MECHATRONICS

ANUSHREE CHAUHAN
2023UG009

RASHMI RAY
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FlowIQ – airflow with intelligence.

RELEVANCE :
Students in hostels often endure hot, humid rooms during intense study sessions or at night. Traditional coolers demand frequent water refilling, manual pump management, and constant adjustment of airflow direction—tasks that become burdensome amid their busy routines. As a result, coolers are used inefficiently or simply neglected, leading to both discomfort and unnecessary water wastage.

OBJECTIVE :

To design and prototype a smart cooler integrating sensors, actuators, and microcontroller programming.

PROJECT DESCRIPTION :

The smart cooler prototype consists of three major functions:

1. Humidity Control: Activates the water pump when humidity rises above the threshold, with hysteresis to avoid rapid switching.
2. User Detection & Directional Cooling: Uses an ultrasonic sensor to detect a person’s presence and rotates the cooler grill via a servo motor to direct airflow.
3. Water Level Monitoring: Continuously measures the water level and indicates how much water needs to be filled for optimal operation, preventing sudden dry-outs.

All feedback is displayed on an LCD screen, making the system user-friendly and autonomous.

Humidity control and water level monitoring

COMPONENTS :

Microcontroller:

1. Arduino Uno

Sensors::

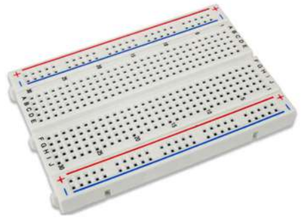
1. DHT Sensor

2. LCD 16x2 I²C

Actuators:

