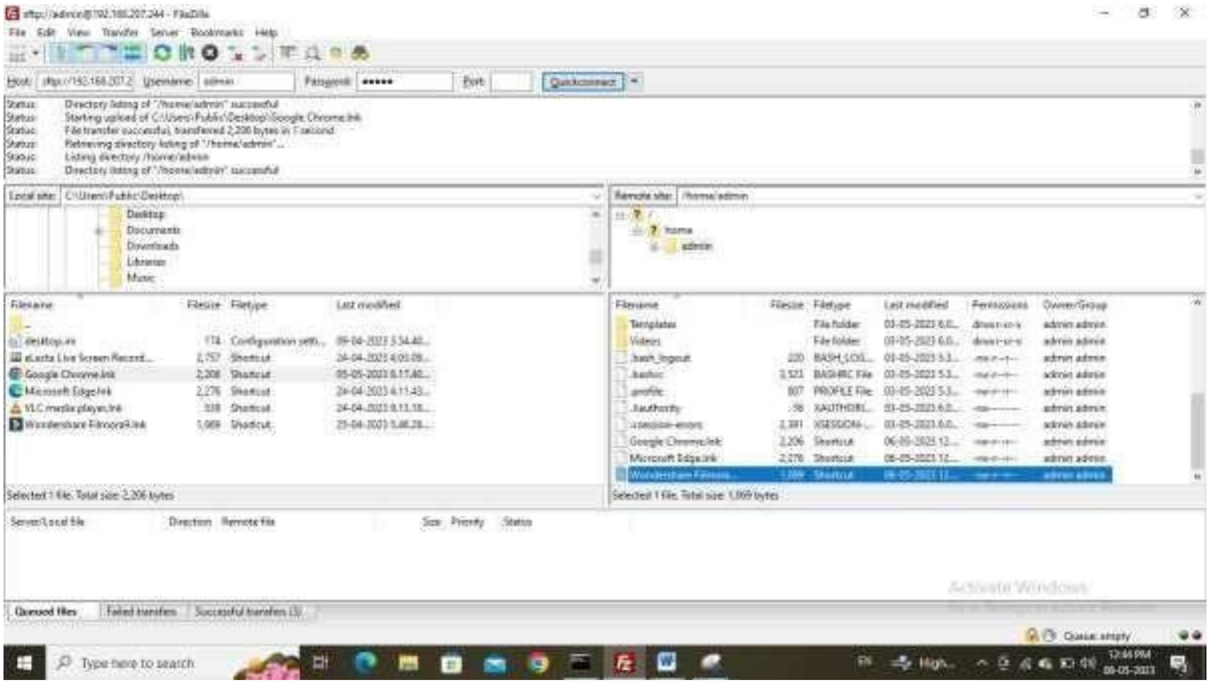












Practical 3

Aim: Write a python code to test motors

Source Code:

```
import RPi.GPIO as GPIO import time
GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)button=12
DC_motor_a=7
DC_motor_b=11

GPIO.setup(DC_motor_a,GPIO.OUT)
GPIO.setup(DC_motor_b,GPIO.OUT)
GPIO.setup(button,GPIO.IN,pull_up_down=GPIO.PUD_UP)

while(1):
        if GPIO.input(button)==GPIO.LOW:
                GPIO.output(DC_motor_a,GPIO.HIGH)
                GPIO.output(DC_motor_b,GPIO.LOW)time.sleep(0.1)

        else: GPIO.output(DC_motor_a,GPIO.LOW)
        GPIO.output(DC_motor_b,GPIO.HIGH)
        time.sleep(0.1)
```

Practical 4

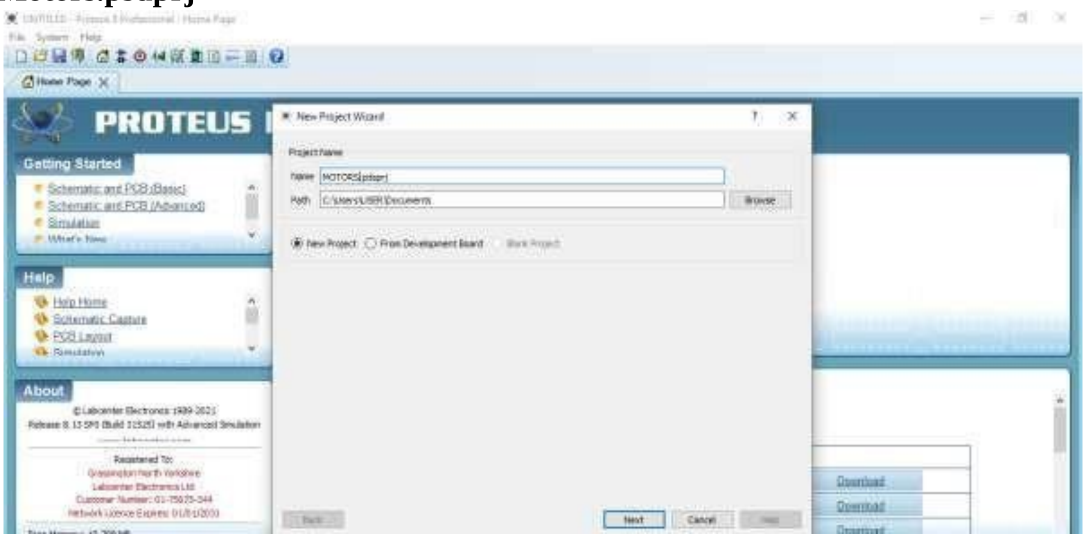
Aim: Write a script to follow a predetermined path.

Components: Raspberry pi Board3, L293D, Simple DC Motor, Button

Steps:

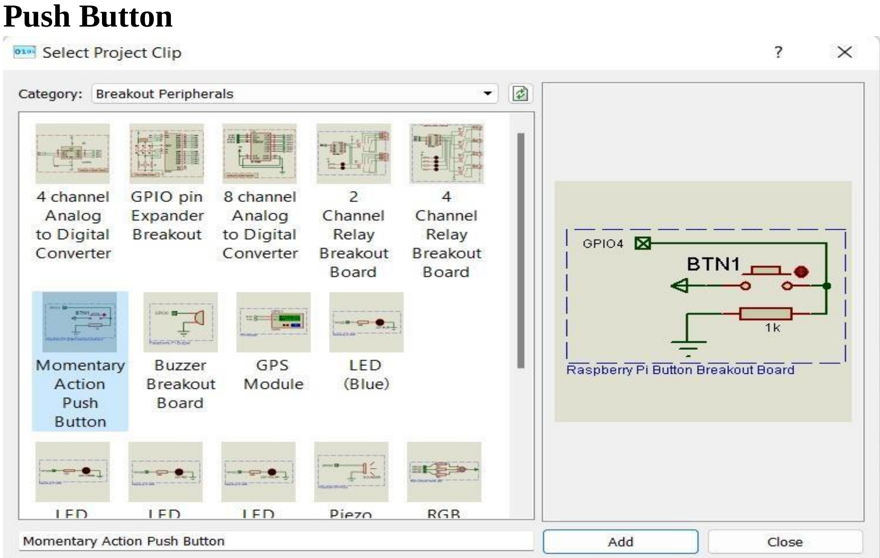
Process of Creation of Project

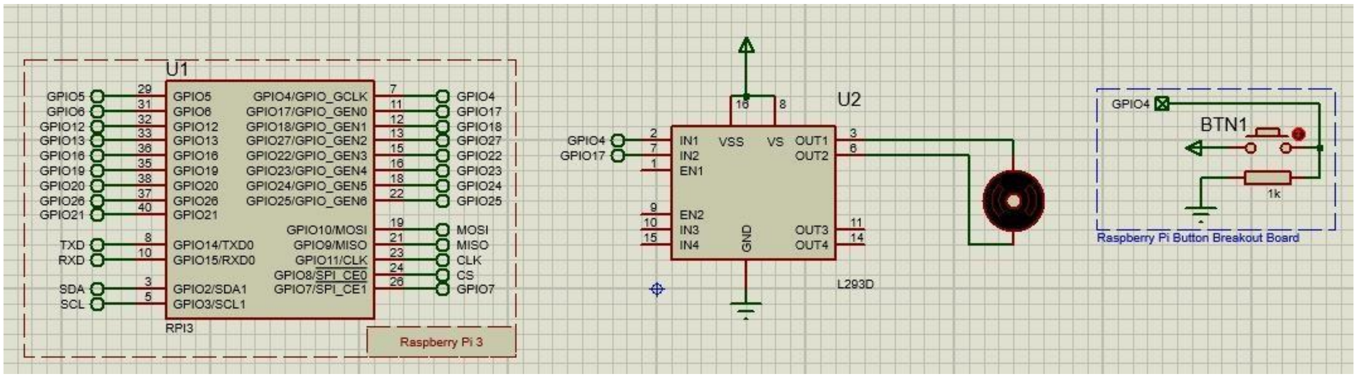
Step I. Go to Proteus, select new project, and change the name of the project and Save As Motors.psdprj



Step II. Create schema as Default, do not create PCB input and then Create Firmware Project Raspberry Pi -> Click Finish

Step III. Implementation of the Circuit – from terminal mode (default, power, ground) and now go to Source code -> Right-Click on RPI3(U1) and click on Add Peripheral then Action Push Button



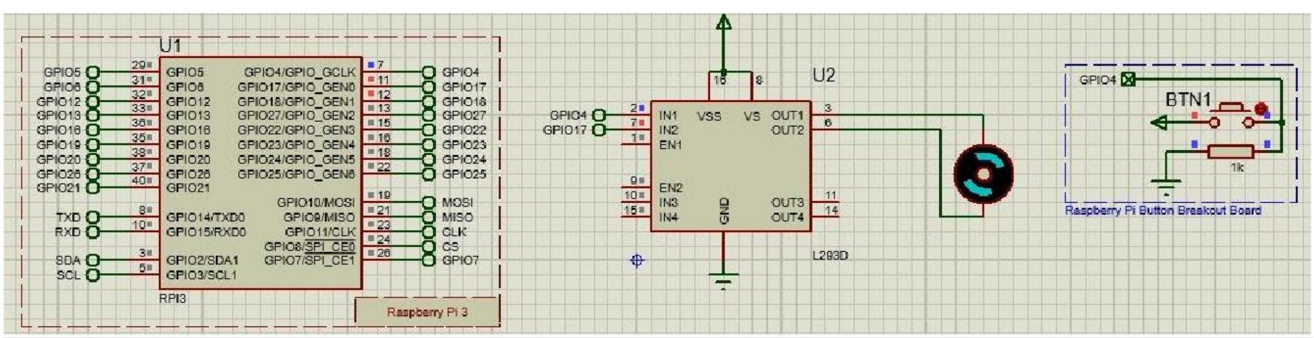


Source Code:

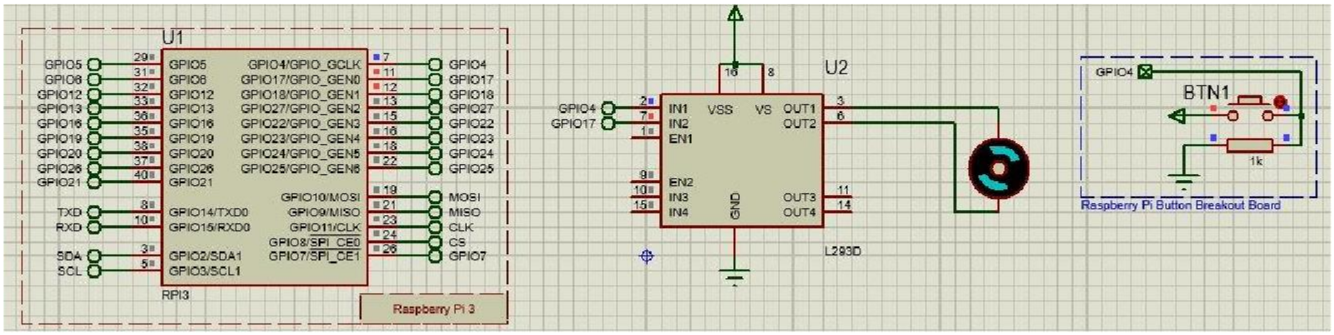
```
import RPi.GPIO as GPIO import
time
GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)button=12
DC_motor_a=7
DC_motor_b=11

GPIO.setup(DC_motor_a,GPIO.OUT)
GPIO.setup(DC_motor_b,GPIO.OUT)
GPIO.setup(button,GPIO.IN,pull_up_down=GPIO.PUD_UP)

while(1):
        if GPIO.input(button)==GPIO.LOW:
                GPIO.output(DC_motor_a,GPIO.HIGH)
                GPIO.output(DC_motor_b,GPIO.LOW)
                time.sleep(0.1)

        else:
        GPIO.output(DC_motor_a,GPIO.LOW)
        GPIO.output(DC_motor_b,GPIO.HIGH)time.sleep(0.1)
```

Conclusion: The movement of the motors are used to represent motion on a path given output –

<u>Motors moving in Clockwise direction</u>



Motors moving in anticlockwise direction



Practical 5

Aim: Develop Python code for testing the sensors.

