UNIVERSITY OF MUMBAI

DEPARTMENT OF COMPUTER SCIENCE

M.SC (Computer Science)

CERTIFICATE

Certified that the work entered in this journal was done in the computer laboratory by the student

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Of the Class - MSc computer Science

First Year Sem 2

Semester during the year **2021-2022** in a Satisfactory manner.

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Practical No. 1

Aim: Design and implement basics embedded circuits

1. Automatic Alarm system- Alarm should get trigger by sensor
2. Timer based buzzer
3. Sensor based Counting device

Theory:

- Motion Detector: it is an electrical device that utilizes a sensor to detect nearby motion. Such a device is often integrated as a component of a system that automatically performs a task or alerts a user of motion in an area. They form a vital component of security, automated lighting control, home control, energy efficiency, and other useful systems
- Home Gateway: it is a small consumer-grade gateway which bridges network access between connected local area network (LAN) hosts to a wide area network (WAN) (such as the Internet) via a modem, or directly connects to a WAN (as in EttH), while routing. The WAN is a larger computer network, generally operated by an Internet service provider
- MCU Board: A microcontroller (MCU for microcontroller unit) is a small computer on a single metal-oxide-semiconductor (MOS) integrated circuit (IC) chip. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.
- Trip Wire: A tripwire is a passive triggering mechanism. Typically, a wire or cord is attached to a device for detecting or reacting to physical movement.

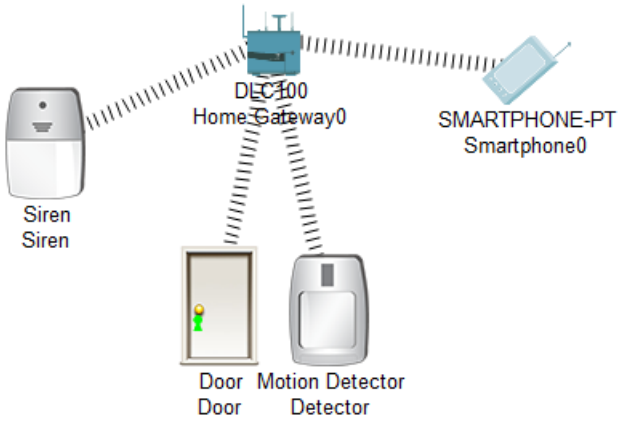
1. **Automatic Alarm system- Alarm should get trigger by sensor**

Apparatus:

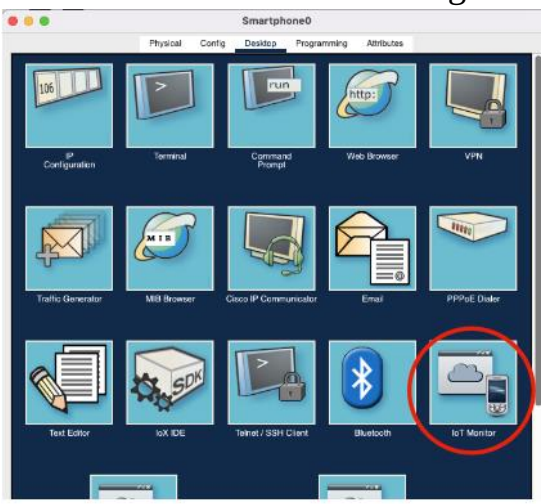
- Siren, HomeGateway, Motion Detector, Door, Smartphone.

Procedure:

1. Open Cisco Packet Tracer and add all components mentioned in the apparatus section and rename them accordingly

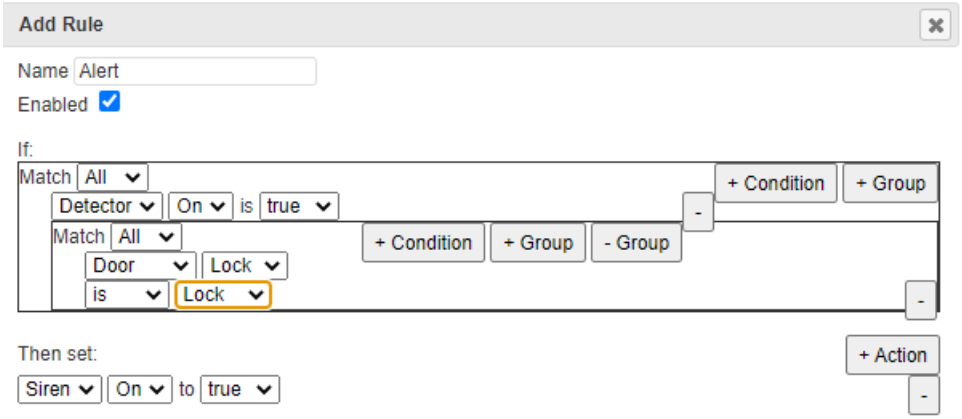


2. Click on all components, go to config and set IoT Server to Home Gateway. For the smartphone, go to config, then wireless and set the SSID to 'HomeGateway', all components should be connected to the Home Gateway as shown above
3. Click on the SmartPhone and go to Desktop and click to IoT Monitor

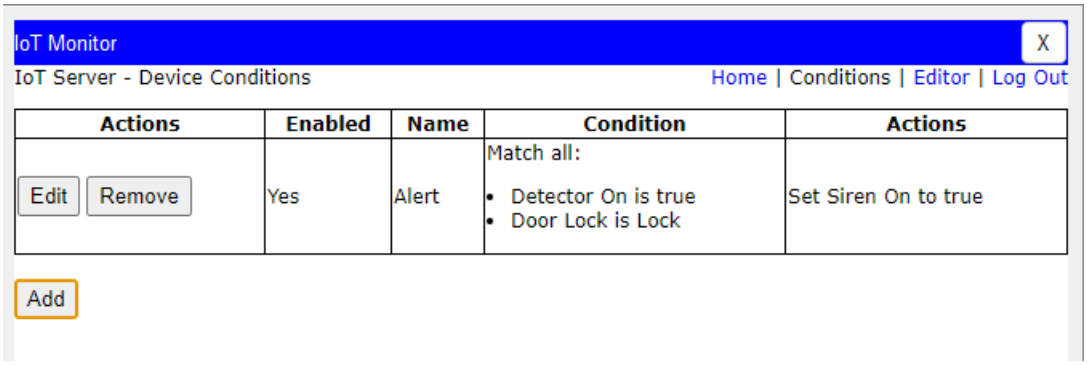


4. Click on Login, all devices connected to the HomeGateway should be visible

5. Click on conditions in the top right and add condition as follows: If motion detector is true and door lock is lock then set Siren on to true



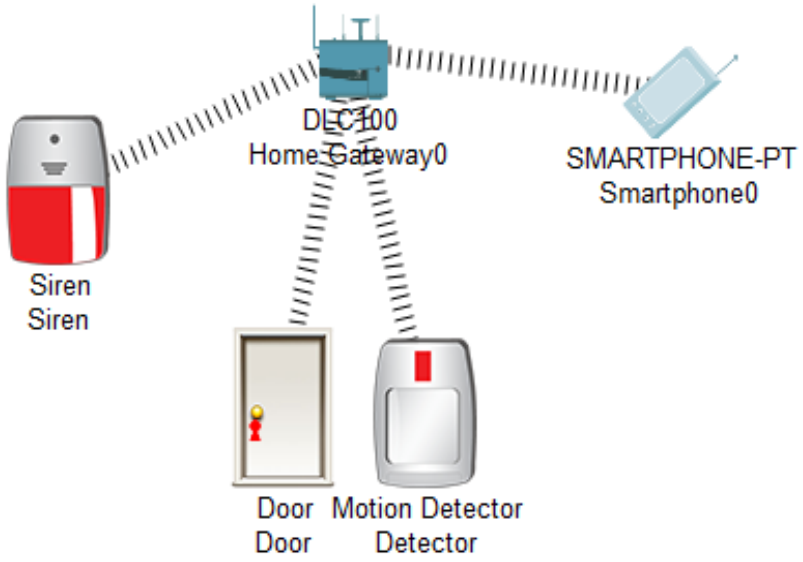
6. Click OK, created condition should be similar to the one shown below



7. In IoT Monitor, make sure the door is locked

8. Test the alert by hovering the mouse over the motion detector sensor while holding alt on keyboard. The siren should go off when motion detector senses motion.