1. Relay module

2. Pump



3. Breadboard

4. 5V adapter

5. jJump wires

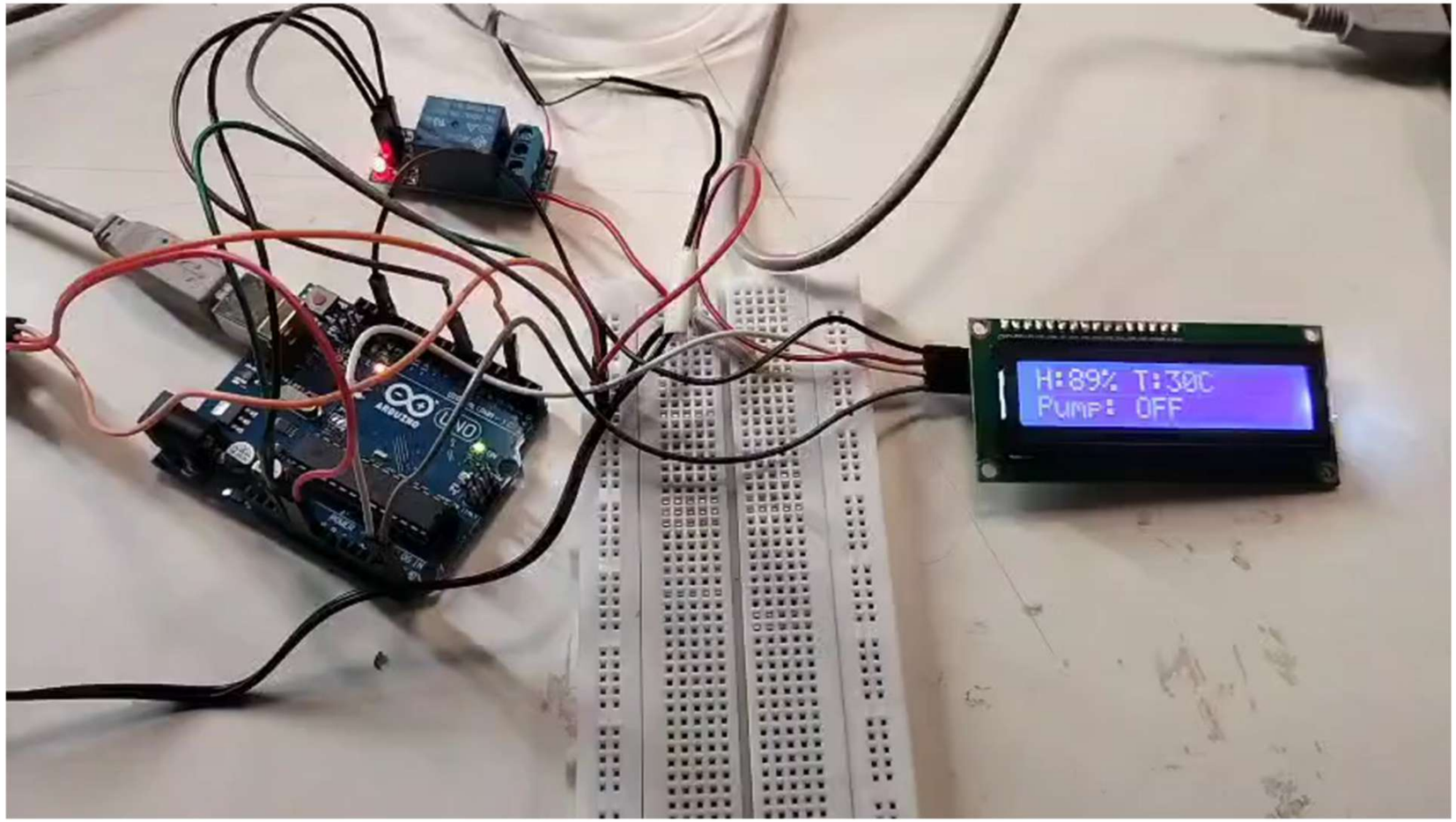
Circuit Design

Circuit Connections

1. DHT Sensor
VCC → 5V
GND → GND
DATA → Digital pin 7

2. I2C LCD (16x2)
VCC → 5V
GND → GND
SDA → A4
SCL → A5

3. Relay Module + Pump
Relay VCC → 5V
Relay GND → GND
Relay IN → Digital pin 8
Relay COM → 5V
Relay NO → Pump +ve
Pump -ve → GND



Programming

Key Features of the Code:

1.DHT11 sensor readings (humidity & temperature)

- Takes 5 readings (NUM_READINGS) with delays in between.
- Averages them for more stable results.

2.Pump control with hysteresis

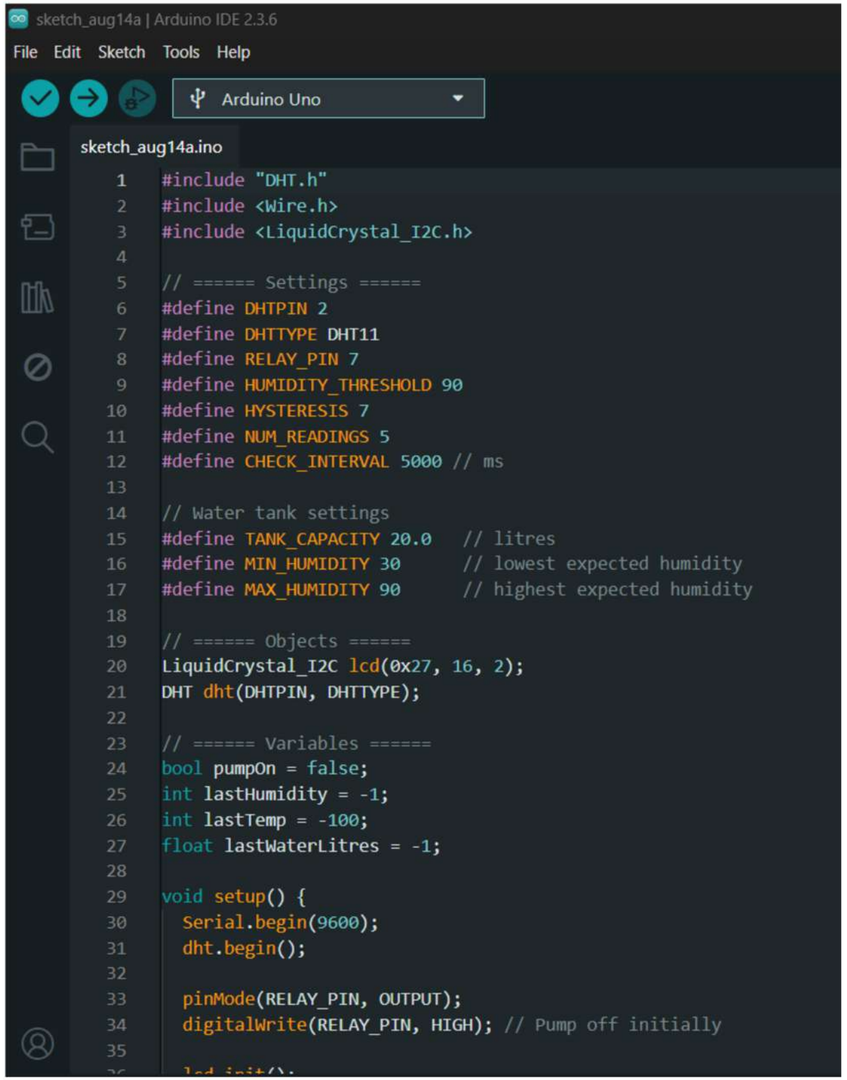
- Pump turns ON when humidity ≤ (threshold - hysteresis) → 65% in your case.
- Pump turns OFF when humidity ≥ threshold → 72%.
- This avoids rapid ON/OFF switching (relay chattering).

