Smart Home System equipped with IOT Technology

Module: CS683 – IOT Security

Due date: 20th August 2023

Assignment: Build Smart Home System equipped with IOT Technology

Group: 5

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1. INTRODUCTION

In the pursuit of luxury and convenience, Jordan, a wealthy business tycoon, has embarked on a project to automate his extravagant residence. With the aim of enhancing his lifestyle, social status, and reducing his effort, he has collaborated with "Home Corp.," a prominent smart-home startup. We as a group of the 5 folks has taken lead on this project, the responsibility falls on us to employ my technical expertise and bring Jordan's vision to life.

The project assignment involves the integration of advanced technologies, such as ultrasonic distance sensors, servo motors, light sensors, temperature and humidity sensors, in conjunction with Arduino board and other essential components. The algorithm has been designed to utilize the data on temperature and humidity generated by the sensors linked with the servo motor. This design enables the algorithm to adjust the speed of the fan, increasing or decreasing it as needed. Additionally, the algorithm controls the opening and closing of the door based on the proximity of a person standing near the door, as sensed by the ultrasonic distance sensor. The ultimate goal is to achieve seamless automation of the door, fans, and lights within Jordan's home.

2. WORKFLOW

1. **Temperature and Humidity Sensing**: The heart of the smart home lies in the precise detection and control of temperature and humidity. The DHT22 sensor provides accurate readings. These readings are pivotal for fan speed regulation and overall comfort.

2. **Fan Speed Regulation**: The comfort level within the home is largely determined by temperature and humidity. The fan's speed, controlled by a stepper motor, adapts in accordance with the conditions defined in the provided table. For instance, as temperatures rise, the fan's speed increases to maintain optimal comfort. The same principle applies to humidity levels. This dynamic control mechanism ensures a consistent and comfortable living environment.

3. **Lighting Automation**: The illumination within the house is monitored using an LDR (light-dependent resistor) sensor. When the light intensity falls below a certain threshold (Lux < 400), the LED lights are automatically turned on. This responsive lighting system enhances the ambiance and provides convenience by eliminating the need for manual intervention.

4. **Door Automation**: An ultrasonic distance sensor plays a crucial role in detecting the presence of individuals at the doorway. When the distance is less than or equal to 200 centimeters, it triggers the servo motor to simulate the door's opening motion by rotating it 90 degrees. After a specified period, the simulated door is closed as the servo motor returns to its original position. This automation feature adds both security and luxury to Jordan's residence.

5. **Continuous Loop Operation**: The entire smart home system operates within a continuous loop to ensure ongoing automation and responsiveness. The loop periodically refreshes the sensor readings, updates the servo motor position, adjusts LED states, and displays the current

temperature and humidity values on an LCD display. Delay times within the loop prevent rapid fluctuations and provide a stable and realistic environment.

3. COMPONENTS

3.1 Microcontroller:

In this project, we have opted to utilize the Arduino Mega Board as the microcontroller of choice. Renowned for its capabilities, the Arduino Mega proves to be an exceptional microcontroller board, particularly suitable for endeavors demanding an extensive array of I/O ports or substantial computational prowess. Tailored to cater to more intricate undertakings, this board's abundance of input/output pins proves superfluous for rudimentary projects.

The Arduino MEGA can be programmed with the Arduino IDE, just like any other Arduino board. Since C is a supported programming language in this IDE, that's what we'll be doing. It allows us to enter in our program, burn it to our microcontroller, and modify our code as needed.

3.2 Servo Motor:

In the Smart Home Automation project, the servo motor plays a pivotal role in executing the motion of the simulated door, which enhances security, convenience, and aesthetic appeal. The servo motor's operation is orchestrated by the Arduino Mega Board, which receives input from the ultrasonic distance sensor to determine the position of the door and simulate its opening and closing actions.

a) **Detection of Human Presence**:
The servo motor's functioning is triggered by the ultrasonic distance sensor, which detects the presence of a person near the doorway. When the distance sensed by the ultrasonic sensor is less than or equal to 200 centimeters, it signals the Arduino to initiate the door-opening sequence.

b) **Door Opening Sequence**:
Upon receiving the signal from the ultrasonic distance sensor, the Arduino commands the servo motor to rotate by 90 degrees. This rotation mimics the motion of a door being opened. As the servo motor turns, it physically changes the position of the simulated door, creating a realistic effect within the smart home environment.

c) **Simulated Door Closure**:
To maintain a realistic and functional simulation, the servo motor's operation also involves the closing of the simulated door after a certain period of time (2 Sec). This is achieved by the Arduino instructing the servo motor to return to its original position, effectively closing the simulated door.

