Embedded Systems Intern Assignment – Heater Control System Design

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Part 1: System Design

1. Sensors Required

Primary Sensor: DHT22 – Digital temperature and humidity sensor

Purpose: Measures ambient temperature (and humidity, if needed).

Reason for Choice:

- Digital output simplifies interfacing with Arduino.
- Supported natively in Wokwi and many libraries (like DHT.h).
- Reliable enough for basic control systems.

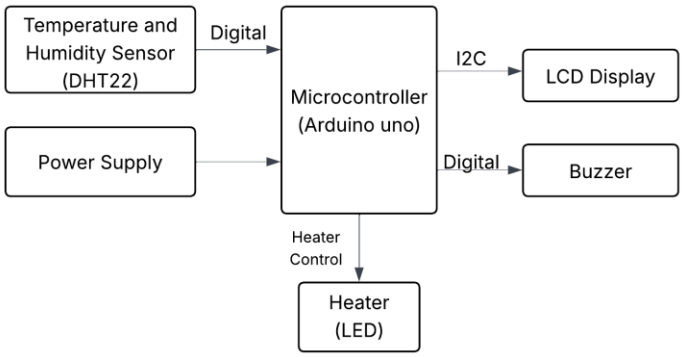
2. Communication Protocol Recommendation

Recommended Protocol: UART (Serial Communication)

Justification:

- Simple and robust.
- Ideal for debugging and real-time monitoring via Serial Monitor.
- Fully supported by Arduino and Wokwi.

3. System Block Diagram



4. Future Roadmap

Overheating Protection

- Introduce a critical temperature threshold (e.g., >60°C) to trigger heater shutdown.
- Add buzzer alert and LCD/Serial warning logs.

Multiple Heating Profiles

- Profile 1: Low (25°C)
- Profile 2: Medium (35°C)
- Profile 3: High (45°C)
- Profiles selectable via buttons or serial input.

BLE Support

- Advertise real-time temperature and heating status to mobile app.
- Implementable with ESP32 for wireless connectivity.

Indicators

- Use LED/buzzer for visual and audio feedback for different states (especially Overheat).

Real-Time Display

- Add OLED or I2C LCD module to show live temperature and current system state.

Part 2: Embedded Implementation

Platform and Tools

- Microcontroller: Arduino Uno
- Simulation Platform: Wokwi (https://wokwi.com/)
- Programming Language: C++ using Arduino framework

Components Used

Component	Purpose	Pin Mapping (Arduino Uno)
DHT22 Sensor	Temperature & humidity sensing	SDA → D2
LED (Heater)	Simulated heater	D3 (via 220Ω resistor)
Buzzer	Overheat alert	D4
16x2 I2C LCD Display	Display temp and system state	SDA → A4, SCL → A5
Breadboard & Wires	Circuit assembly	—

State Machine Design

The system operates in the following **states** based on temperature input:

State	Temperature Range (°C)	Heater (LED)	Buzzer
Idle	< 25	ON	OFF
Heating	25 - 34.9	ON	OFF
Target Reached	35 - 44.9	OFF	OFF
Overheat	≥ 45	OFF	ON

Features Implemented

- Periodic temperature sensing every 1 second using **Timer1 interrupt**
- LCD shows real-time temperature and current state
- Serial Monitor logs system behavior

- Heater control logic using DHT22 sensor
- Buzzer triggers in **Overheat** state