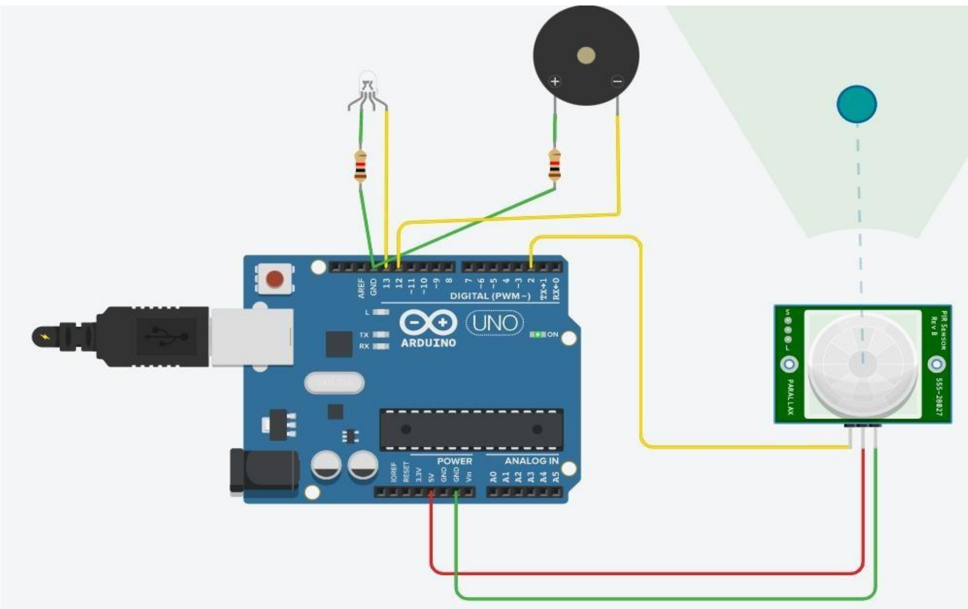
Components: PIR Sensor, Resistor, Piezo, Arduino Uno R3, LED RGB

Step:

Step I. Place the component in TinkerCad.
Step II. Type the following code

```
int pirsensor = 0;void
setup()
        {
        pinMode(2, INPUT);
        pinMode(12, OUTPUT);
        pinMode(13, OUTPUT);
        }
void loop()
        {
        pirsensor = digitalRead(2);if
        (pirsensor == HIGH)
                {
                digitalWrite(13,HIGH);
                tone(12,500,500);
                }
        digitalWrite(13,LOW)
        }
```

Output:



Practical 6

Aim: Add the sensors to the robot object and develop the line follower behaviour code

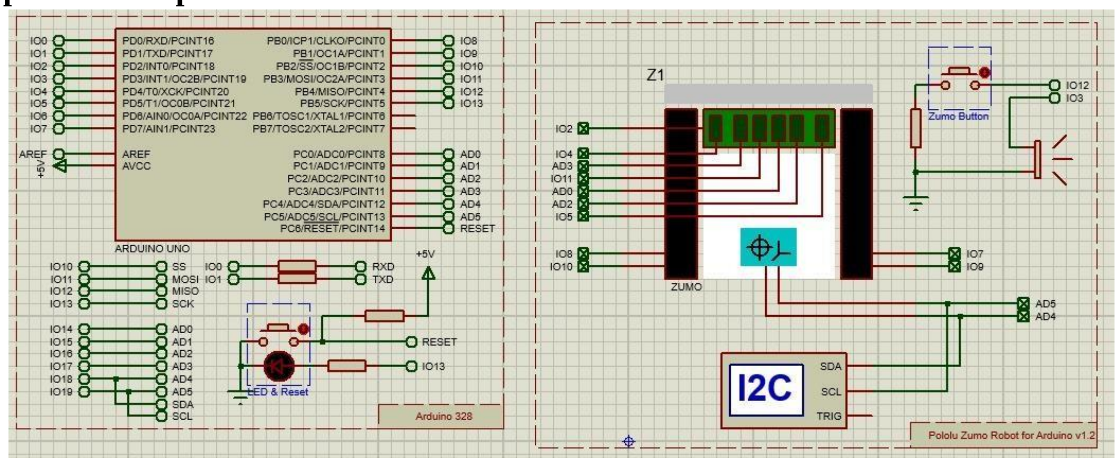
Components: Ardinuo, Button, Zumo robot, Proteus 8.13 simulator

Steps: Process of Creation of Project

Step I. Go to Proteus and select new project,

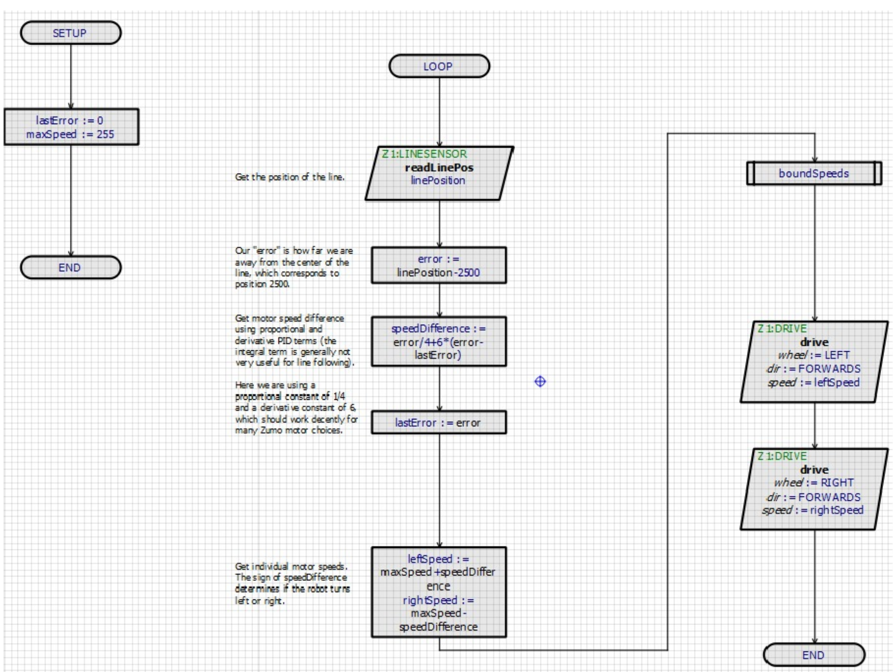
Step II. Change the name of the project and save As Linefollower.psdprj that save it and Export Complied Library (open sample of Arduino Zuno line follower)