Output:


DLC100
Home Gateway0
SMARTPHONE-PT
Smartphone0
Siren
Siren
Door
Door
Motion Detector
Detector

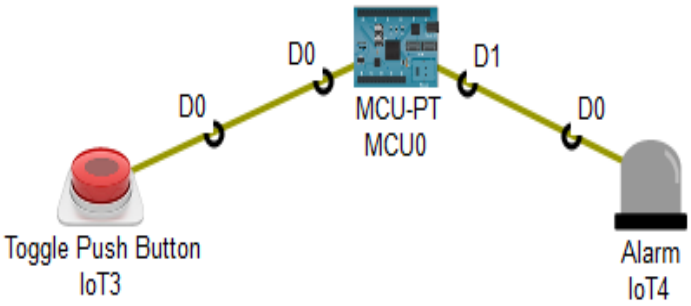
2. **Timer based buzzer**

Apparatus:

- Toggle Push Button, MCU Board, Alarm, IoT cables

Procedure:

1. Add all components from the apparatus section on the cisco packet tracer simulating area
2. Connect the Toggle Push Button and Alarm to the MCU Board as shown below

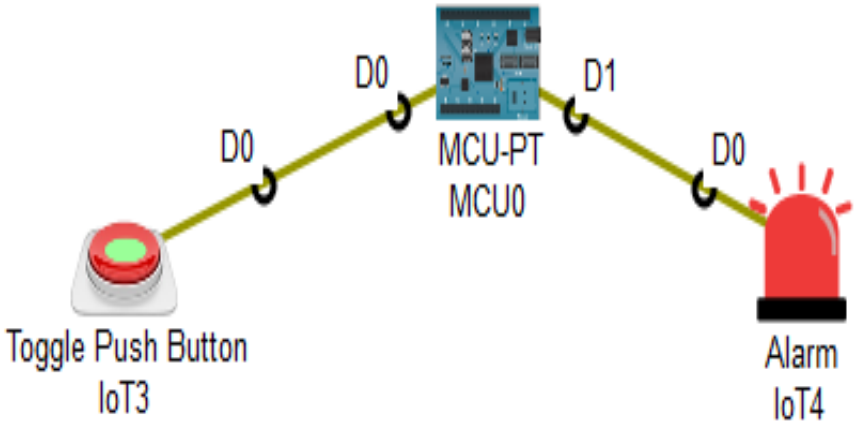


3. Click on MCU Board, go to programming, create a new empty python project and open main.py
4. Type the following code and run it

```
from gpio import *
from time import *
pinMode(0, INPUT)
pinMode(0, OUTPUT)
while True:
    if digitalRead(0)== HIGH:
        sleep(5)
        digitalWrite (1, 1023)
    else:
        digitalWrite (1, 0)
```

5. Back on the simulating area, press ALT key and push the toggle button, the alarm state should change in 5 seconds

Output:



3. **Sensor based counting device**

Apparatus:

- Trip Wire, MCU Board, IoT cables

Procedure:

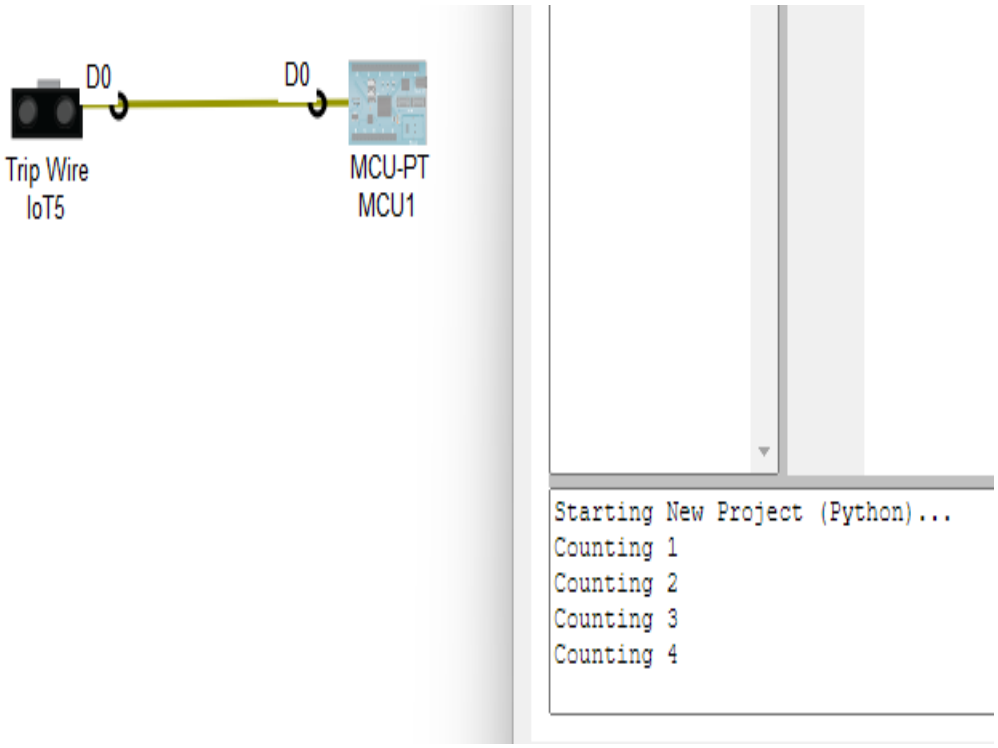
1. Add the mentioned components and connect them using IoT cables as shown below

2. Click on MCU Board, go to programming, create a new python project and open main.py
3. Type the following code and run it

```
from gpio import *
from time import *

count = 0

pinMode(0, INPUT)
pinMode(0, OUTPUT)

while True:
   if digitalRead(0) == HIGH:
      count = count + 1
      print("Counting " + str(count))
      sleep(0.3)
```

4. Back on the simulating area, press the ALT key and move the cursor over the trip wire to see the count increase in the console of the programming window

Output:


D0
D0
Trip Wire
IoT5
MCU-PT
MCU1
Starting New Project (Python)...
Counting 1
Counting 2
Counting 3
Counting 4

Practical No. 2

Aim: Demonstrate communication between two embedded devices using UART port

Theory:

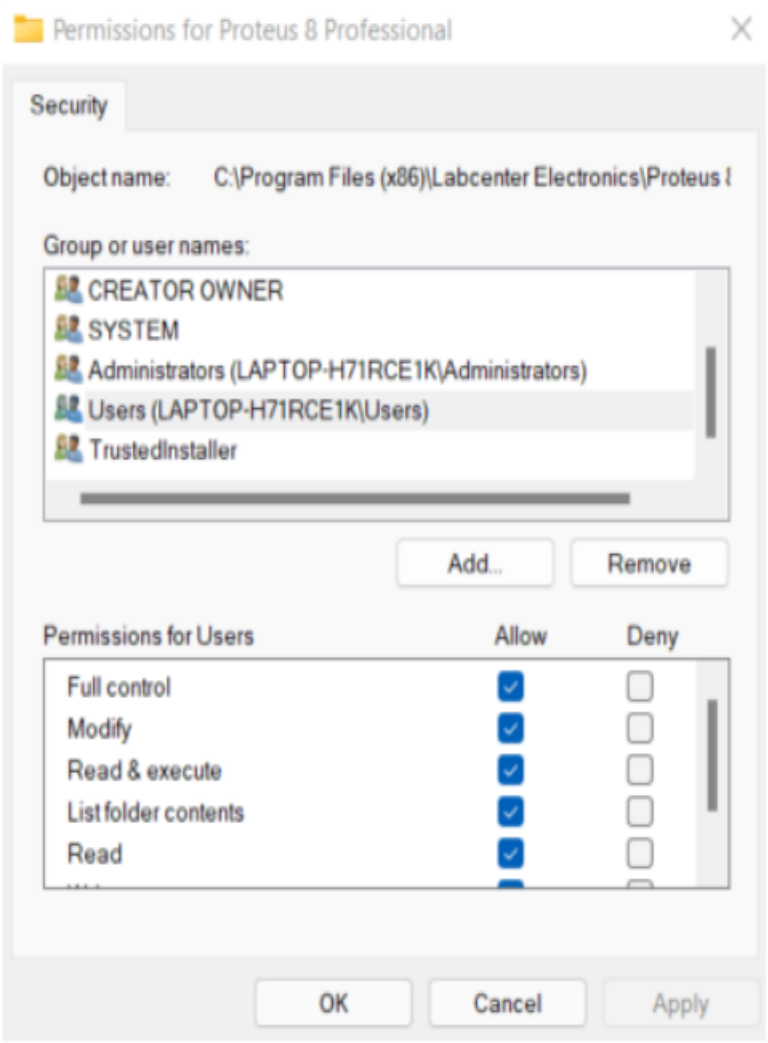
- UART (stands for Universal Asynchronous Reception and Transmission). It is a simple serial communication protocol that allows the host to communicate with the other devices. It has two data lines, one to transmit (TX) and another to receive (RX). For different embedded devices, you will need to check on the datasheets to understand which pins can be used for UART.

Apparatus:

- Proteus 8, Arduino IDE, Arduino UNO Library, Virtual Terminal

Prerequisites:

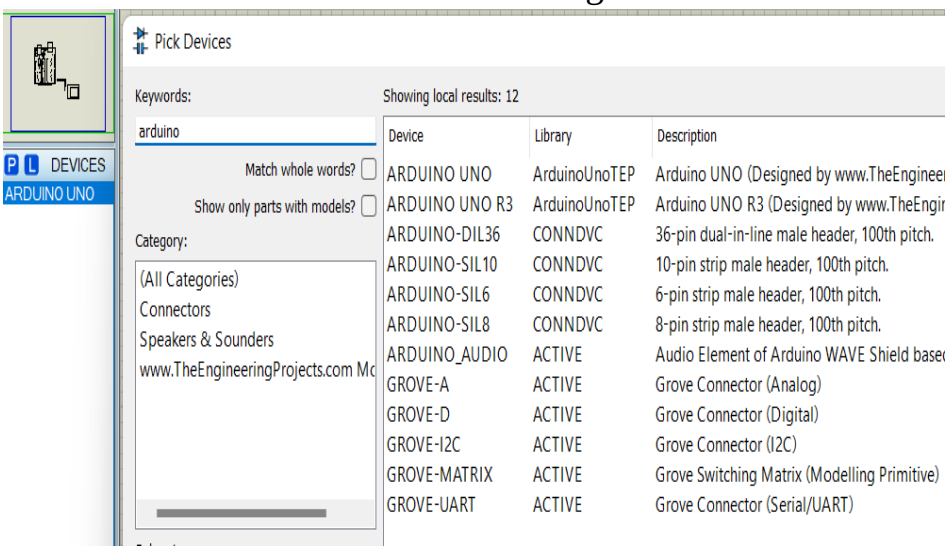
- For this practical, Proteus 8 will be used, if no libraries are found on its pick a device button then perform the following steps
- go to c: program files x86 Labcenter Electronics
- Here right click on folder “Proteus 8 professional” now properties window will open up now go to security menu of properties window.
- Now here click on edit button scroll down the groups and user name to “users(Laptop)”
- And below in permissions give all permissions and then click.
- Now u can see u are able to open pick devices window of proteus software.