3.3 LCD Display

This is an I2C- compatible LCD display with a 20X4 pixel matrix. We are using GND, VCC, SDA, SCL pins. The LCD display is used to show the temperature, humidity, FAN Speed, Door Regulation and LED illumination status values in real-time. These values are refreshed in every iteration of the simulation loop. This component provides a visual representation of the environmental conditions in the room and how they change over time.

3.4 Ultrasonic Distance Sensor

The ultrasonic distance sensor is used to detect the presence of a person at the doorway. It measures the distance from the sensor to the object in front of it. If the measured distance is less than or equal to 200 centimeters, the simulation triggers the servo motor to rotate by 90 degrees. This simulates the motion of the door opening. After a predefined period, the servo motor is returned to its original position, simulating the closure of the door.

3.5 Photoresistor (LDR) Sensor

A photoresistor is characterized by photoconductivity because its resistance reduces as the intensity of the incoming light increases. The sensor is equipped with four pins, which are labeled VCC, GND, DO, and AO. Below is the LUX determination logic has been embedded into the system.

1. LDR is sensing the luminous value and sending it to pin A0 of Arduino
2. Using analog read method function, we are reading the raw sensor value received on the pin A0.
3. Raw sensor value is further converted into LUX.
   Note: GAMMA = 0.7 and RL10 = 50

```
// Read light sensor value
int analogValue = analogRead(lightSensorPin);
float voltage = analogValue / 1024. * 5;
float resistance = 2000 * voltage / (1 - voltage / 5);
float lux = pow(RL10 * 1e3 * pow(10, GAMMA) / resistance, (1 / GAMMA));
```

3.6 DHT22 Senor

Digital temperature and humidity sensing is accessible with the DHT22. It utilizes a capacitive humidity sensor and a thermistor to detect the ambient air and outputs a digital signal on the data pin; analogue input connections are not required. There are pins labelled VCC (5v positive), SDA (signal line to a digital pin), NC (not connected), and GND.

3.7 Stepper Motor

The stepper motor is responsible for controlling the fan speed based on the temperature and humidity readings. The simulation uses the provided temperature and humidity values to match the conditions in the table 1. The stepper motor is adjusted to rotate to different positions (representing different fan speeds) based on the specified conditions. This provides a visual representation of the fan speed control logic.

TEMPERATURE	HUMIDITY	FAN SPEED
25 and below	-	0
25-29	40-60	2
25-29	61-80	3
25-29	81-100	4
30-34	40-60	3
30-34	61-80	4
30-34	81-100	5
35-39	40-60	4
35-39	61-100	5
40 and above	40-100	5

Table 1: Temp, Humidity and FAN Speed data

4. CIRCUIT DAIGRAM

Using the listed components in the requirement, we have setup the below circuit as follows:

1. Temperature sensor and Humidity sensor
2. Servo motor
3. HC-SR04 Ultrasonic Distance Sensor
4. Light sensor
5. Arduino board
6. Stepper motor
7. LCD Display (20X4)