3. Relay handling

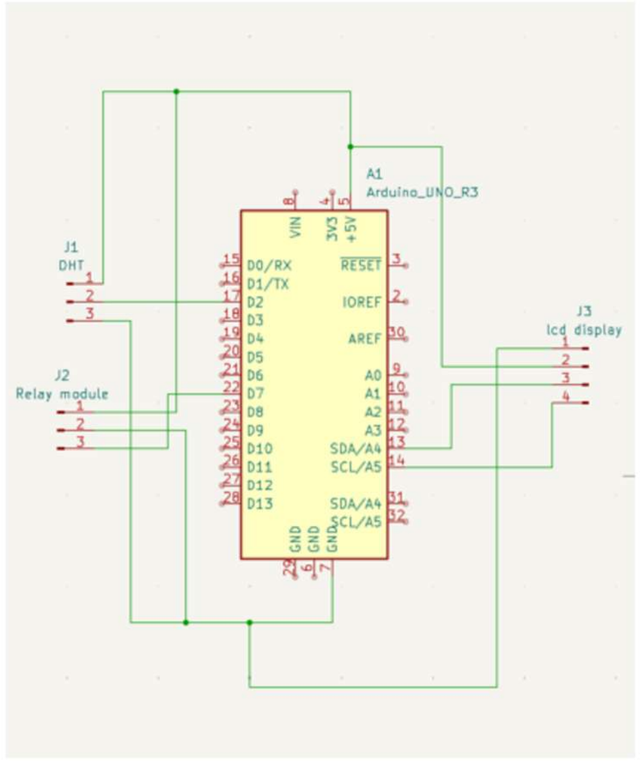
- Active LOW relay logic (digitalWrite(RELAY_PIN, pumpOn ? LOW : HIGH)).
- Ensures the pump is safely off by default.