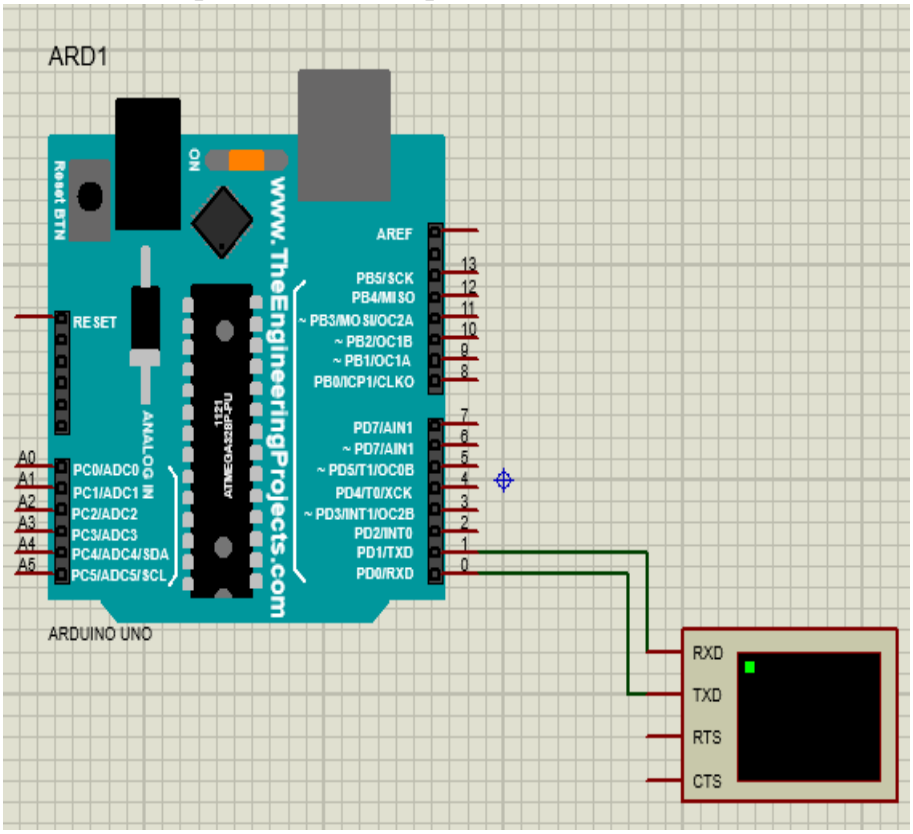
- To add Arduino UNO in proteus 8, go to the following URL and download the zip file
  https://www.theengineeringprojects.com/2015/12/arduino-uno-library-proteus.html
- Unzip the downloaded file, copy the 2 files present in the extracted folder and paste them in the following directory
  "C:\Program Files (x86)\Labcenter Electronics\Proteus 8 Professional\data\LIBRARY"
- Download the Arduino IDE from the internet

Procedure:

1. Open Proteus 8, click on the P button (Pick a device), search for Arduino and add Arduino UNO to the simulating area



2. Go the virtual instruments mode on the left side menu and add virtual terminal to the simulating area
3. Click on the pins of the components and connect them as shown below



4. Now open Arduino IDE, go to file menu > Examples > Basic > DigitalReadSerial this will open up the following code

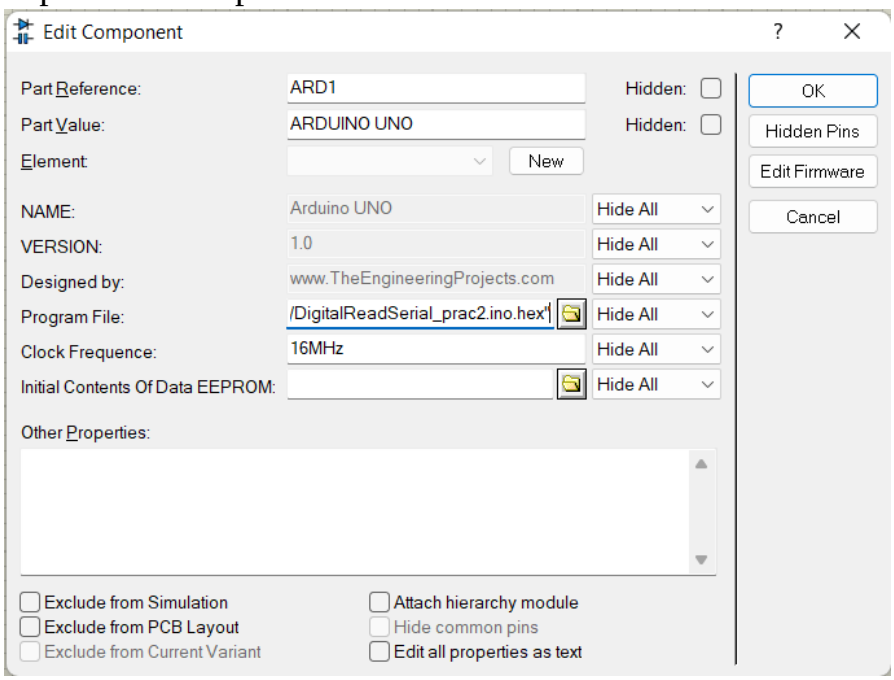
DigitalReadSerial_prac2 | Arduino 1.8.19

File Edit Sketch Tools Help

DigitalReadSerial_prac2

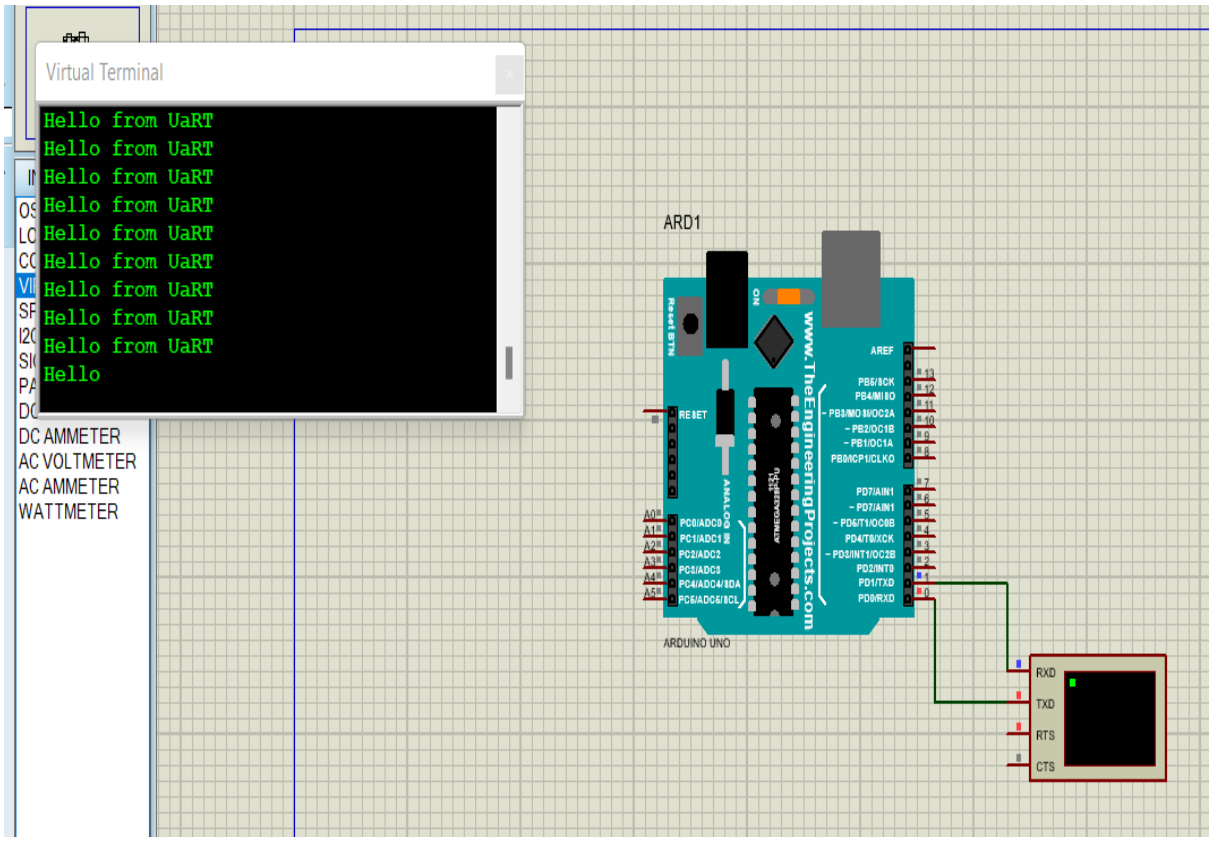
```
// the setup routine runs once when you press reset:
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
  // make the pushbutton's pin an input:
}

// the loop routine runs over and over again forever:
void loop() {
  // read the input pin:

  // print out the state of the button:
  Serial.println("Hello from UaRT");
  delay(1);        // delay in between reads for stability
}
```

5. Run this file and copy the hex file path from the console
   Note: if .hex path is not shown then click on file preferences and select the compile and upload checkboxes and click on ok and re run the code.
6. Now on Proteus 8, click on Arduino and in program file field, paste the copied hex file path



7. Now click on the play button in the left bottom of the window to get the output

Output:


Virtual Terminal
Hello from UaRT
Hello from UaRT
Hello from UaRT
Hello from UaRT
Hello from UaRT
Hello from UaRT
Hello from UaRT
Hello from UaRT
Hello from UaRT
Hello
DC AMMETER
AC VOLTMETER
AC AMMETER
WATTMETER
ARD1
www.TheEngineeringProjects.com
ARDUINO UNO
RXD
TXD
RTS
CTS

Practical No. 3

Aim: Built an IoT system to send ticket before entering the bus

Theory:

- RFID: Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number can be used to track inventory goods.