Step III. Upload this HEX file in Arduino

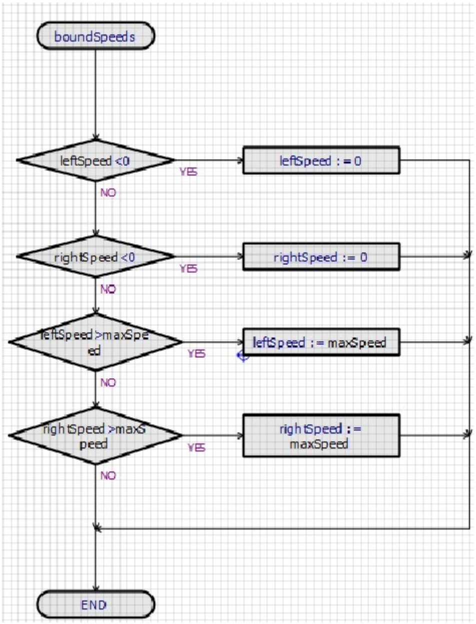


Flowchart of Project

Main Flowchart



Subroutine Flowchart

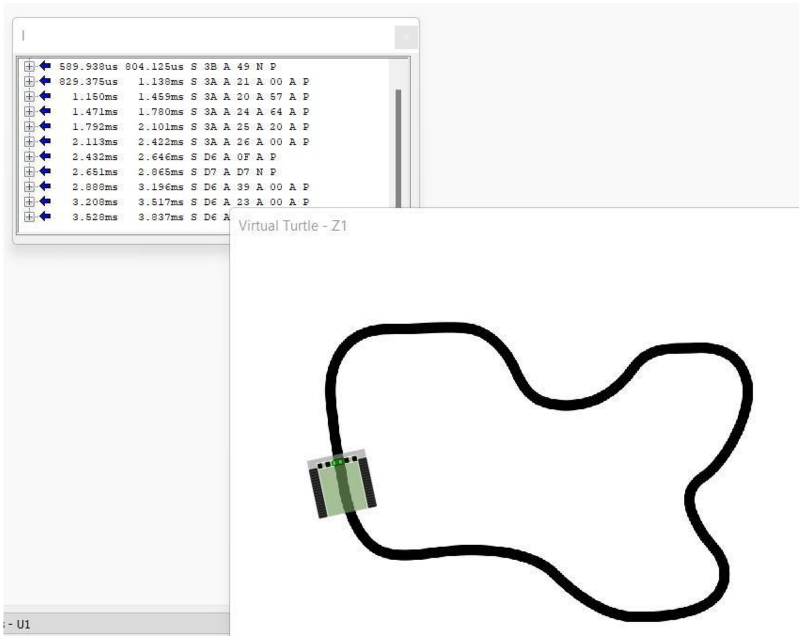


Source Code

```
#pragma GCC push_options
#pragma GCC optimize ("Os")

#include <core.h> // Required by cpu#include <cpu.h>
#include <TimerOne.h>
#include <L3G.h> // Required by Z1:DRIVE #include
<LSM303.h> // Required by Z1:DRIVE#include <Wire.h>
// Required by Z1:DRIVE #include <Servo.h> // Required
by Z1:DRIVE#include <Zumo.h>

#pragma GCC pop_options

// Peripheral ConstructorsCPU
&cpu = Cpu;
TimerOne &timer1 = Timer1;
DRIVE Z1_DRIVE = DRIVE (8, 10, 7, 9);
LINESENSOR Z1_LINESENSOR = LINESENSOR (4, A3, 11, A0, A2, 5, 2);COMPASS
Z1_COMPASS = COMPASS ();
GYRO Z1_GYRO = GYRO ();

void peripheral_setup ()
{
  Z1_DRIVE.begin ();
  Z1_LINESENSOR.begin ();
  Z1_COMPASS.begin ();
  Z1_GYRO.begin ();
```

```
}

void peripheral_loop() {
}
//---CONFIG_END--- //
Flowchart Variables long
var_linePosition;long
var_error;
long var_lastError;
long var_speedDifference;long
var_leftSpeed;
long var_rightSpeed;long
var_maxSpeed; float
var_magX; float
var_magY; float
var_magZ;
// Flowchart Routinesvoid
chart_SETUP() {
  var_lastError=0,var_maxSpeed=255;
}

void chart_LOOP() { var_linePosition=Z1_LINESENSOR.readLinePos();
var_error=var_linePosition-2500; var_speedDifference=var_error/4+6*(var_error-
var_lastError); var_lastError=var_error;
var_leftSpeed=var_maxSpeed+var_speedDifference,var_rightSpeed=var_maxSpeedvar_speedDifference;
  chart_boundSpeeds(); Z1_DRIVE.drive(1,1,var_leftSpeed);
  Z1_DRIVE.drive(2,1,var_rightSpeed);
}

void chart_boundSpeeds() {
            if(var_leftSpeed<0) {
            var_leftSpeed=0;
            }
            else {
                        if(var_rightSpeed<0) {
                        var_rightSpeed=0;
                        } else { if(var_leftSpeed>var_maxSpeed) {
                        var_leftSpeed=var_maxSpeed;
                        } else { if(var_rightSpeed>var_maxSpeed) {
                        var_rightSpeed=var_maxSpeed;
                        }
                        }
                        }
                        }
}
```

// Entry Points and Interrupt Handlers
void setup () { peripheral_setup(); chart_SETUP(); }void loop () {
peripheral_loop(); chart_LOOP(); } **Output**



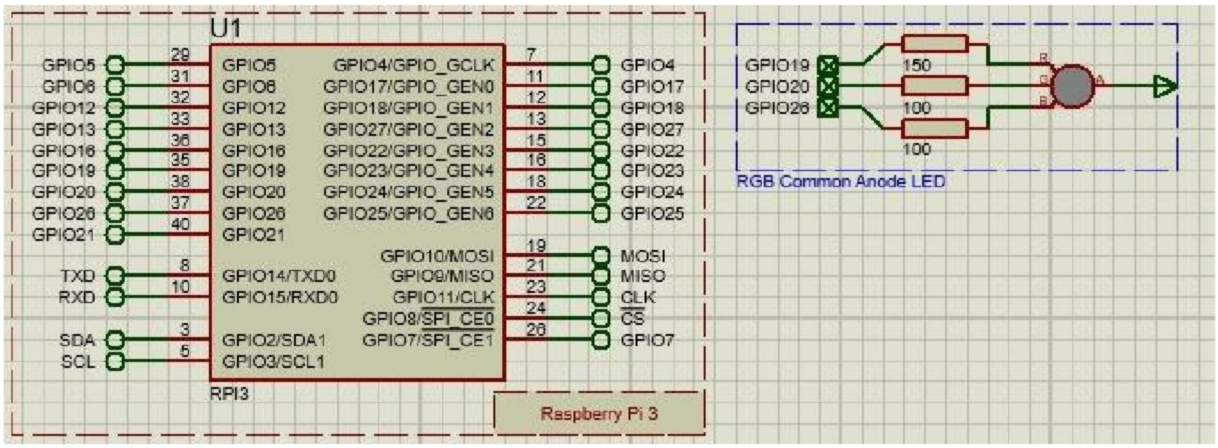
Practical 7

Aim: Using Light strip to develop and debug the line follower robot

Components: Raspberry pi, strip RGB LED Circuit

Procedure:

Circuit connection (open samples and select Raspberry Pi Tri Colour LED)

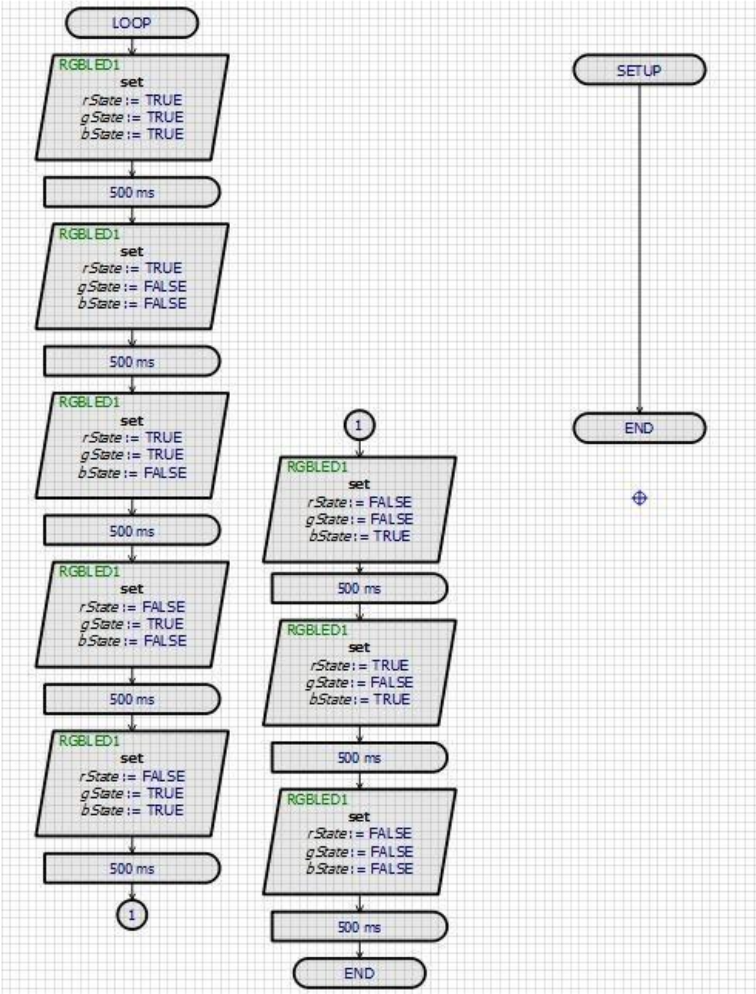


Source code in python

```
from goto import with_gotofrom
stddef import * import var
import pio import
resource
from datetime import datetime
# Peripheral Configuration Code (Do Not Edit)#---
CONFIG_BEGIN---
import cpu import
FileStoreimport timer
import VFP import
Generic

def peripheral_setup () :
# Peripheral Constructors pio.cpu=cpu.CPU ()
        pio.storage=FileStore.FileStore ()
        pio.timer=timer.Timer ()
        pio.server=VFP.VfpServer ()
        pio.RGBLED1=Generic.RgbLedCa (pio.GPIO19, pio.GPIO20, pio.GPIO26)pio.storage.begin ()
        pio.server.begin (0)
```

```
# Install interrupt handlersdef
peripheral_loop () :
        pio.timer.poll ()
        pio.server.poll ()

#---CONFIG_END---
def variables_setup () :
# Flowchart Variablespass
# Flowchart Routines
        @with_goto
def chart_SETUP () : return
        @with_goto
def chart_LOOP () :
        pio.RGBLED1.set (True, True, True)sleep((500)*0.001)
        pio.RGBLED1.set (True, False, False)sleep((500)*0.001)
        pio.RGBLED1.set (True, True, False)
        sleep((500)*0.001)
        pio.RGBLED1.set (False, True, False)sleep((500)*0.001)
        pio.RGBLED1.set (False, True, True)
        sleep((500)*0.001)
        pio.RGBLED1.set (False, False, True)sleep((500)*0.001)
        pio.RGBLED1.set (True, False, True)
        sleep((500)*0.001)
        pio.RGBLED1.set (False, False, False)sleep((500)*0.001)
        return

# Main functiondef
main () :
# Setup
        variables_setup ()
        peripheral_setup ()
        chart_SETUP ()
# Infinite loop
        while True :
        peripheral_loop ()
        chart_LOOP ()
# Command line execution
        if___name_____== '_main_' :main()
```

Flowchart:



Output:

Figure of the led showing blue color

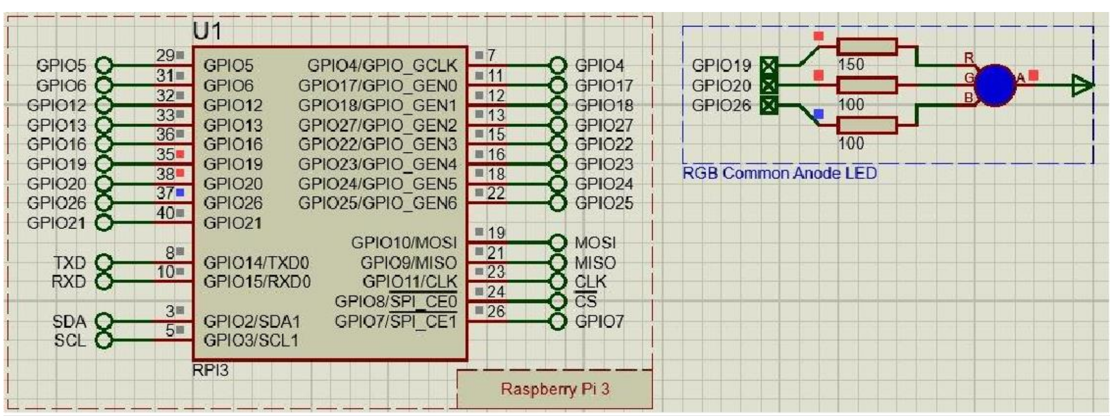


Figure of the led showing red color

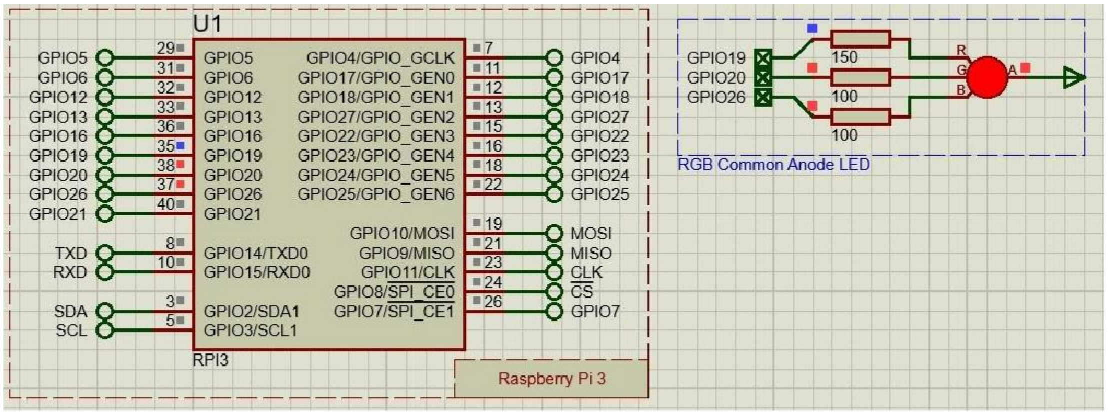


Figure of the led showing green color

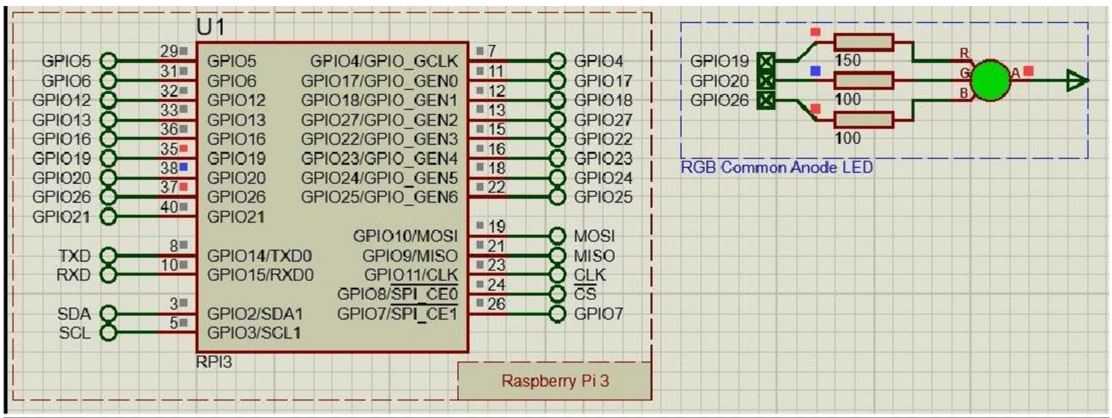
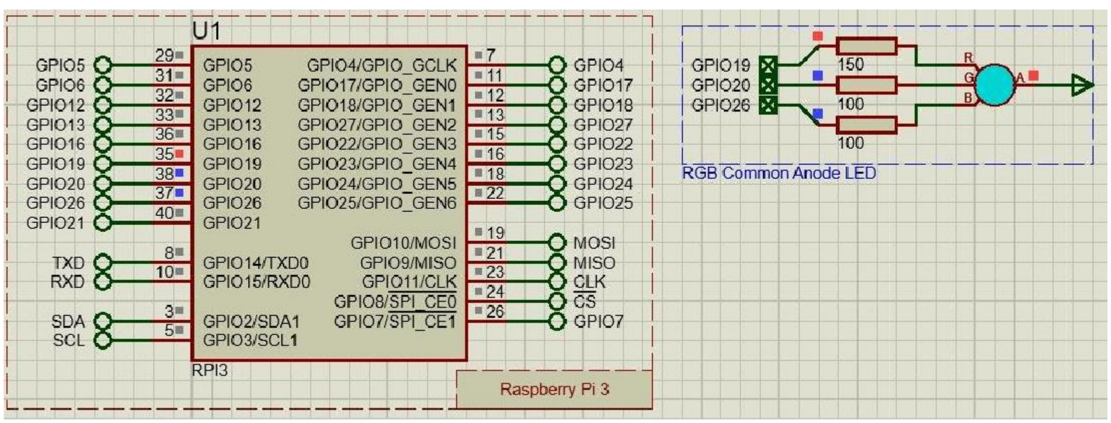


Figure of the led showing lightblue color



Conclusion: Hence we have programmed the RBG strip led for the observation of various colors used to identify the paths.

Practical 8

Aim: Create an obstacle avoidance behaviour for robot and test it.

Components: Arduino uno, Zumo robot

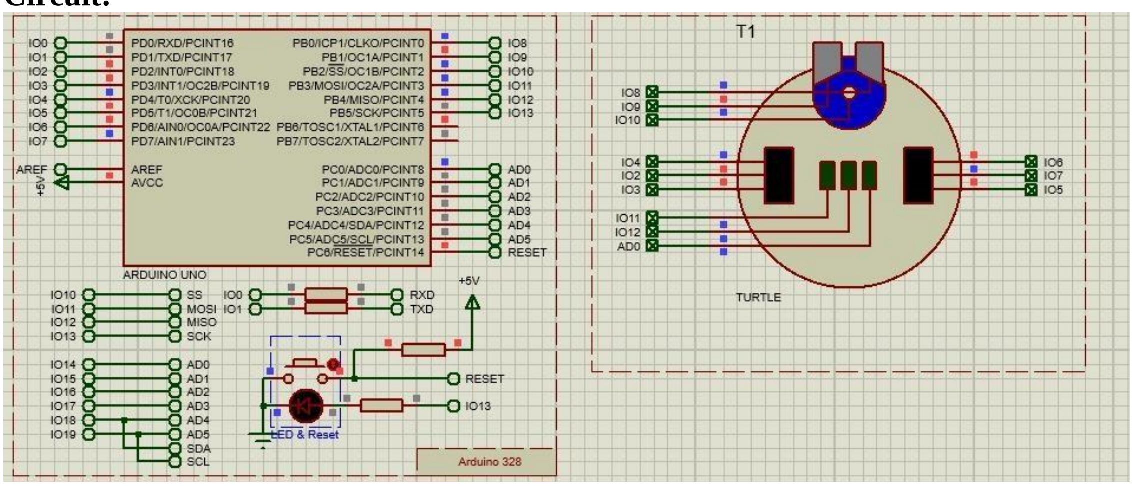
Theory: Description of Zumo robot- The Zumo robot for Arduino is an Arduino-controllable tracked robot platform. It includes two micro metal gearmotors coupled to a pair of silicone tracks, a stainless-steel bulldozer-style blade, an array of six infrared reflectance sensors for line following or edge detection, a buzzer for simple sounds and music, a 3-axis accelerometer, magnetometer, and gyro for detecting impacts and tracking orientation. The zumo is a more advanced turtle than the Funduino and can perform far better at line following and maze escape challenges but it does not have ultrasonic range finder and therefore is not as well suited to obstacle avoidance challenges.