4. LCD display optimization

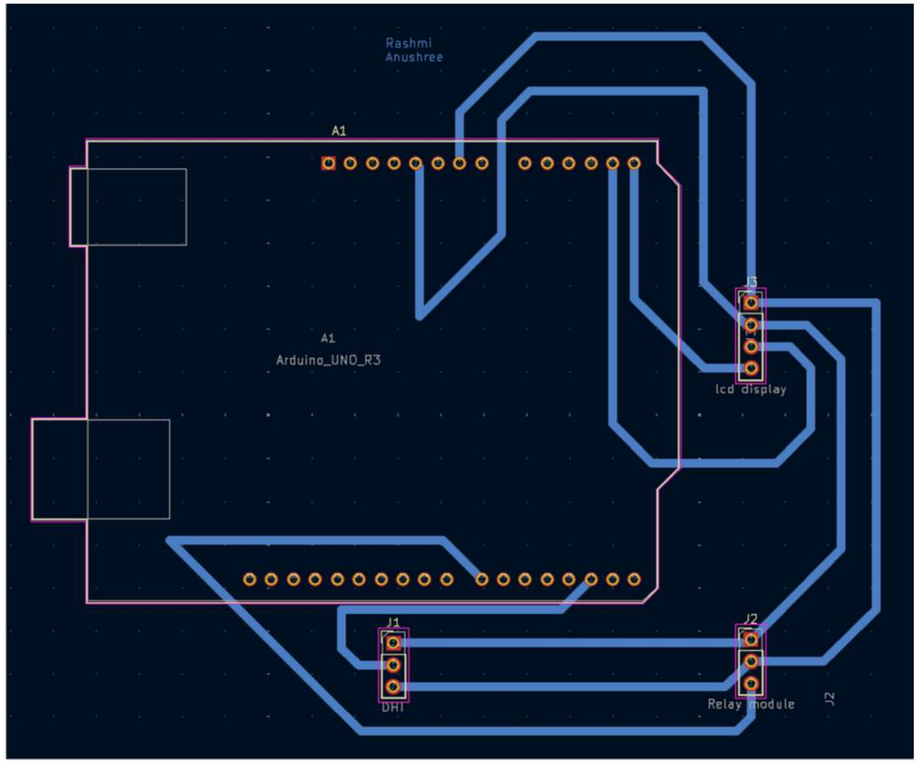
- Updates LCD only if humidity/temp changes → prevents flickering.
- Shows Humidity, Temp, and Pump status.



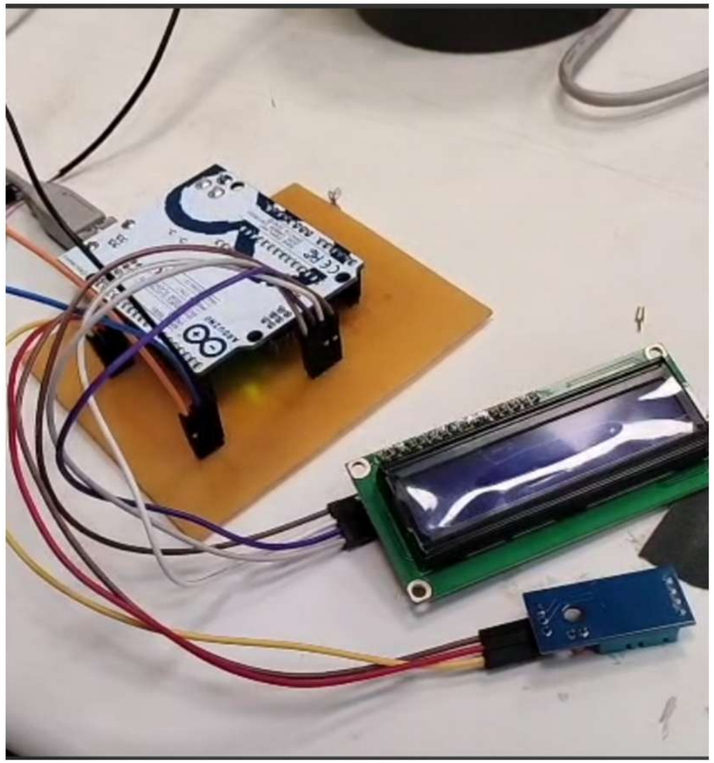
PCB Circuit Design & Fabrication



Schematic Deisgn



PCB Layout



Assembly

Process of Pcb making

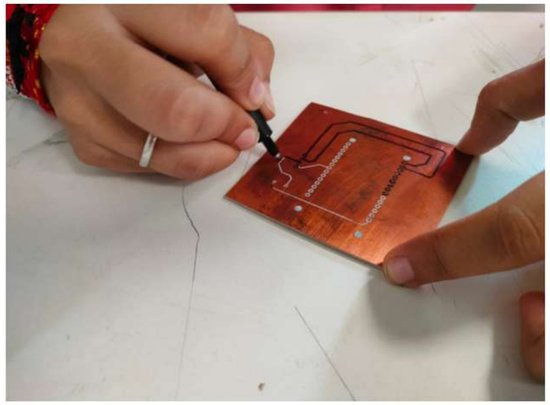
01.

Dip the board in Ferric Chloride solution

02.

Cleaning with thinner

03.