Libraries Used

cpp

CopyEdit

#include <DHT.h>

#include <Wire.h>

#include <LiquidCrystal_I2C.h>

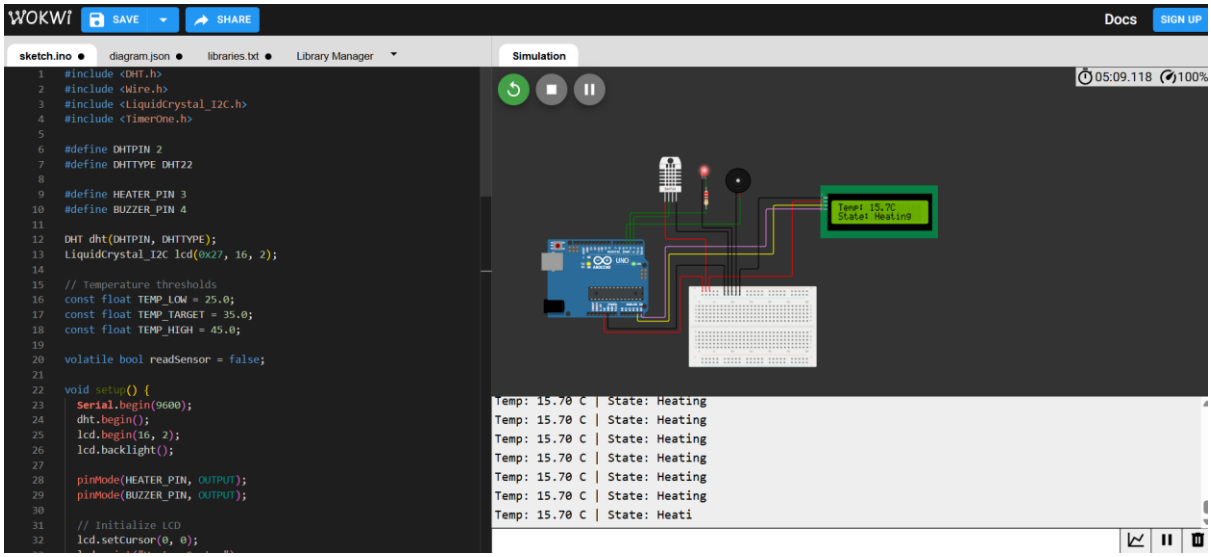
#include <TimerOne.h>

Code Overview

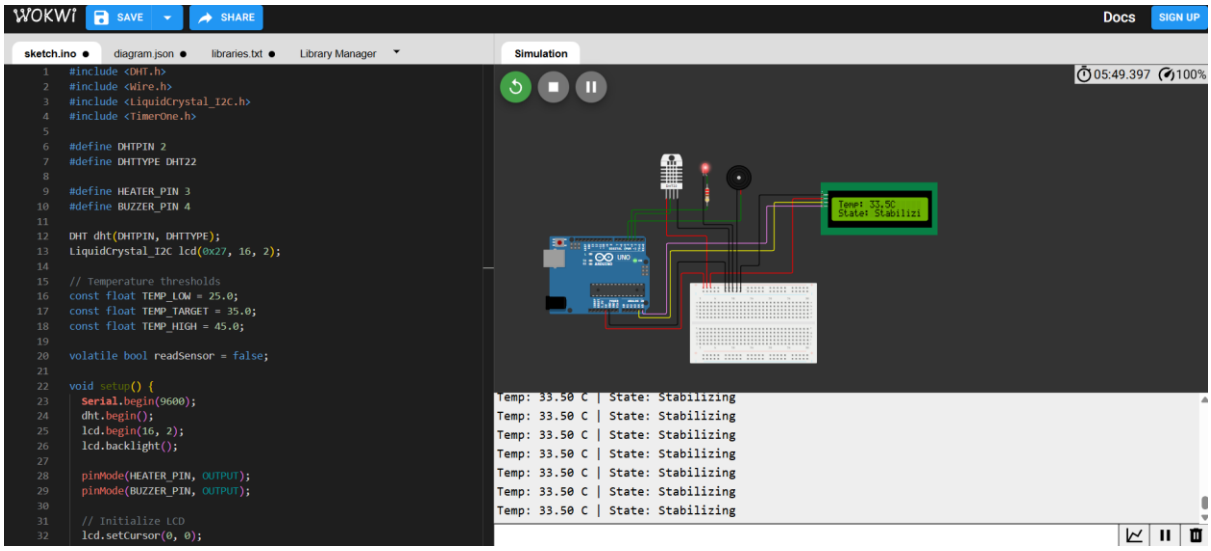
The main loop() responds to a flag set by the Timer1 interrupt every second. This ensures:

- Sensor data is read cleanly without delay()
- LCD and Serial are updated periodically
- State logic controls LED and buzzer based on temperature