Procedure:

To create and apply an environment for simulation (use sample Avoid Obstacles)

1) Draw the required route / obstacles in the graphics package of your choice. Remember that the scale is 1 pixel to 1 mm so drawing a 5-pixel wide line will equate to 5mm in the real world. Width of the line being followed can affect the algorithm (e.g., if all the sensors are never over the line) so it's important to give this some thought.
2) Save the graphic as a PNG file into the same directory as your Proteus project.
3) Edit the turtle component on your schematic and specify the graphic you have just saved as the obstacle map

Circuit:



Source code:

```
//---CONFIG_BEGIN---
#pragma GCC push_options
#pragma GCC optimize ("Os")

#include <core.h> // Required by cpu#include <cpu.h>
#include <TimerOne.h>
#include <Servo.h> // Required by T1: DRIVE#include
<Turtle.h>
```

```
#pragma GCC pop_options

// Peripheral ConstructorsCPU
&cpu = Cpu;
TimerOne &timer1 = Timer1;
TurtleDrive T1_DRIVE = TurtleDrive (2, 4, 3, 6, 7, 5);
TurtleSonarHead T1_SH = TurtleSonarHead (8, 9, 10); TurtleLineHunter T1_LH =
TurtleLineHunter (11, 12, A0);

void peripheral_setup () {
  T1_DRIVE.begin ();
  T1_SH.begin (); T1_LH.begin ();
}

void peripheral_loop() {
}
//---CONFIG_END--- //
Flowchart Variableslong
var_speed; long var_dir;
long var_count; long
var_range; long
var_fast; long
var_slow; long
var_tstart;long
var_tstop;

// Flowchart Routinesvoid
chart_SETUP() {
  var_speed=180,var_range=10,var_dir=0;
  T1_SH.setAngle(0); T1_SH.setRange(25);
  T1_DRIVE.forwards(var_speed);
}

void chart_LOOP() {
  if(!(T1_LH(0,0,0))) {
  if(T1_LH(1,1,1)) {
      chart_Correct();
      } else { if(T1_LH(0,1,1))
        {
        T1_DRIVE.drive(1,1,5*var_speed/4);
        T1_DRIVE.drive(2,1,var_speed/2); var_dir=10;
        chart_Avoid();
        } else { if(T1_LH(0,0,1))
          {
          T1_DRIVE.drive(1,1,5*var_speed/4);
          T1_DRIVE.drive(2,0,var_speed/5);
          var_dir=30;
```

```
        } else { if(T1_LH(1,1,0))
          {
            T1_DRIVE.drive(2,1,5*var_speed/4);
            T1_DRIVE.drive(1,1,var_speed/2); var_dir=-
            10;
            chart_Avoid();
          } else { if(T1_LH(1,0,0))
            {
              T1_DRIVE.drive(2,1,5*var_speed/4);
              T1_DRIVE.drive(1,0,var_speed/5); var_dir=-
              30;
            } else {
              if(T1_LH(-1,1,-1)) {
                T1_DRIVE.forwards(var_speed);
                var_dir=0;
                chart_Avoid();
            }
          }
        }
      }
    }
  }
 }
}

void chart_Correct() {
 var_count=0;
l3:;
   if(var_dir>0) { T1_DRIVE.drive(2,1,var_speed);
   T1_DRIVE.drive(1,0,var_speed/3);
 } else { if(var_dir<0) {
     T1_DRIVE.drive(1,1,var_speed);
     T1_DRIVE.drive(2,0,var_speed/3);
   }
   }
   delay(1);
   var_count=var_count+1;
   if(var_count<1000) {
     if (T1_LH(1,1,1)) goto l3;
   } else {
   T1_DRIVE.stop();
   var_dir=0;
 }
}

void chart_Avoid() { if(T1_SH(var_range,0)) {
   T1_DRIVE.backwards(2*var_speed/3);delay(250);
```

```
      T1_DRIVE.turn(80);
      do {
        delay(5);
    } while ((!(T1_SH(1.5*var_range,0))) == false);T1_DRIVE.stop();
    delay(500);
    T1_DRIVE.turn(80);
    var_tstart=cpu.millis();
    while (!(T1_SH(1.5*var_range,0))) {
    }
    var_tstop=cpu.millis(); var_count=(var_tstop-
    var_tstart)/10;T1_DRIVE.stop();
    delay(500);
    T1_DRIVE.turn(-80);
    while (var_count>0) {
        var_count=var_count-1;
        delay(5);
        }
    T1_DRIVE.backwards(2*var_speed/3);delay(300);
    T1_DRIVE.forwards(var_speed/2);
  }
}

// Entry Points and Interrupt Handlers
void setup () { peripheral_setup();   chart_SETUP(); }void loop () {
peripheral_loop();   chart_LOOP();
```

Output for obstacle avoidance using zumo robot:

Conclusion: Hence the obstacle is avoided using the Zumo robot

Practical 9

Aim: Detect faces with HAAR cascades

Code: #!pip install opencv_python import

cv2

#reading the image
img = cv2.imread("face.jpg")

#converting image to grayscale
gray_img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

#Loading the required haar-cascade.xml classifier file haar_cascade =
cv2.CascadeClassifier(cv2.data.haarcascades +"haarcascade_frontalface_default.xml")
eye_cascade = cv2.CascadeClassifier(cv2.data.haarcascades +"haarcascade_eye.xml")

faces_rect = haar_cascade.detectMultiScale(gray_img, 1.3, 5)eyes =
eye_cascade.detectMultiScale(gray_img)

```
for(x, y, w ,h) in faces_rect:
    cv2.rectangle(img, (x,y), (x+w, y+h), (0,255,0), 1)for(ex, ey, ew ,eh) in eyes:
        cv2.rectangle(img, (ex,ey), (ex+ew, ey+eh), (0,255,0), 1)
```

cv2.imshow('Detected faces', img)
cv2.waitKey(0)

Output: Hence the face detection is done using HAAR cascades in python

Practical 10

Aim: Using the robot to display its camera as a web app on a phone or desktop and then use camera to drive smart colour and face tracking behaviours.