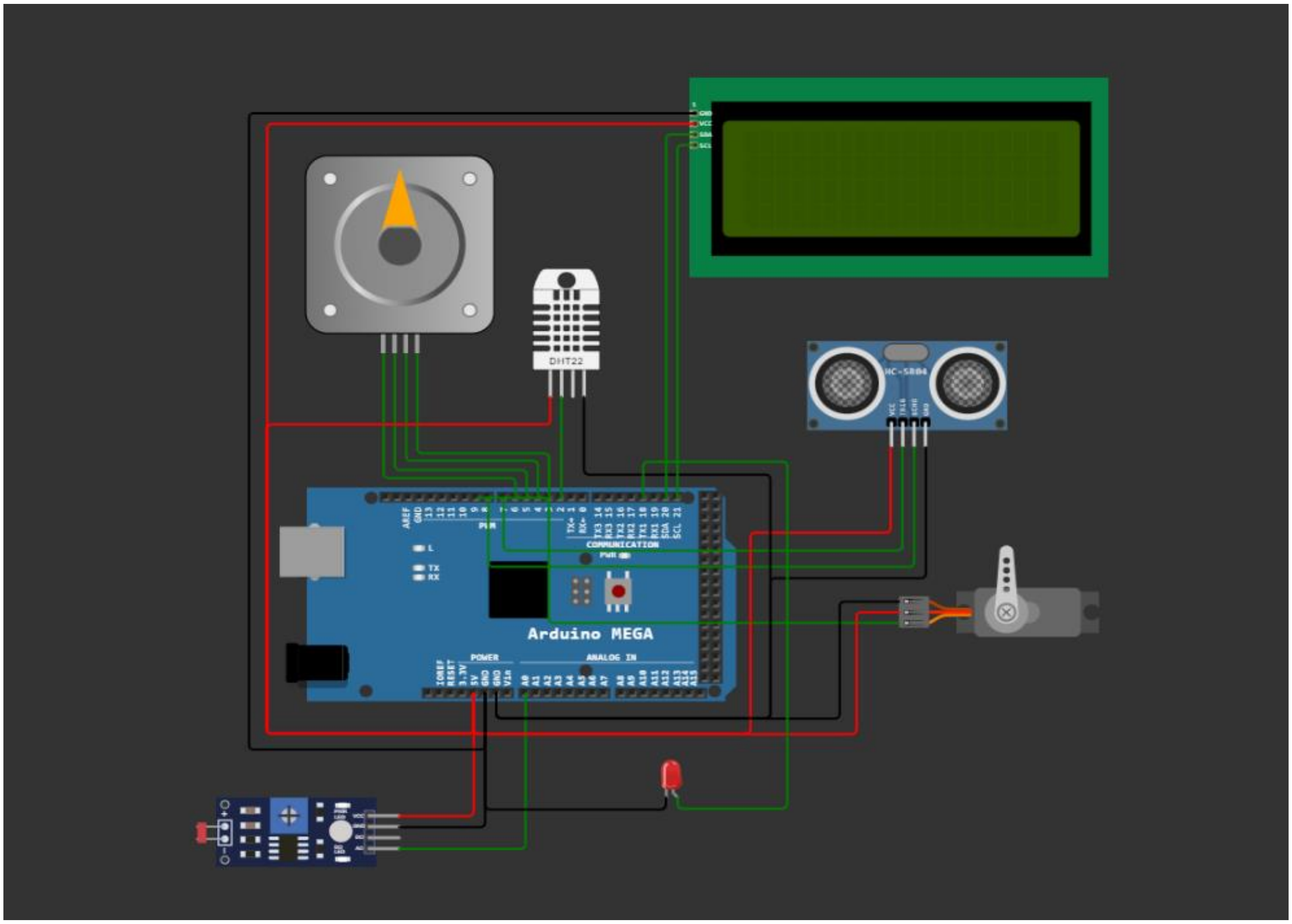


Figure 1: Schematic for Smart Home System showing all components.