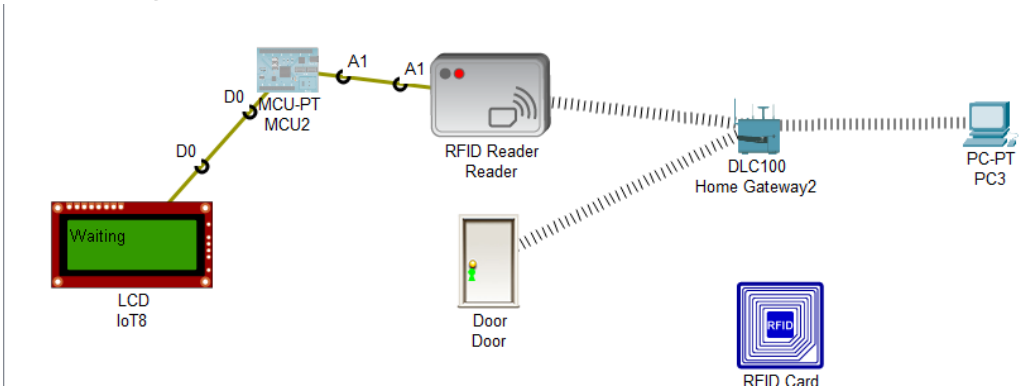
Apparatus:

- RFID card, RFID Reader, MCU Board, LCD Display, Door, Home Gateway, PC

Procedure:

1. We simulate the back door of the bus where the passengers get onboard for this practical which will be conducted in Cisco Packet Tracer
2. Drag and drop all components from apparatus section to the simulating area
3. Connect LCD Display to MCU Board with IoT cables on the ‘D0’ port for both sides
4. Connect RFID Reader to MCU Board with IoT cables on the ‘A1’ port for both sides. If A1 port is not available open RFID Reader, go to I/O config and set Analog ports to 2
5. Now connect RFID Reader to Home Gateway by changing the network adapter in I/O config of RFID Reader to PT-IOT-1W-AC and it should connect automatically
6. Connect the PC to Home Gateway wirelessly by replacing its network component with a wireless one which are any of the ones shown below in the physical section of PC

7. Your things network should be similar to this



8. Go to config of PC and in wireless set the SSID to 'HomeGateway'
9. Now on MCU Board create an empty python project and type the following code and run it

```
chanfrom gpio import *
from time import *
from ioeclient import IoEClient

def main():
	pinMode(0, OUT)
	pinMode(1, IN)

	while True:
		customWrite(0, "Waiting")
		rfid = analogRead(A1)

		if(rfid == 0):
			customWrite(0, "Success")
		delay(3000)

if __name__ == "__main__":
	main()
```

10. Now in RFID Reader, go to programming and make the following changes in the loop function of main.py

    Change setState() parameter from 2 to 1

    Add the following line of code above delay(DELAY_TIME)

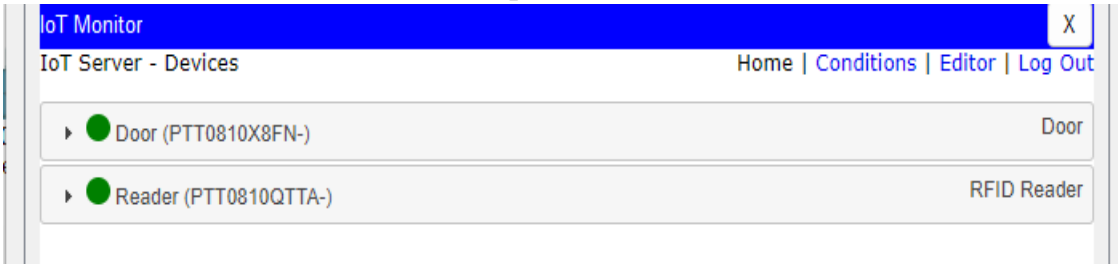
```
if cardID == '1001':
		setState(0)
	else:
		setState(1)
```

    the loop function should look like this:

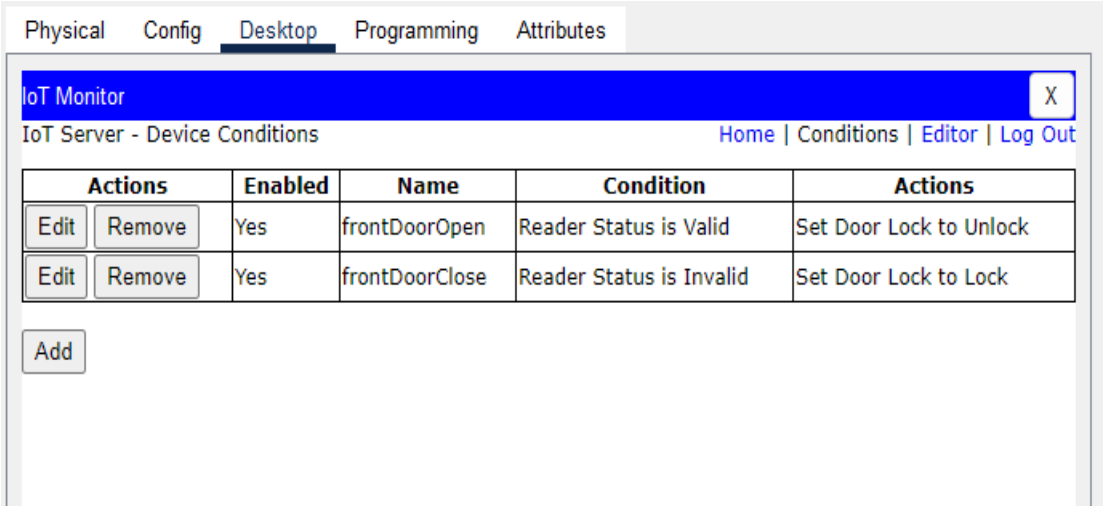
Reload Copy Paste Undo Redo Find Replace Zoom: + -

```
def loop ():
    global cardID, lastCardID, state
    devices = devicesAt(getCenterX(), getCenterY(), X_READ_DI
    found = False        # var found
    for i in xrange(0, len(devices)) :
        if devices[i] is getName():
            continue

        cardID = getDeviceProperty(devices[i], 'CardID')
        found = True
        break


    if not found:
        cardID = lastCardID = 0
        setState(1)
    else:
        if lastCardID != cardID:
            lastCardID = cardID
            sendReport()
    if cardID == '1001':
        setState(0)
    else:
        setState(1)

    delay(DELAY_TIME)
```

11. Now set the IoT Server of all components to Home Gateway and in PC IoT Monitor make sure these components are visible

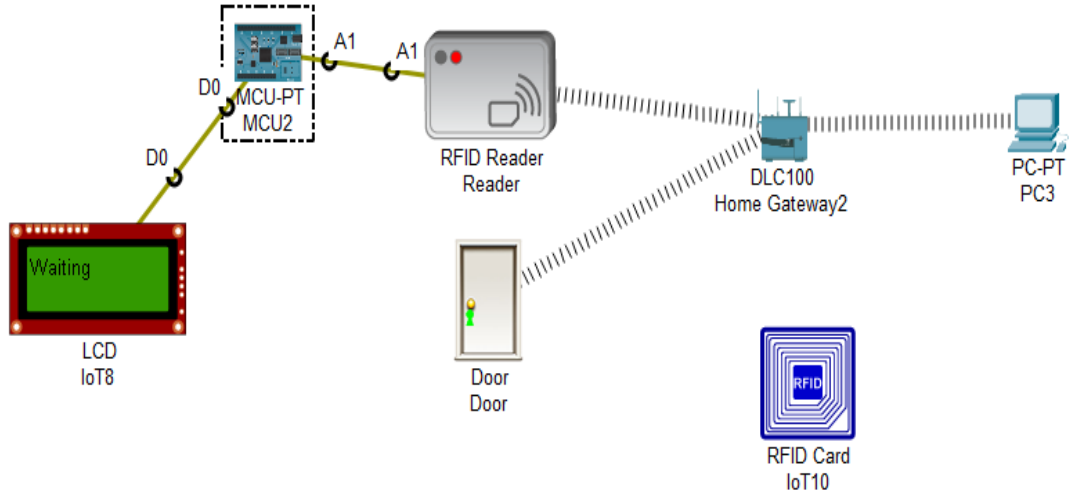


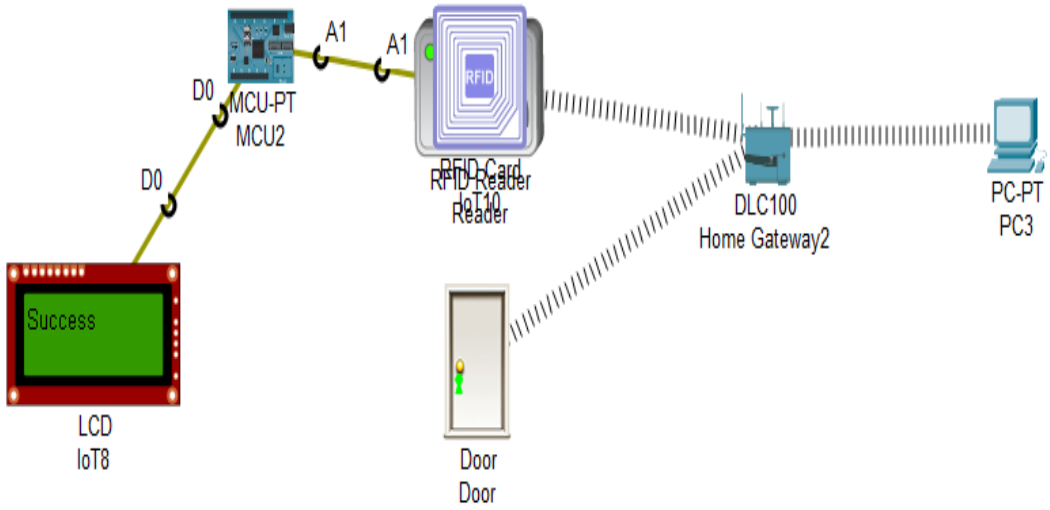
12. Now create the following functions in PC