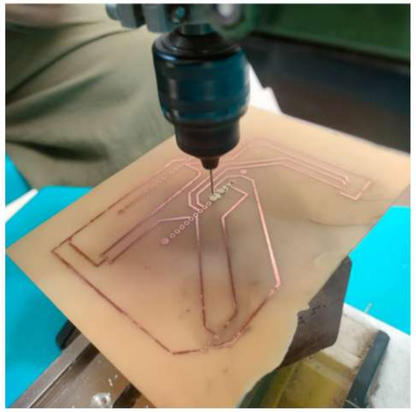


Reconnecting the broken Connection

04.

Soldering with the led wire for better connectivity

05.



Drilling Holes to mount the components

User detection and direction

COMPONENTS :

Microcontroller:

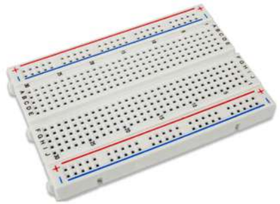
Esp 32

Sensors::

Ultrasonic Senor

Actuators:

Servo Motor

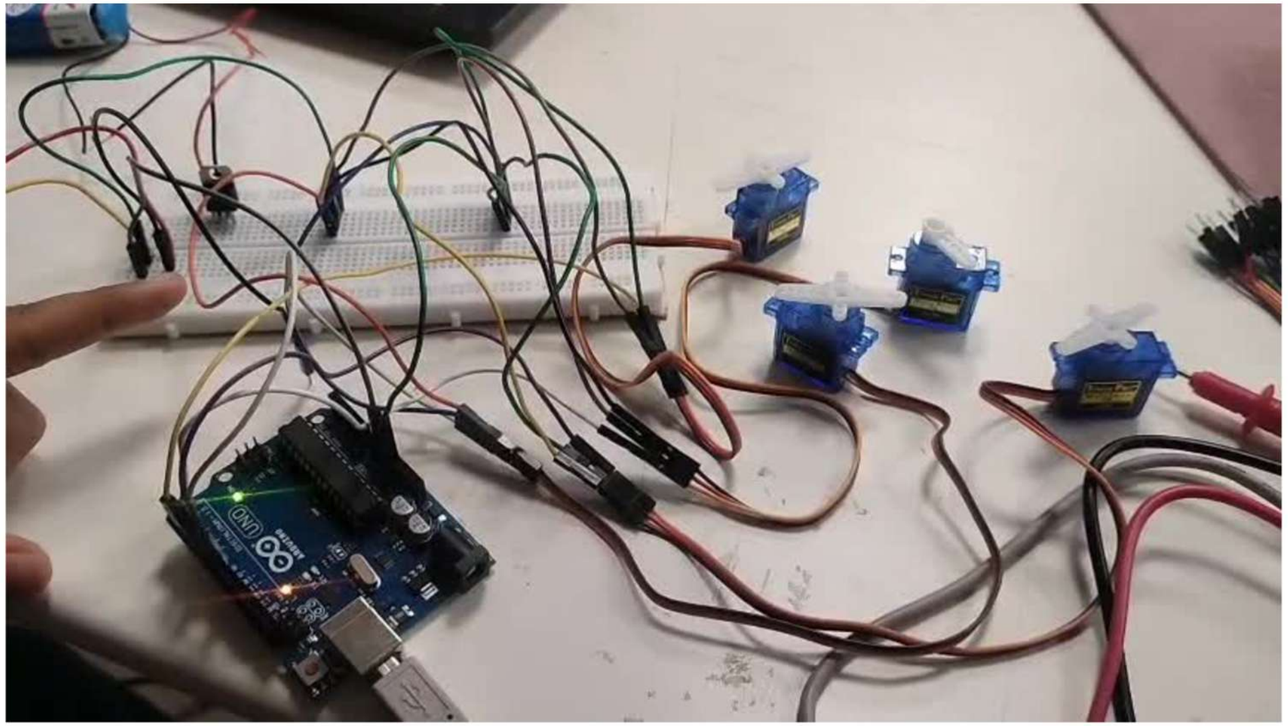


Bread Board

Jumper wire

5v dc Adapter

1st Attempt



PROBLEM

-
- Initially, four servos powered from a single source—only 1–2 moved.
- Added a relay driver, but issue persisted.
- Root cause: power supply couldn’t deliver enough current for all servos, especially at startup.
- Relay solved control, not power deficiency.