5. PROJECT LINK

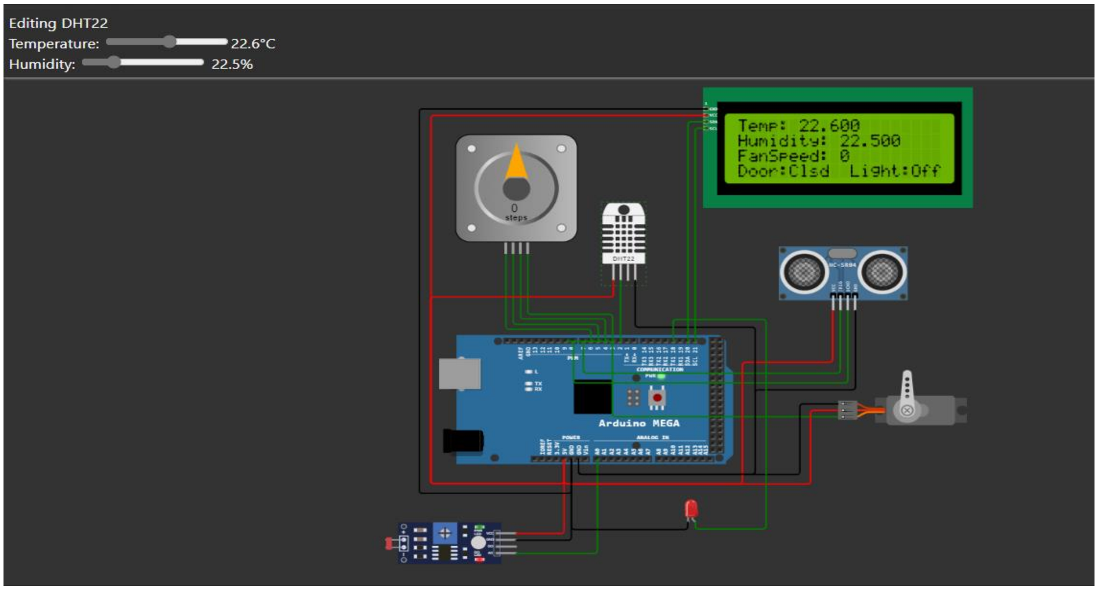
Please find the attached simulation link for reference and evaluation purpose.

https://wokwi.com/projects/373125653704707073

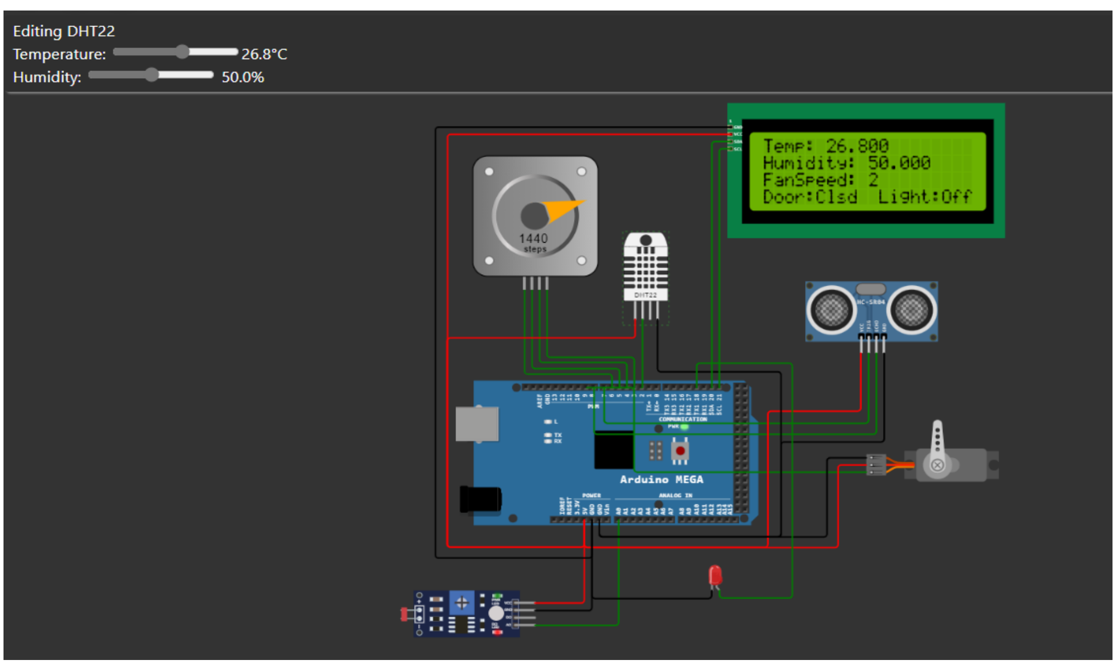
6. EXPECTED FUNCTIONALITY RESULTS

The system has been configured successfully using the said sensors and based upon the table-1 given for Temperature, Humidity and Fan Speed, the expected functionality simulation observation has been recorded for each required use-case during the simulation process and has been given below for reference.