13. Now Drag and hover the RFID card over the reader while pressing the ALT key to get the output

Output:


A1
A1
D0
MCU-PT
MCU2
D0
RFID Reader
Reader
DLC100
Home Gateway2
PC-PT
PC3
Waiting
LCD
IoT8
Door
Door
RFID
RFID Card
IoT10


A1
A1
D0
MCU-PT
MCU2
D0
RFID
RFID Card
IoT10
Reader
DLC100
Home Gateway2
PC-PT
PC3
Success
LCD
IoT8
Door
Door

Practical No. 4

Aim: Develop an IoT application that will raise an alarm whenever with going to rain outside based on the weather prediction data

Theory:

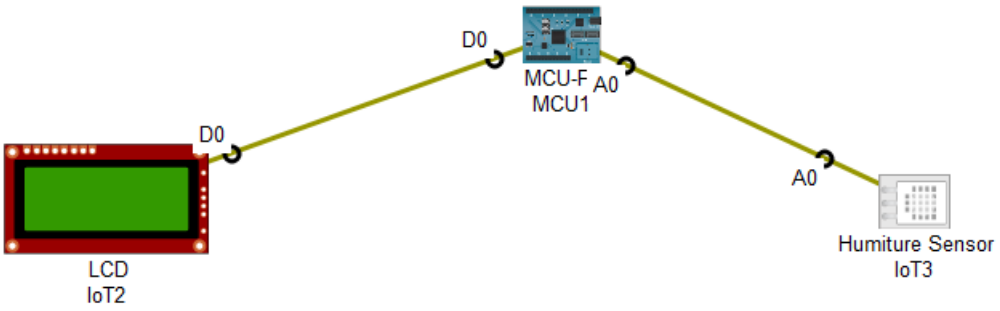
- Humidity is the concentration of water vapour present in the air. Water vapor, the gaseous state of water, is generally invisible to the human eye. Humidity indicates the likelihood for precipitation, dew, or fog to be present. Humidity depends on the temperature and pressure of the system of interest.
- Humidity value : - when the relative humidity is greater than about 70%. Rain. Often, rain will be falling from clouds where the humidity is 100% into air with a lower humidity. For example, it can rain at a ground humidity of 60%, but over time, the humidity will increase.

Apparatus:

- LCD, MCU Board, Humiture sensor

Procedure:

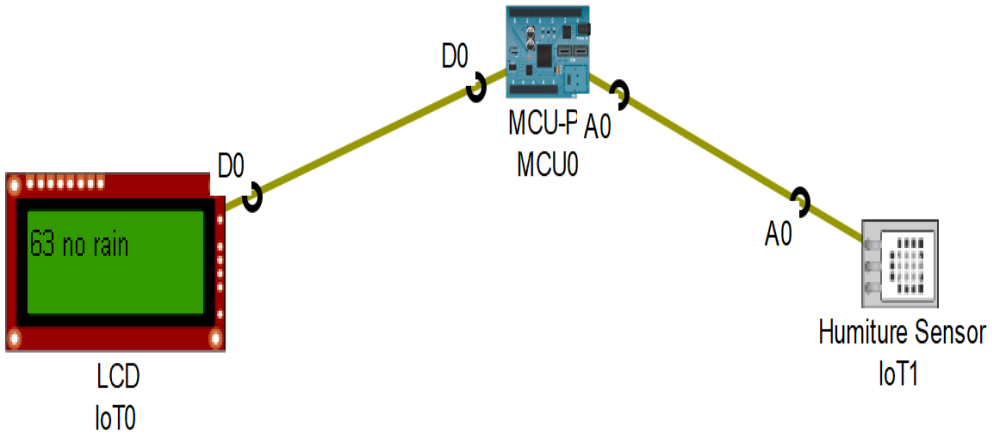
1. Open Cisco Packet Tracer, drag and drop the following components to the simulating area
   - LCD
   - MCU Board
   - Humiture Sensor
2. Connect LCD to the MCU Board with IoT custom cables on the D0 port
3. Connect Humiture Sensor to the MCU Board with IoT custom cables on the A0 port
4. The circuit should look similar to the image below



5. Now click on the MCU Board and in the programming tab create a new empty javascript project
6. Type the following code and run it

```
function getSensorData()
{
  return Math.floor(map(analogRead(A0), 0, 1023, 0, 100) + 0.5);
}

function setup() {
  attachInterrupt(A0, function() {
        processData(getSensorData());
  });
}


function processData(data) {
  if(data > 90) {
        customWrite(0, data + " going to rain");
  }else {
        customWrite(0, data + " no rain");
  }
}
```

Output:



Practical No. 5

Aim: Deploy an IoT application which will alert you by beeping or vibrating your phone whenever you get someone call your name.

Theory:

- Vibration can be defined as the mechanical oscillation about an equilibrium position of a machine or component or simply the back and forth motion of a machine or component.

Apparatus:

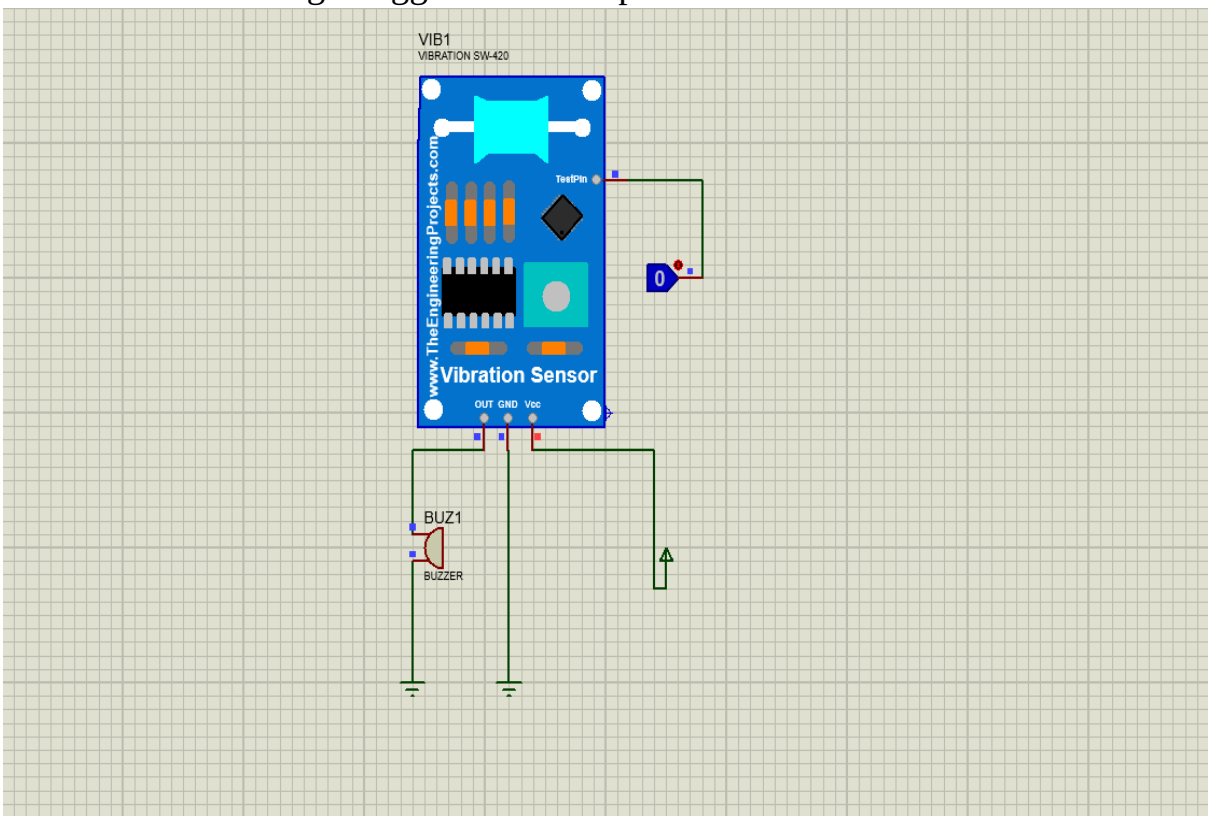
- Vibration Sensor (Vibration SW-420), LED-yellow, Logic toggle, GROUND, POWER

Prerequisites:

- If the vibration sensor library is not available in Proteus already then extract the downloaded vibration sensor .rar file, copy all the files and paste in `program files (x86) > labcenter electronics > proteus > data > library`