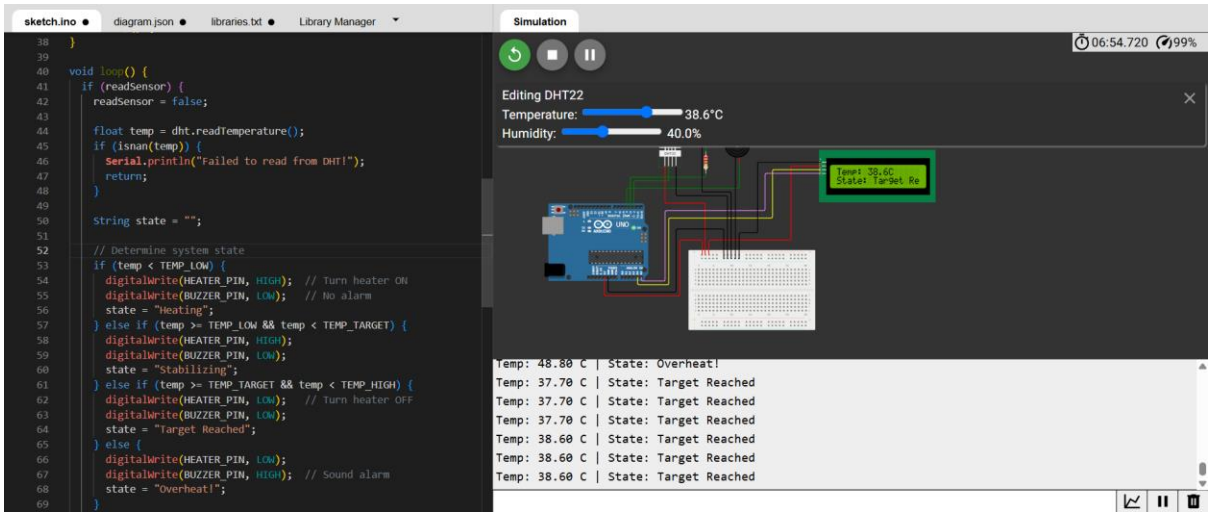
Result:



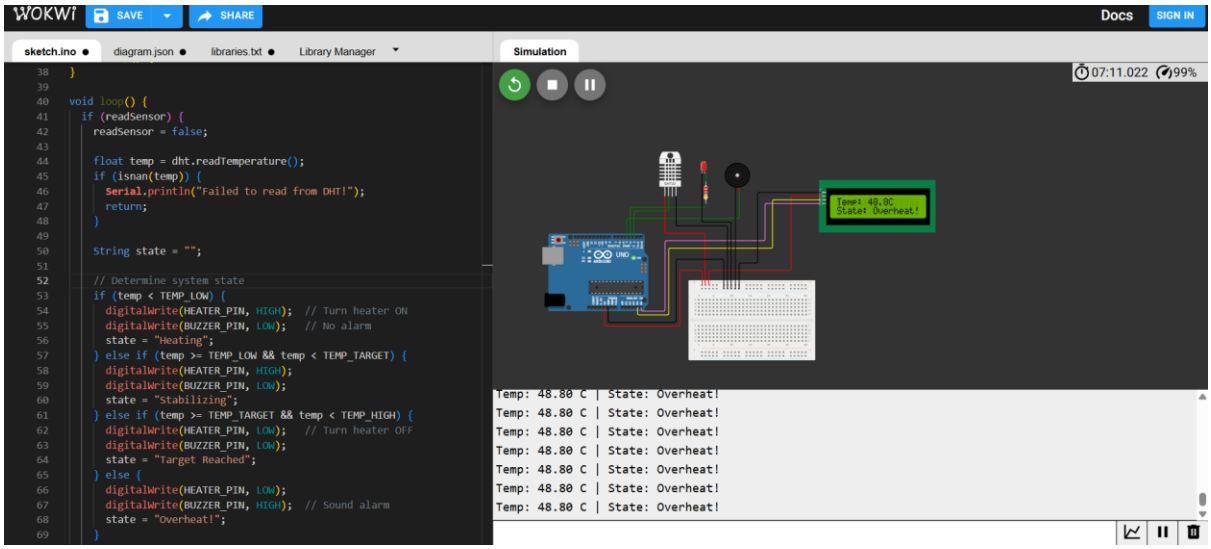
At Heating state



At Stabilizing state



At Target Reached state



At Overheat state

Code Repository

https://github.com/Sachin10036/Basic-Heater-Control-System-

Wokwi Simulation Link

https://wokwi.com/projects/430686060274520065