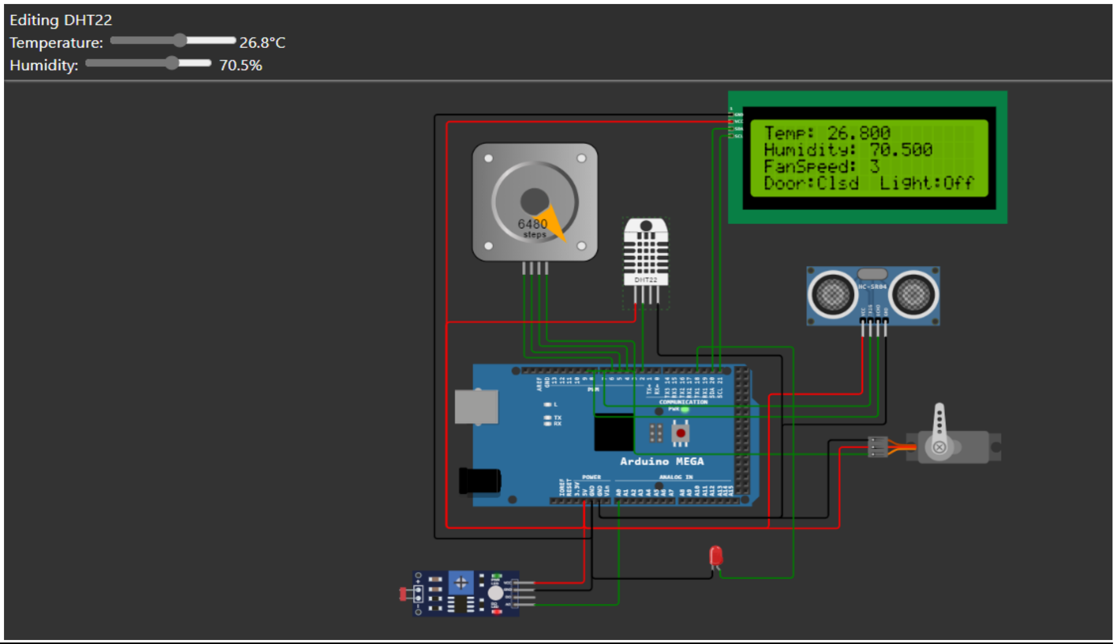
1. **Use-Case-1**: Temperature and humidity (DHT22) sensor has sliders to adjust the readings. The fan speed (a stepper motor) should change with the change in temperature and humidity values according to the rules defined in the table above.
   Simulation-1: Here we have simulated the Temperature set as 22.6 and Humidity set as 22.5 which resulted in FAN speed recorded as 0 (default). Same Temp and Humidity value recorded can be observed in the LCD shown in below fig.



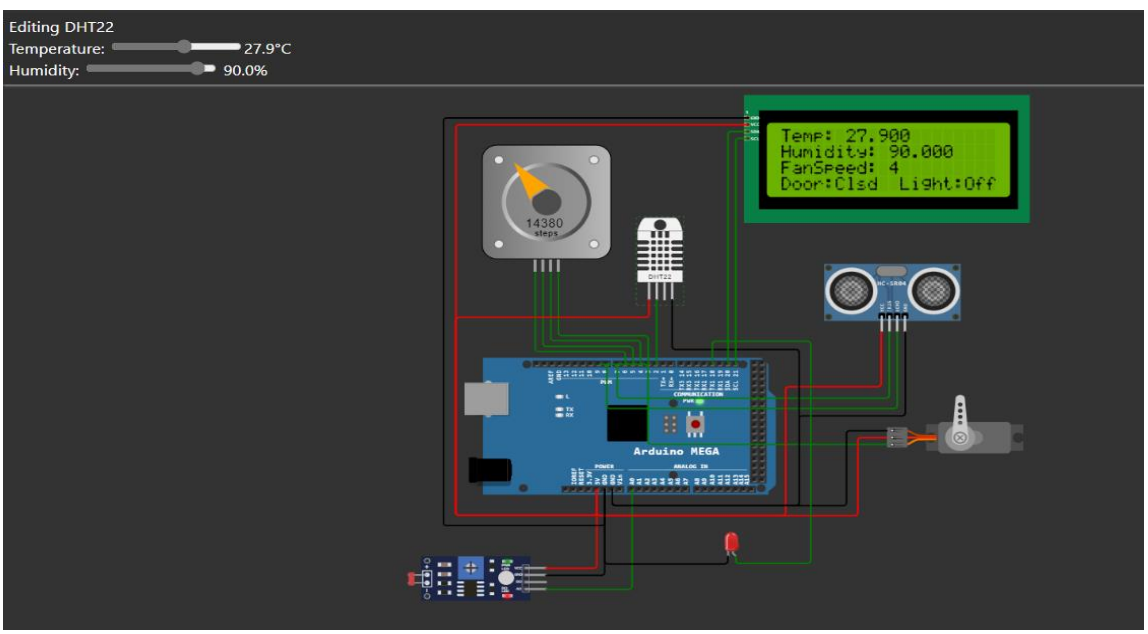
   Simulation-2: Here we have simulated the Temperature set as 22.8 and Humidity set as 50 which resulted in FAN speed recorded as 2. Same Temp and Humidity value recorded can be observed in the LCD shown in below fig.