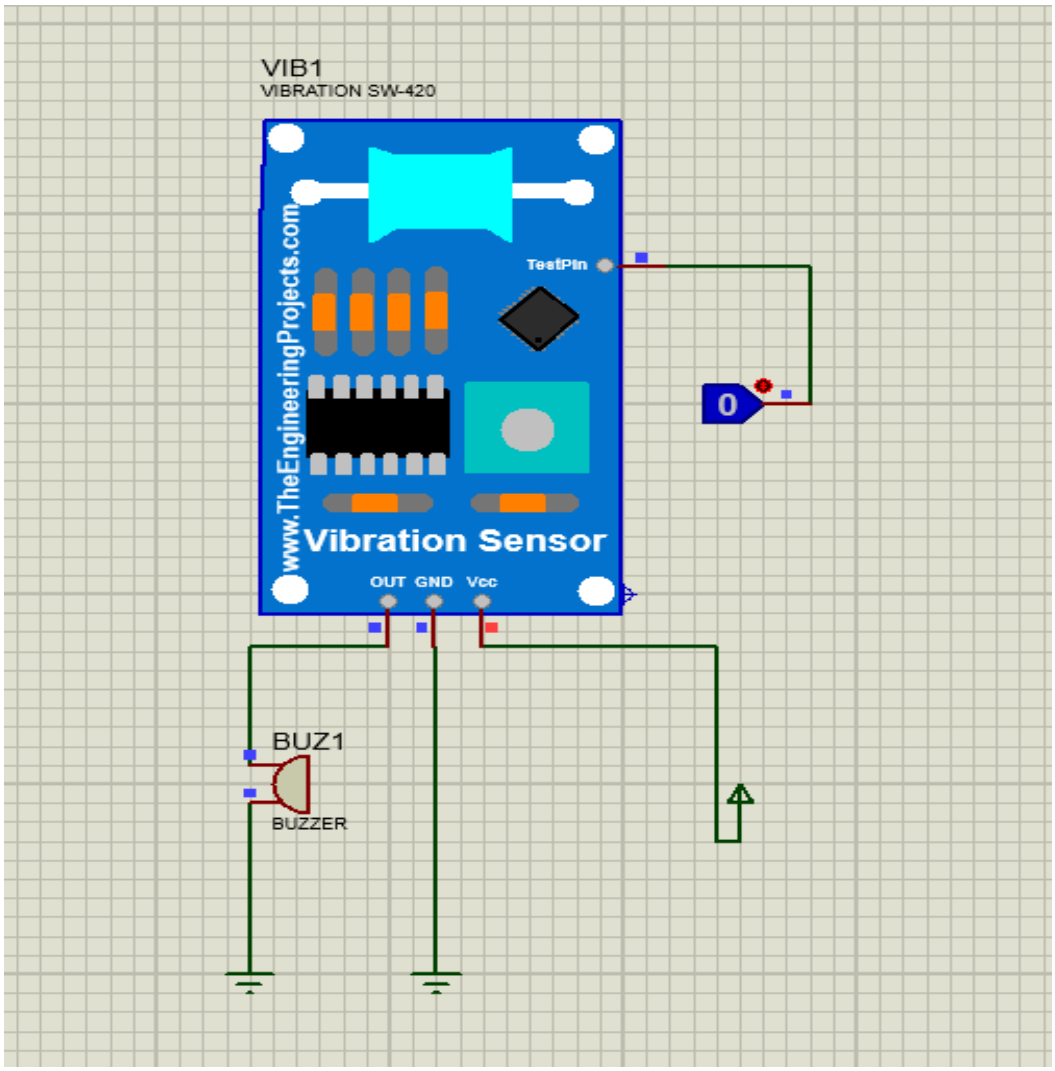
Procedure:

1. In Proteus 8, import the required components from pick a device, i.e. the vibration sensor and logic toggle
2. Drag and drop those components to the simulating area
3. Go to the Terminal section and drag 2 GROUND and a POWER component
4. Connect the GND of vibration sensor board to the GROUND and POWER to the Vcc
5. Drag the buzzer and connect one of its pin to OUT of vibration board and the other pin of buzzer to the 2nd GROUND
6. Now connect the Logic toggle to the test pin of vibration sensor



7. The circuit should be similar to the image above
8. Load the Hex file by clicking on vibration sensor and browse to where the HEX file is located and press play
9. Click on the toggle button to hear the buzzer sound

Output:


VIB1
VIBRATION SW-420
www.TheEngineeringProjects.com
TestPin
0
Vibration Sensor
OUT GND Vcc
BUZ1
BUZZER

Practical No. 6

Aim: Develop an IoT application for monitoring water levels in tanks and automatically start the motor to fill the tank if the level goes below the critical level.

Theory:

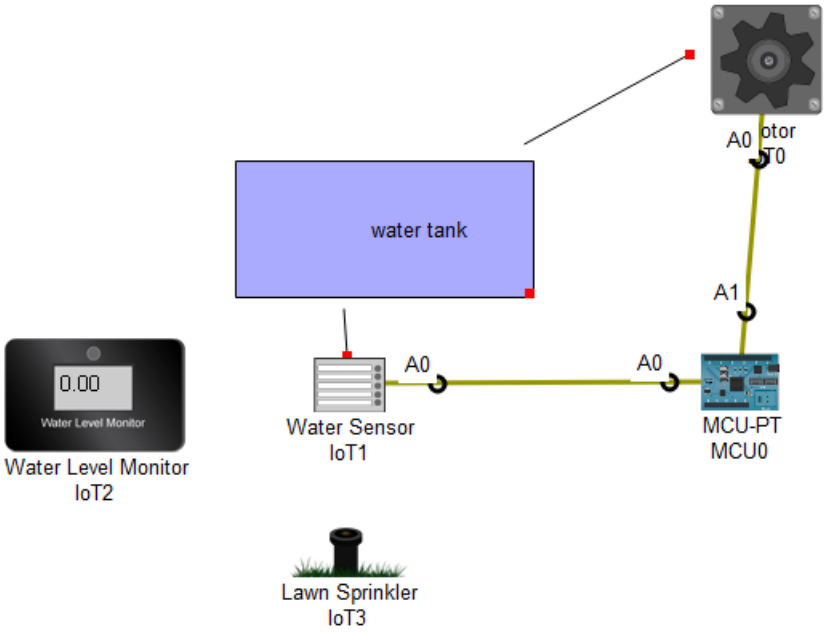
- Level sensors detect the level of liquids and other fluids and fluidized solids, including slurries, granular materials, and powders that exhibit an upper free surface. Substances that flow become essentially horizontal in their containers (or other physical boundaries) because of gravity whereas most bulk solids pile at an angle of repose to a peak. The substance to be measured can be inside a container or can be in its natural form (e.g., a river or a lake). The level measurement can be either continuous or point values. Continuous level sensors measure level within a specified range and determine the exact amount of substance in a certain place, while point-level sensors only indicate whether the substance is above or below the sensing point. Generally the latter detect levels that are excessively high or low.

Apparatus:

- Motor, MCU Board, Water level sensor, Water level monitor, IoT cables

Procedure:

1. Open Cisco Packet Tracer and drop the components mentioned in the Apparatus section to the simulating area. It should look similar to this

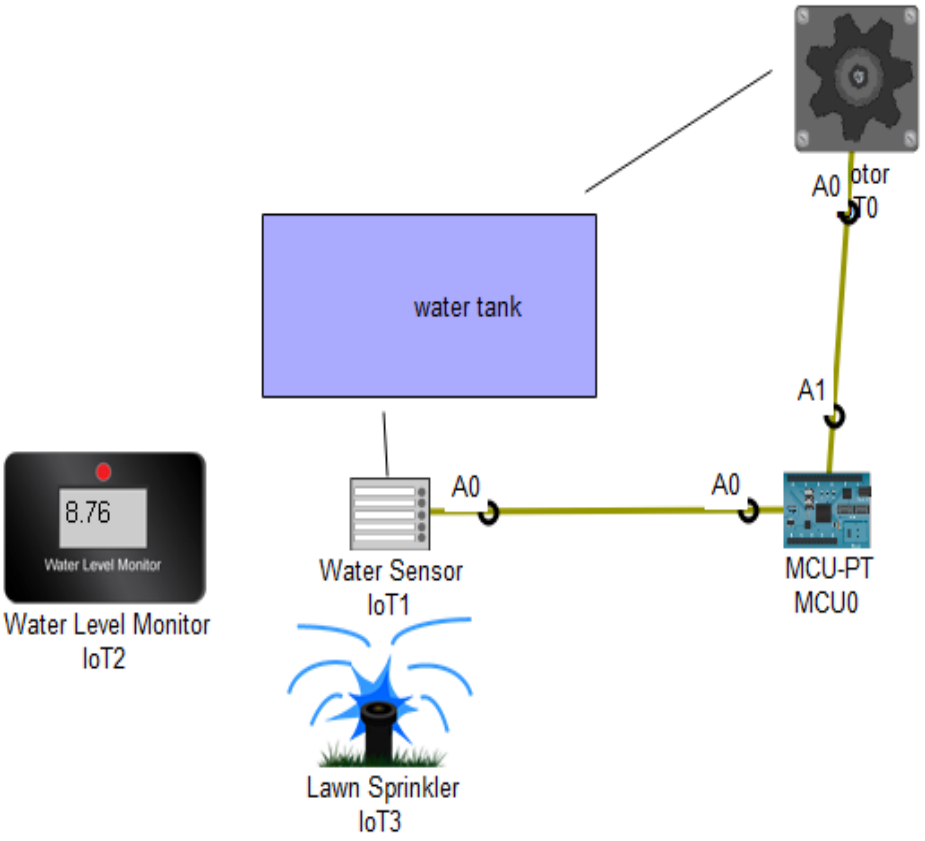


2. The water tank and those connections around it is just a rectangle and 2 lines, totally unnecessary
3. Now go to programming in MCU Board and create a new python empty project and type the following code and run it

```
from gpio import *
from time import *

while True:
          water_level = analogRead(A0)

          if water_level < 400:
           digitalWrite(A1, HIGH)
          else:
           digitalWrite(A1, LOW)
          sleep(0.3)
```

4. Press on lawn sprinkler while holding the ALT key to turn it on and bring it close to the water level sensor
5. Once the water level value on the monitor rises enough the motor will stop and the water levels go down again if you move the lawn sprinkler away

Output:


otor
A0
T0
water tank
A1
A0
A0
8.76
Water Level Monitor
Water Level Monitor
IoT2
Water Sensor
IoT1
MCU-PT
MCU0
Lawn Sprinkler
IoT3

Practical No. 7

Aim: Develop an IoT module to which measure the intensity of light and send the same to your PC/ Phone

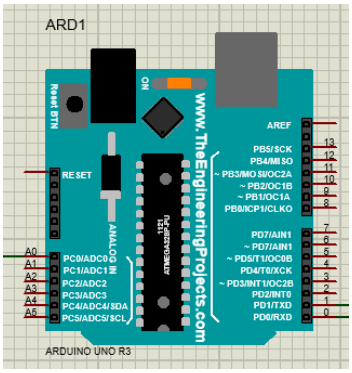
Theory:

- A photoresistor (also known as a Photocell, or light-dependent resistor, LDR, or photo-conductive cell) is a passive component that decreases resistance with respect to receiving luminosity (light) on the component's sensitive surface. The resistance of a photoresistor decreases with increase in incident l intensity; in other words, it exhibits photoconductivity.