SOLUTION

- Replaced 9 g servos with MG996R (large) servos.
- Added 5 V adapter to supply sufficient current.

Servo Motor driver

Servo Motor

MG996R

5v dc Adapter

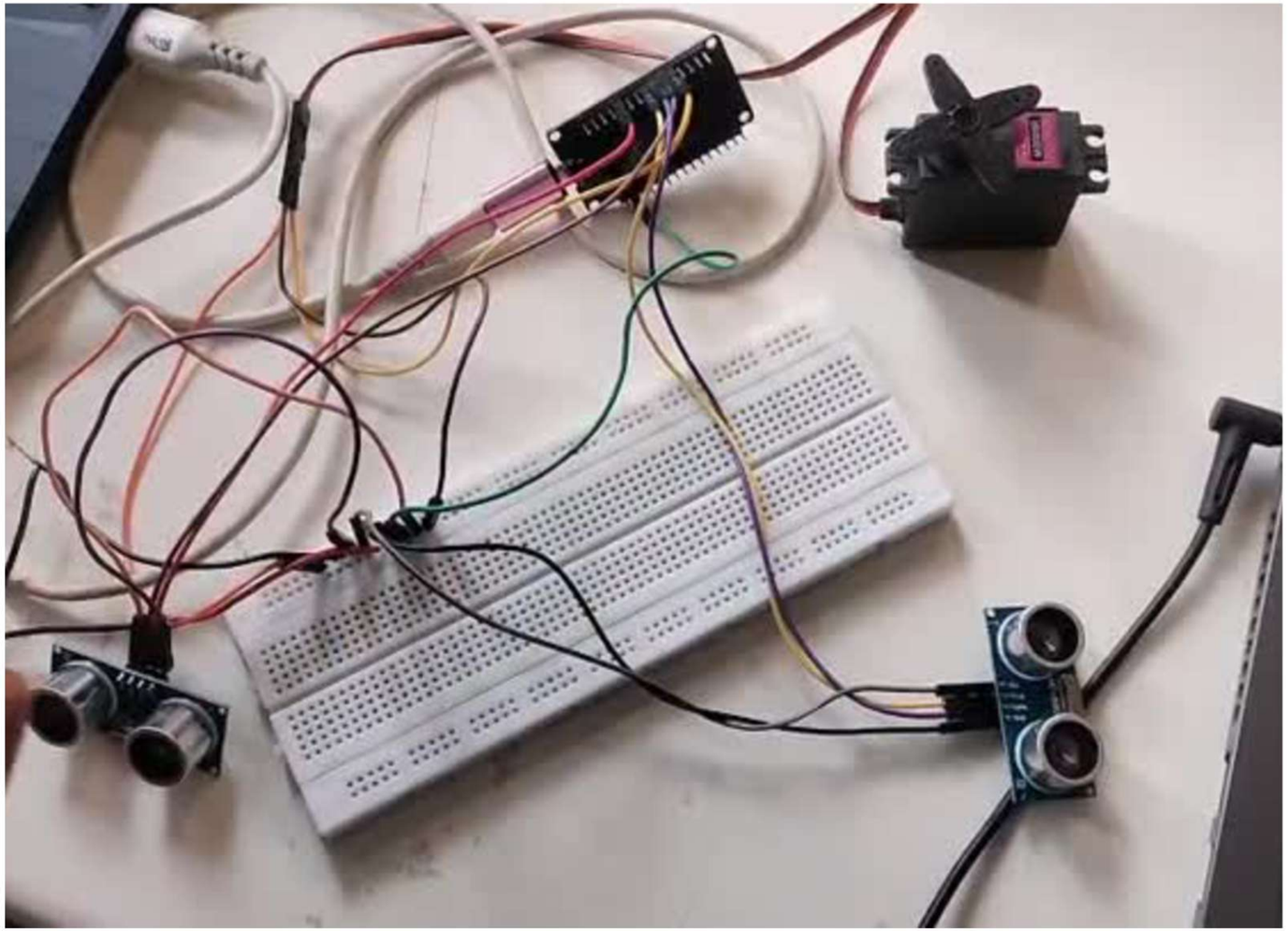
Circuit Design

Circuit Connections

1. Ultrasonic Sensor (HC-SR04) → ESP32
VCC → 5V (from ESP32 or adapter)
GND → GND
Trig → GPIO 5
Echo → GPIO 18

2. Servo Motor → ESP32
VCC (Red) → 5V external supply
GND (Brown/Black) → Common GND (ESP32 + Adapter)
Signal (Orange/Yellow) → GPIO 19