Simulation-3: Here we have simulated the Temperature set as 26.8 and Humidity set as 70.5 which resulted in FAN speed recorded as 3. Same Temp and Humidity value recorded can be observed in the LCD shown in below fig.



Simulation-4: Here we have simulated the Temperature set as 27.9 and Humidity set as 90 which resulted in FAN speed recorded as 4. Same Temp and Humidity value recorded can be observed in the LCD shown in below fig.

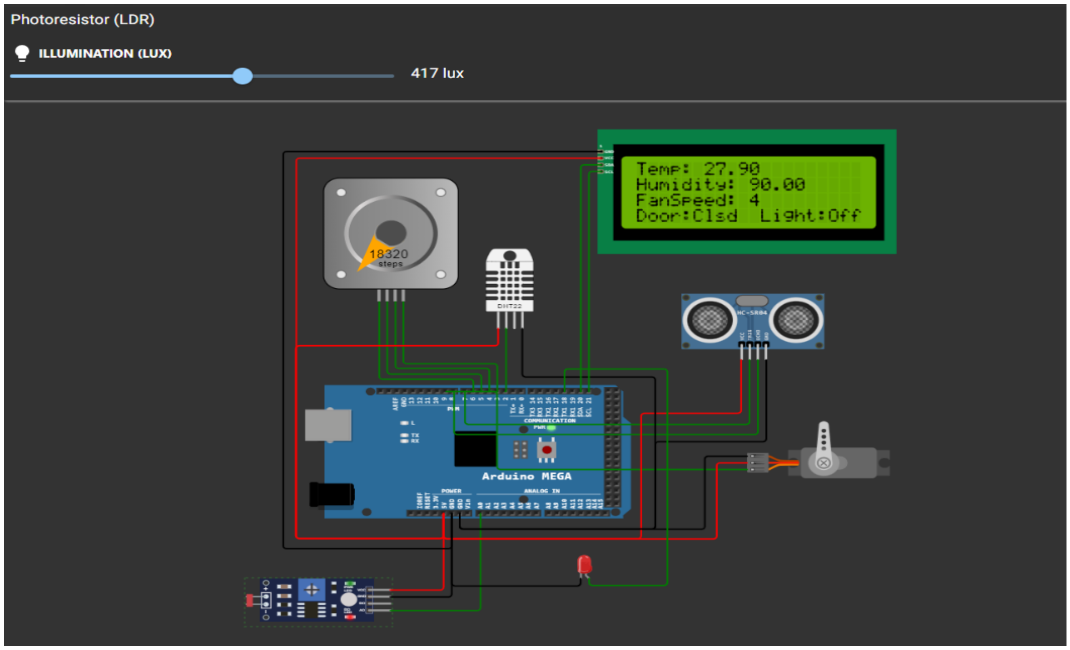


Note: Above reading has been defined in the report however for testing remaining reading from the given table pertaining to Temp, Humidity, FAN Speed we ran the build circuit as per the defined process and observed the reading.