Components: Proteus Simulator 8.9 and above, Lcd TFT, Button, Raspberry pi camera

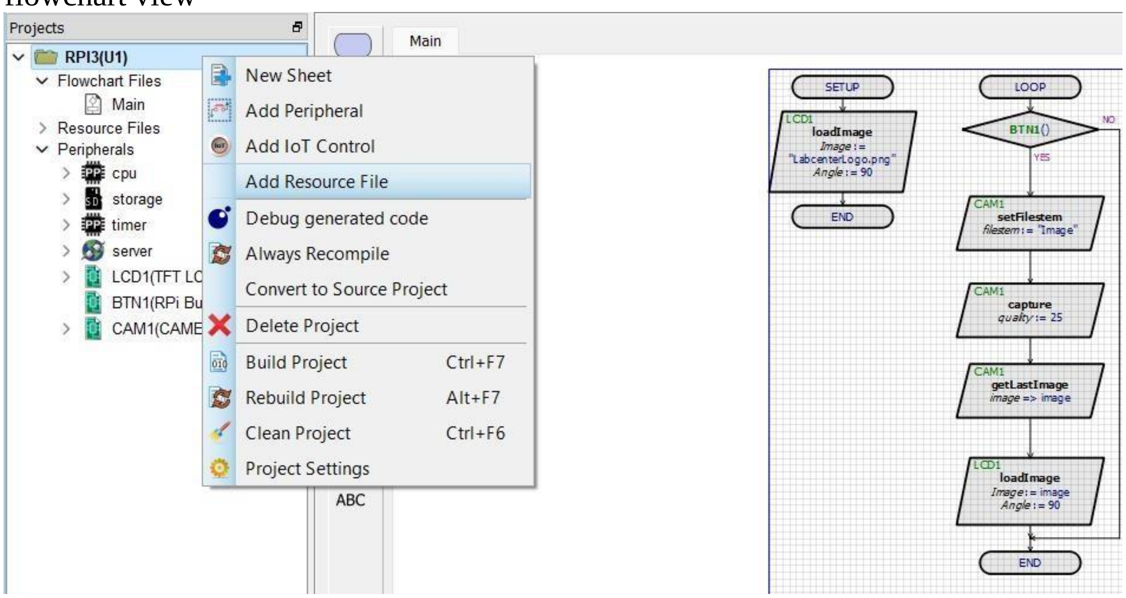
Procedure:

First the components from the library and place it in the schematic chart

Step I. Select new project from the tab, select flow chart project (Open sample and select TFT Display with Camera)

Step II.Create new folder and save the project by remaining as camera.psdrpj in proteus.

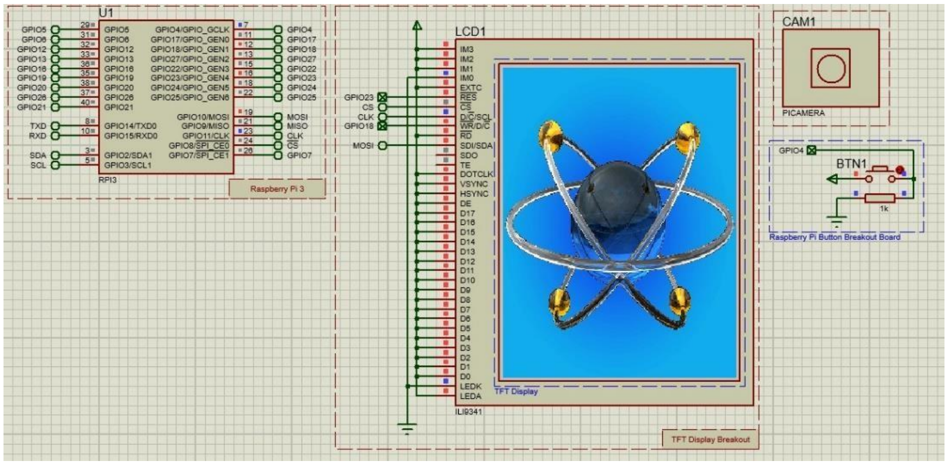
Step III. Select a picture and place it in the resource file by right clicking on raspberry pi in the flowchart view

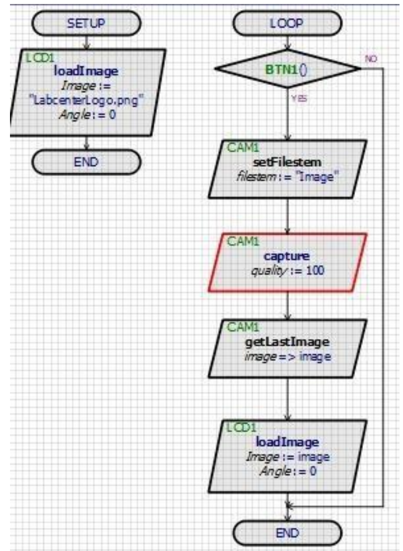


Step IV. Once you click on add resource it will take you to project folder place a bit map image in it. Example shown here is the Labcenterlogo.png

Save it and then run the simulation once you run the simulation you will see the output as shown below

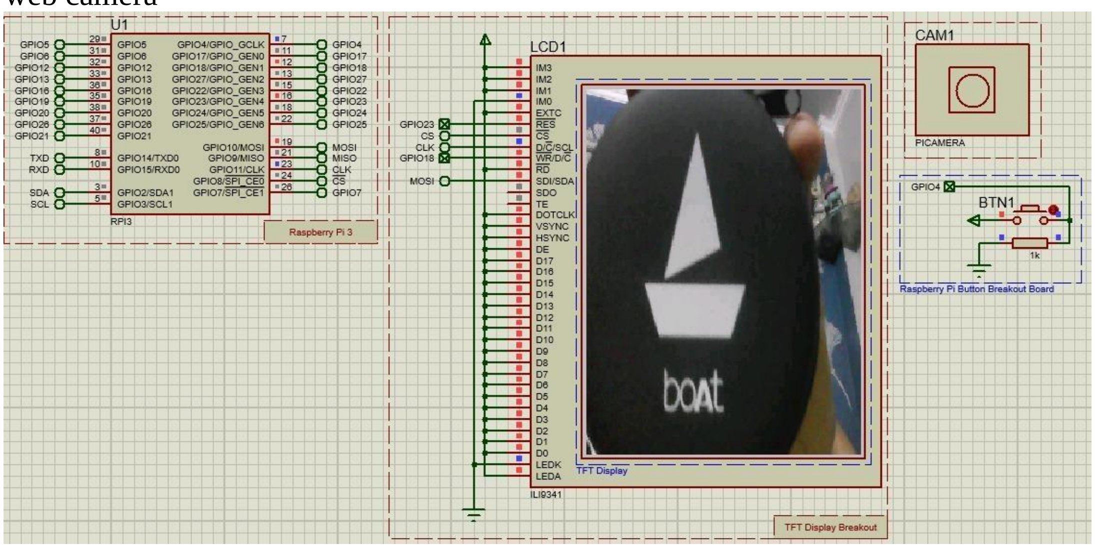
Before doing the above process complete the flow chart





Flowchart:

Step V. Once you click the button in the schematic view, we can see our image on the TFT LCD selected. For displaying your image, please keep the camera of the laptop on in case desktop use the web camera



The camera will click the image and display the real time image on the TFT display as shown above.

Conclusion: - Hence we have studied the camera function and displayed it using the webapp