Apparatus:

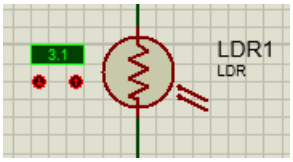
- Arduino UNO R3

  Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. Arduino UNO features AVR microcontroller Atmega328, 6 analogue input pins, and 14 digital I/O pins out of which 6 are used as PWM output.



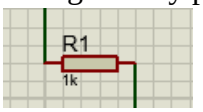
- Photoresistor / LDR

  Photoresistors are also sometimes referred as LDR (Light Dependent Resistor), semiconductor photoresistor, photoconductor, or photocell. Photoresistor changes its resistance only when it is exposed to light. In other words, the flow of electric current through the photoresistor increases when the intensity of light increases.



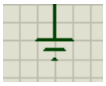
- Resistor (MINRES1K)

  The main purpose of resistor is to reduce the current flow and to lower the voltage in any particular portion of the circuit.



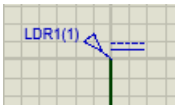
- GROUND

  Grounding something simply means connecting it to ground. And in electronics, ground is just a name we give to a certain point in the circuit. For example, in a circuit with one battery (with a positive and a negative terminal), we usually refer to the negative terminal as ground.



- DC Power

  Direct current (DC) is one-directional flow of electric charge. An electrochemical cell is a prime example of DC power. Direct current may flow through a conductor such as a wire but can also flow through semiconductors and insulators.



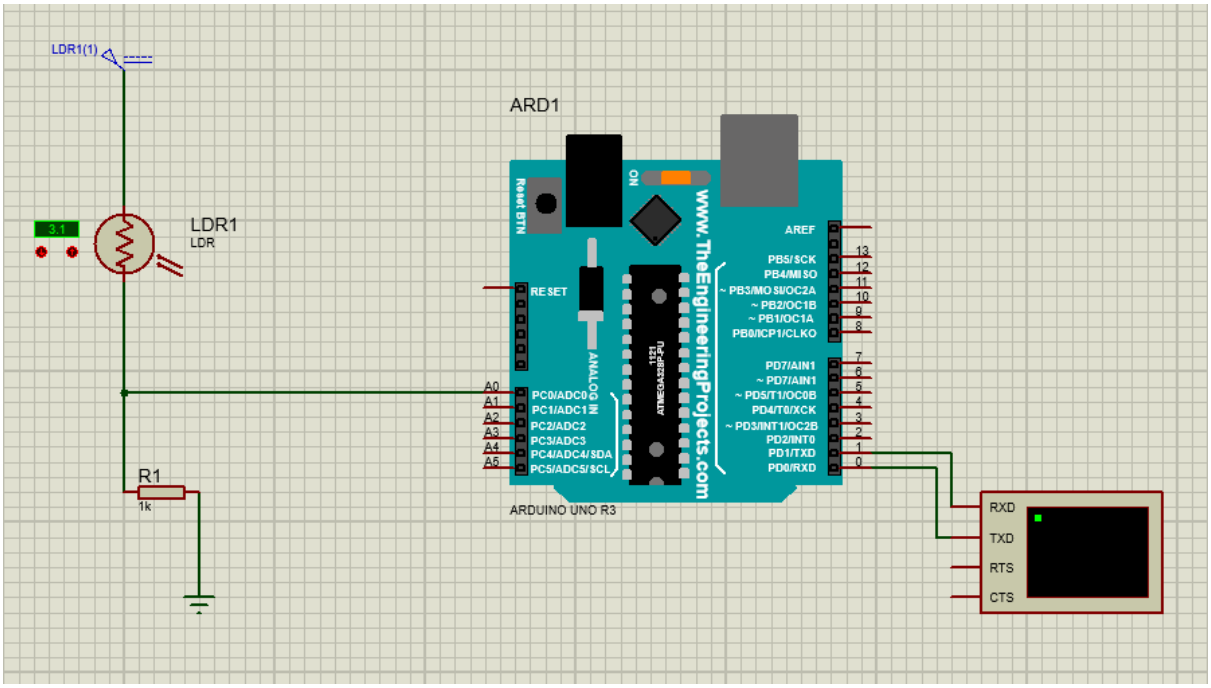
Procedure:

- *Prerequisites*
    1. Proteus 8 software
    2. Arduino IDE app
    3. Arduino UNO R3 library from https://www.theengineeringprojects.com/2015/12/arduino-uno-library-proteus.html

1. Install all softwares and required libraries from the prerequisite section
2. For importing of library, extract the downloaded .rar file from the given link > Copy both files from it > paste it in the following directory

    ```
    C:\Program Files (x86)\Labcenter Electronics\Proteus 8 Professional\LIBRARY
    ```

3. Open Proteus 8 and create a new project with all the default options selected
4. Once the schematic capture window is visible, click on the component mode on the left pane
5. Click on P (Pick a device), search for the following components on the new window, double click on them and click OK; to find them on your working window
    UNO R3
    LDR
    MINRES1K
6. Now click on Generators in the left pane and select DC add it to simulating area
7. Similarly add GROUND from the left pane in terminals section
8. Connect the DC to first terminal of LDR
9. The second terminal of LDR to the Analog A0 port of the Arduino board and the first terminal of the resistor to the same
10. Connect the second terminal of the resistor to the GROUND
11. To supply some power to the circuit, click on the DC power and change the value of the voltage field to 5
12. From the left pane, select the virtual terminal from the virtual instruments mode and add it to the simulating area
13. Connect the RXD pin of the terminal to the PD1/TXD port in Arduino and TXD pin to PD0/RXD
14. The circuit should be similar to the below image



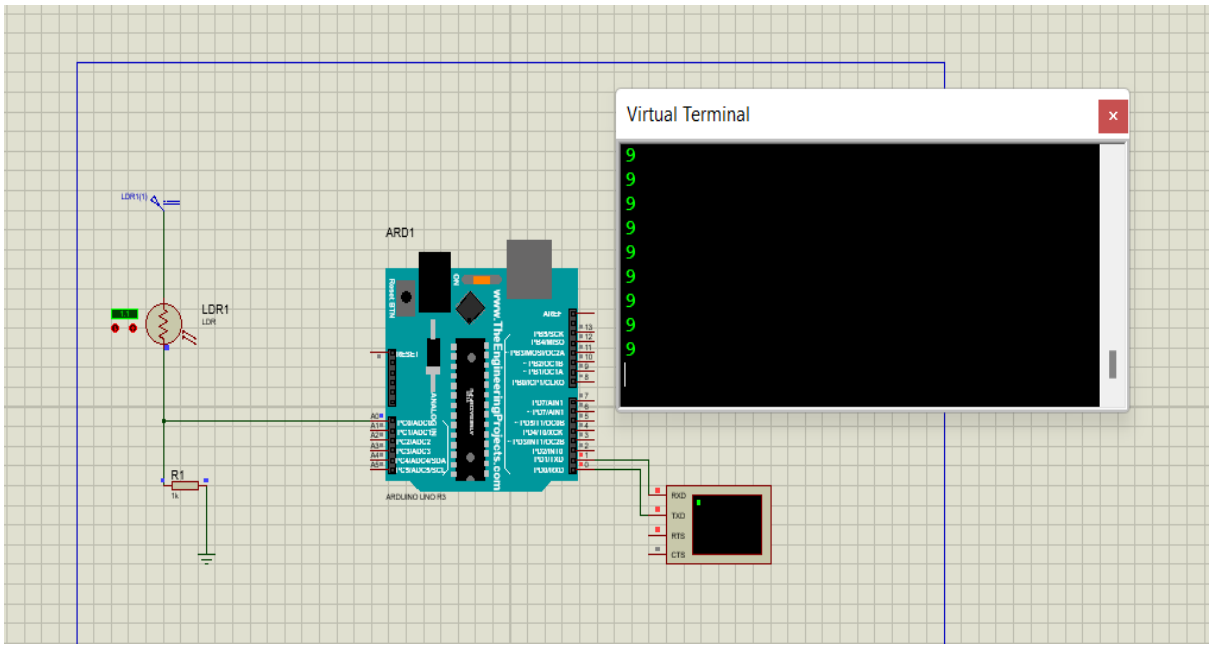
15. Now on Arduino IDE, type the following code

```
void setup()
{
  Serial.begin(9600);
}
void loop()
{
  Serial.println(analogRead(A0));
}
```