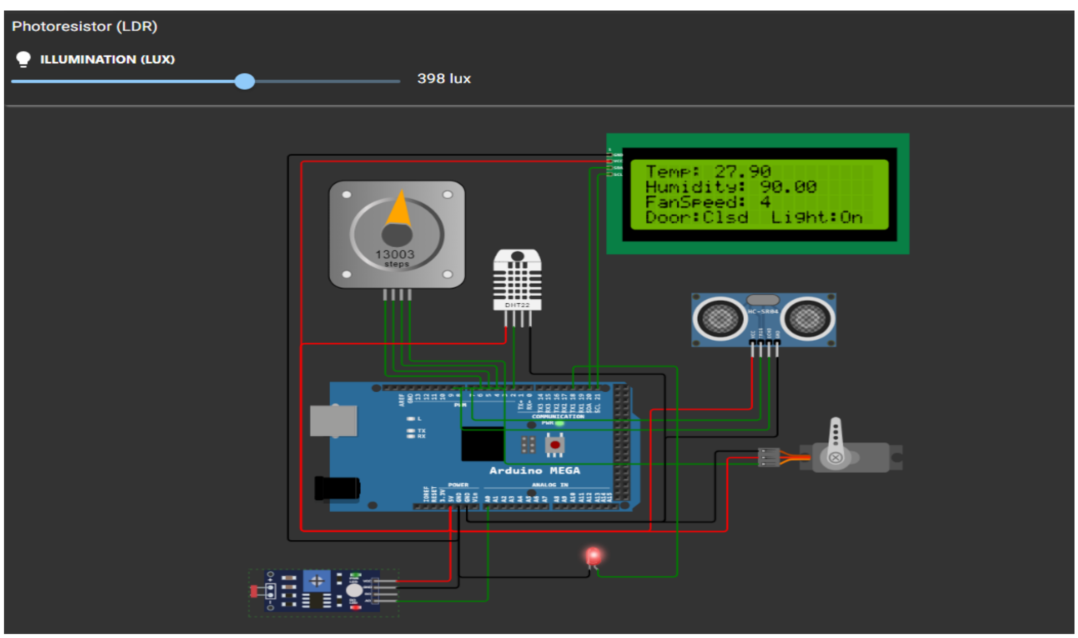
2. **<u>Use-Case-2:</u>** Turn ON the lights (LED) based on the illumination in the room. You can use LDR to measure illumination.

   <u>Simulation-1</u>:

   a) Here we have simulated the LUX set as 417 where LED has been recorded as turned off (which is above the 400 threshold) show in below fig.



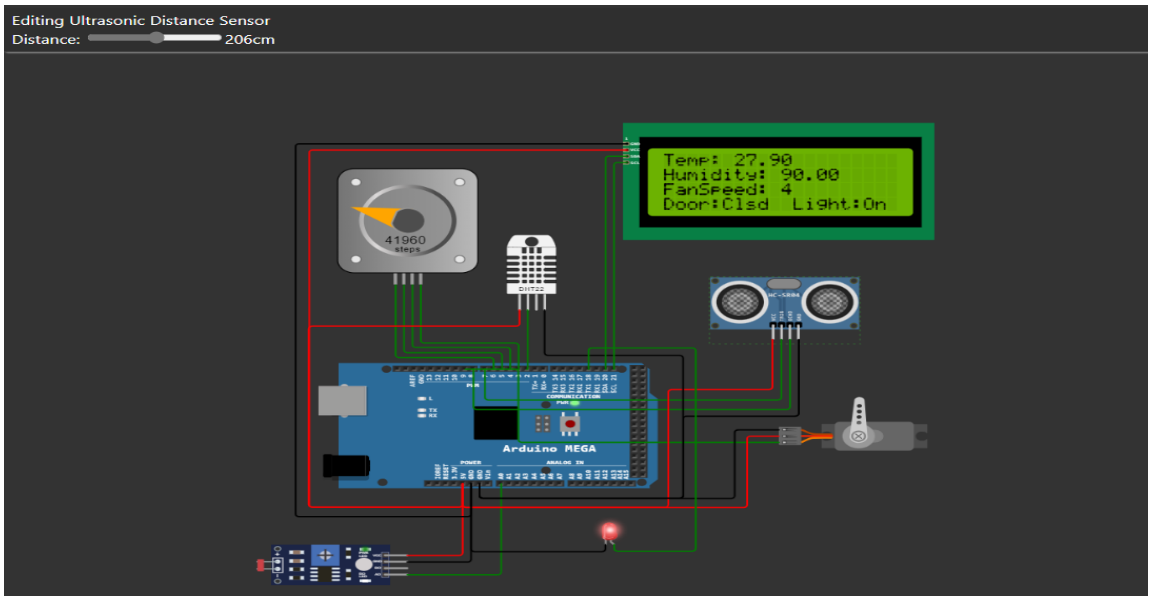
   b) Here we have simulated the LUX set as 398 where LED has been recorded as turned ON (which is below the 400 threshold) show in below fig.



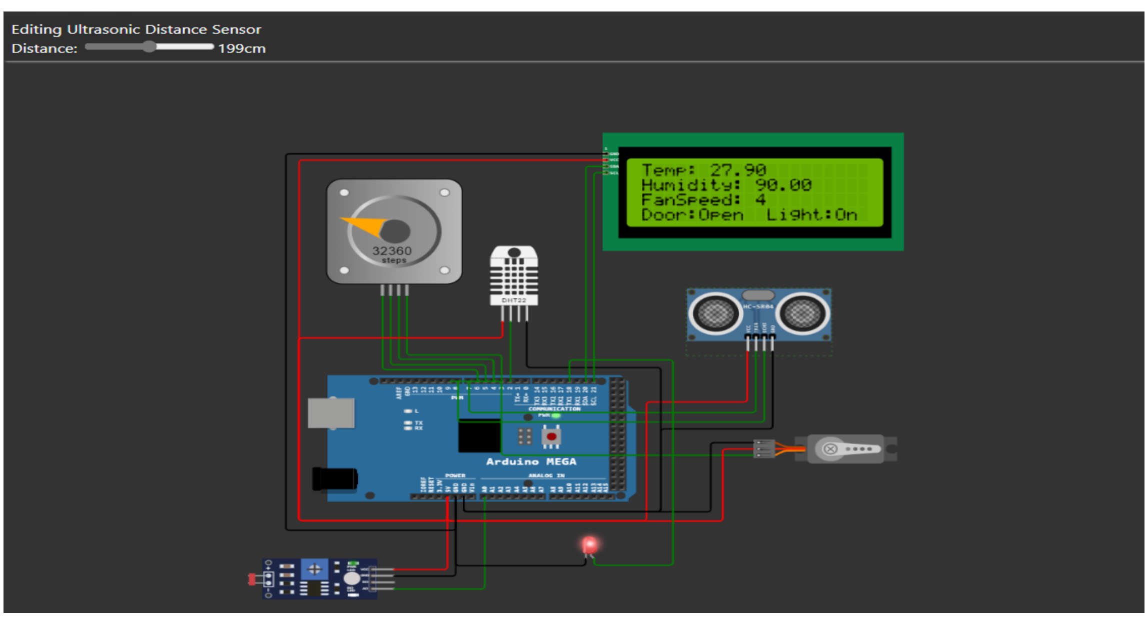
3. **Use-case-3**: Use an ultrasonic distance sensor to detect the presence of a person at the doorway. When the measured distance is less than or equal to 200 centimeters, rotate the servo motor by 90-degree, simulating the motion of the door opening. After a certain period, initiate the closure of the simulated door by returning the servo motor to its original position.

Simulation-1:

a) Here we have simulated the distance from the sensor as 316cm which results in door will remain closed show in LCD within below fig.



b) Here we have simulated the distance from the sensor as 199 cm (which is less than 200 cm threshold) which results in door will remain open show in LCD within below fig.



7. REFERENCES

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- HC-SR04 Ultrasonic Distance Sensor Available at *https://docs.wokwi.com/parts/wokwi-hc-sr04*
- Wokwi-lcd2004 – LCD Available at: https://docs.wokwi.com/parts/wokwi-lcd2004
- Wokwi-stepper-motor Available at: https://docs.wokwi.com/parts/wokwi-stepper-motor
- Wokwi-dht22 Available at: https://docs.wokwi.com/parts/wokwi-dht22
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