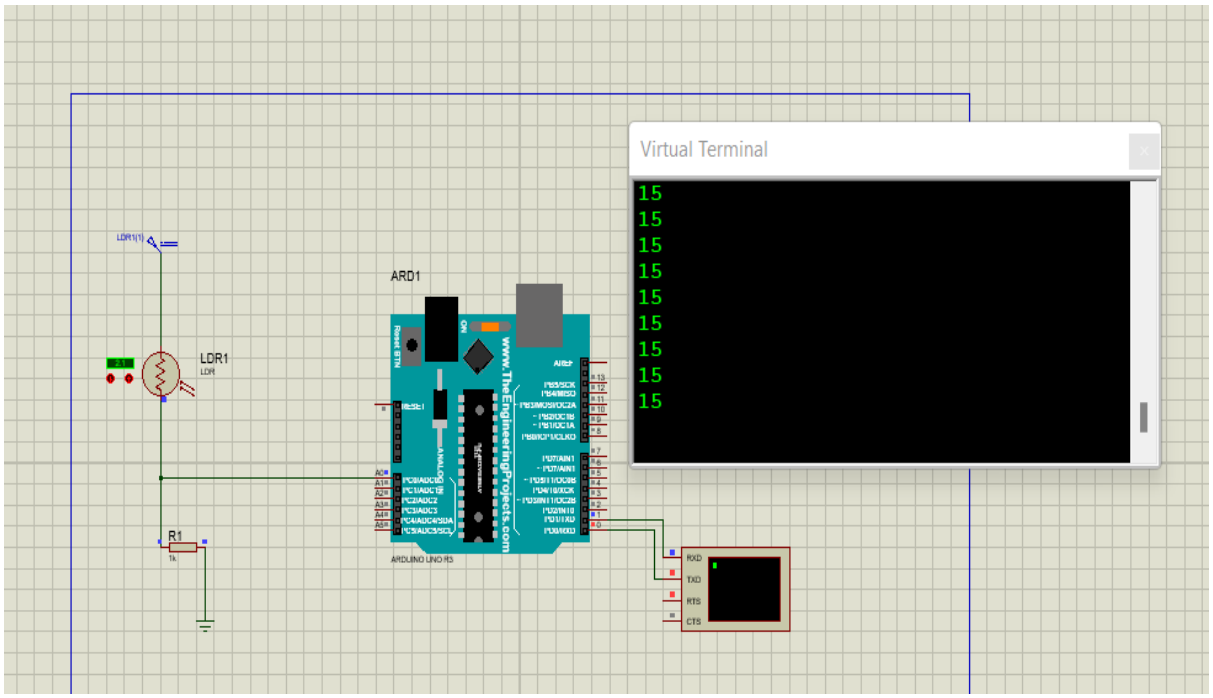
16. Now to generate the binary .HEX file, compile the code by clicking on Sketch from the top menu bar and click on Verify / Compile
17. Next, Click on Export compiled binary
18. Copy the path of the generated .hex file from the below terminal
19. Back on Proteus 8, click on Arduino UNO R3 and in the program file field, paste the copied hex file path OR browse to the specific directory and select the hex file and click OK
20. Now run the simulation by clicking on play button in the bottom left of the window
21. A terminal window pops up that shows the current analog signal from the LDR
22. Change the intensity of the LDR to see changes in the output value of the terminal window

Output:

Before changing the intensity value



After changing the intensity value



Practical No. 8

Aim: Develop an IoT application for Motion detection.

Theory:

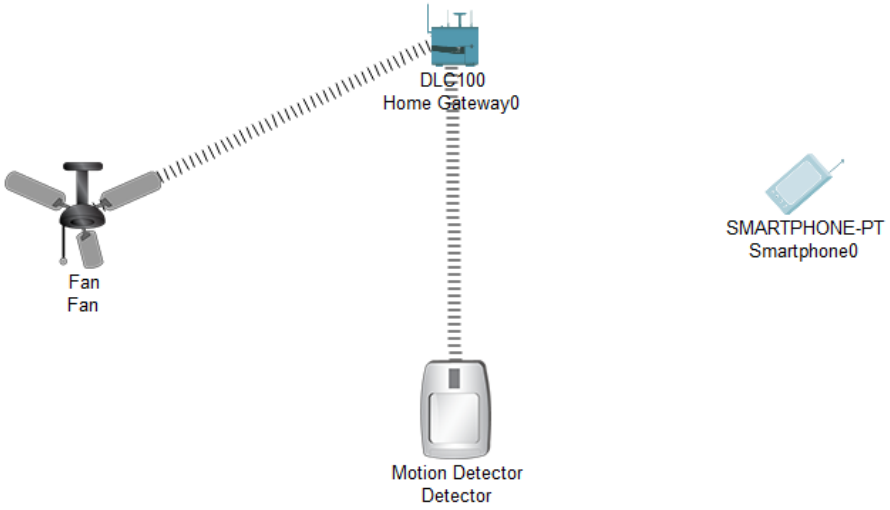
- A motion detector is an electrical device that utilizes a sensor to detect nearby motion. Such a device is often integrated as a component of a system that automatically performs a task or alerts a user of motion in an area. They form a vital component of security, automated lighting control, home control, energy efficiency, and other useful systems.

Apparatus:

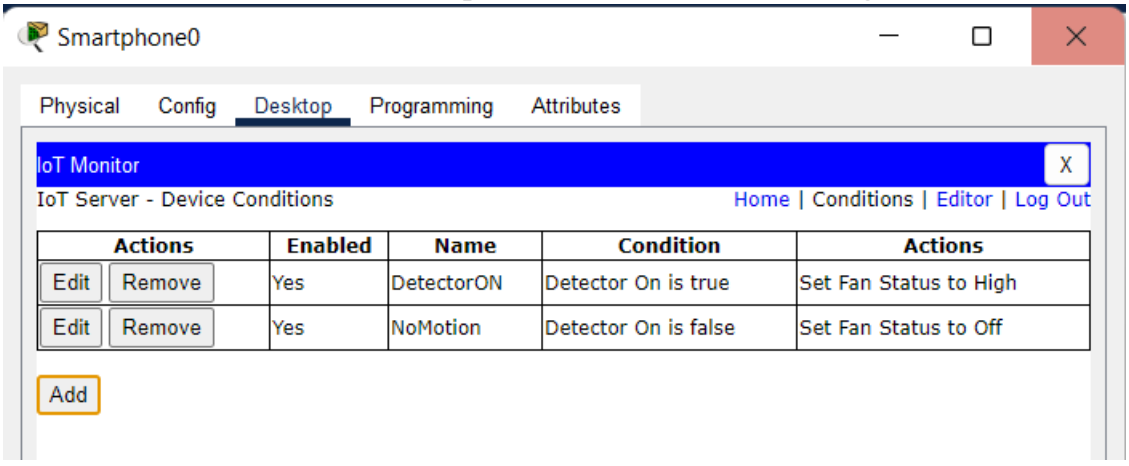
- Home Gateway, Motion Detector, Fan, Smartphone

Procedure:

1. Open Cisco Packet Tracer and drag the components mentioned in the apparatus to the simulating area
2. It should be similar to this

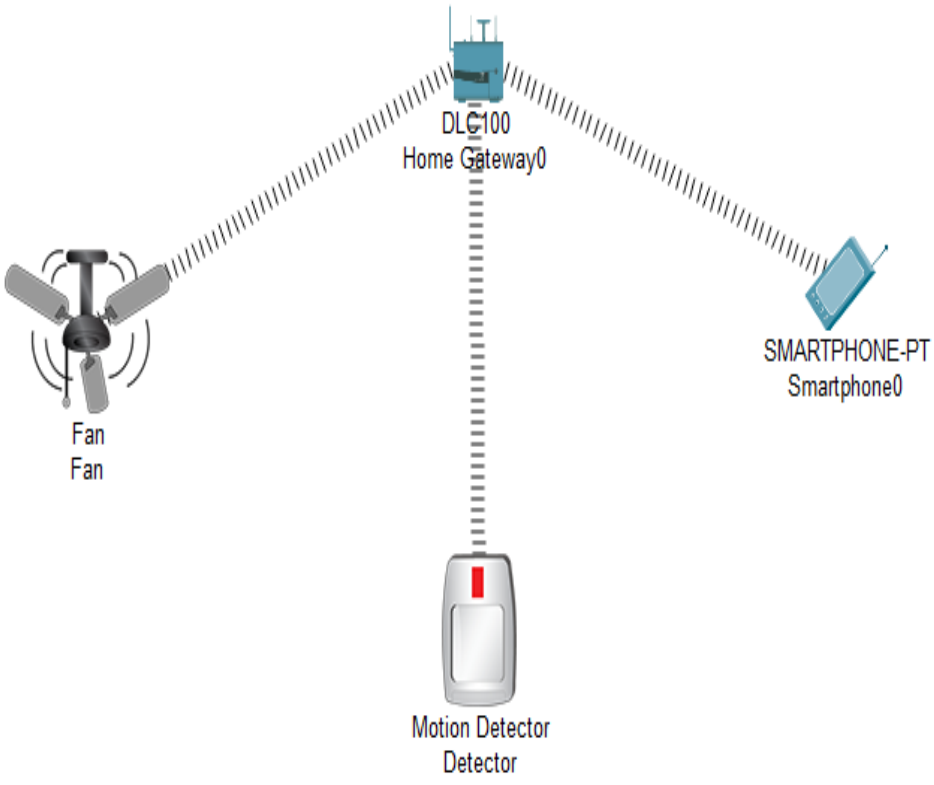


3. If the fan doesn't connect with Home Gateway automatically, go to I/O config of fan and change the network adapter to one of the wireless ones
4. Connect the smartphone by going to confifg > wireless and set the SSID to 'HomeGateway'
5. Set the IoT Server to Home Gateway on both the fan and motion detector
6. Go to the IoT monitor in smartphone and set the following conditions



7. Press the alt key and hover the cursor over the motion detector to see the output

Output:


DLC100
Home Gateway0
Fan
Fan
SMARTPHONE-PT
Smartphone0
Motion Detector
Detector