3. Power (5V Adapter)
Adapter +5V → Breadboard + Rail
Adapter GND → Breadboard – Rail
ESP32 Vin → Breadboard + Rail (if powering via adapter)
ESP32 GND → Breadboard – Rail

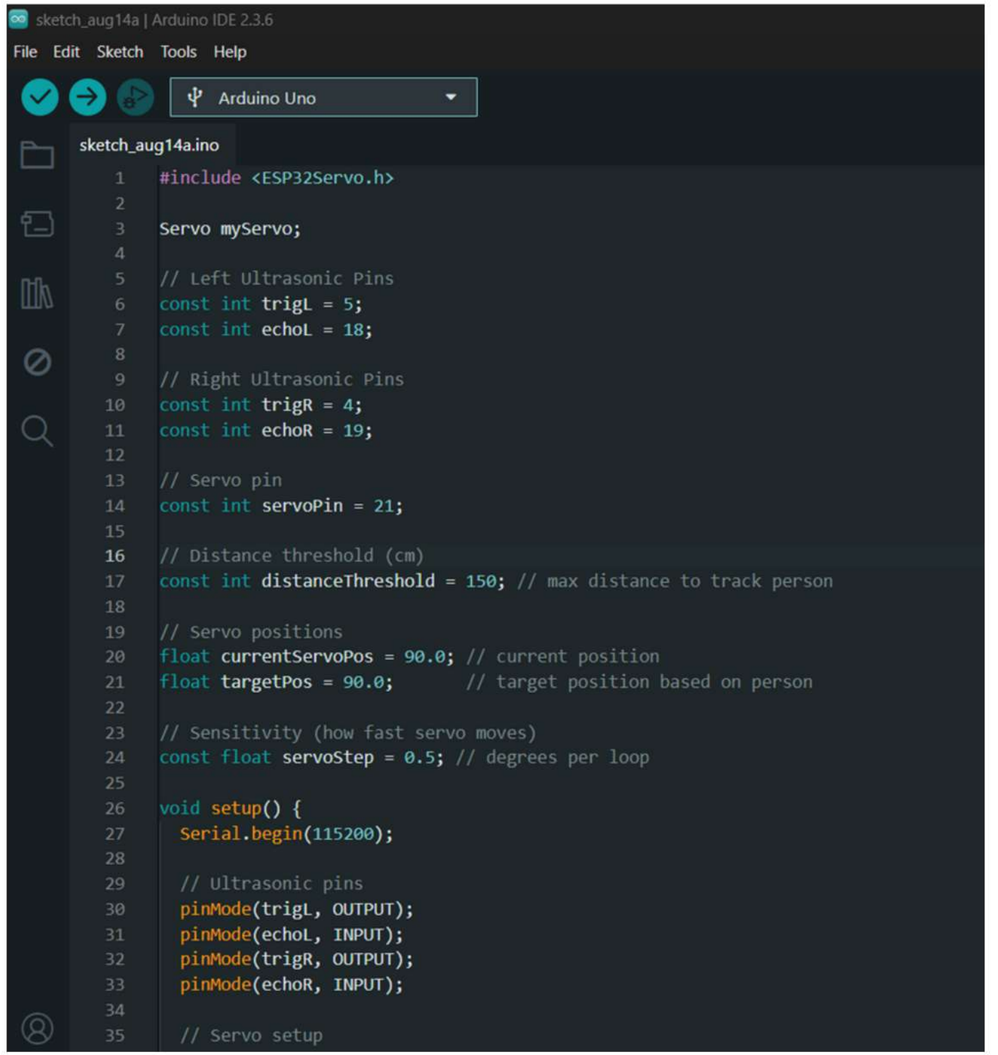


Programming

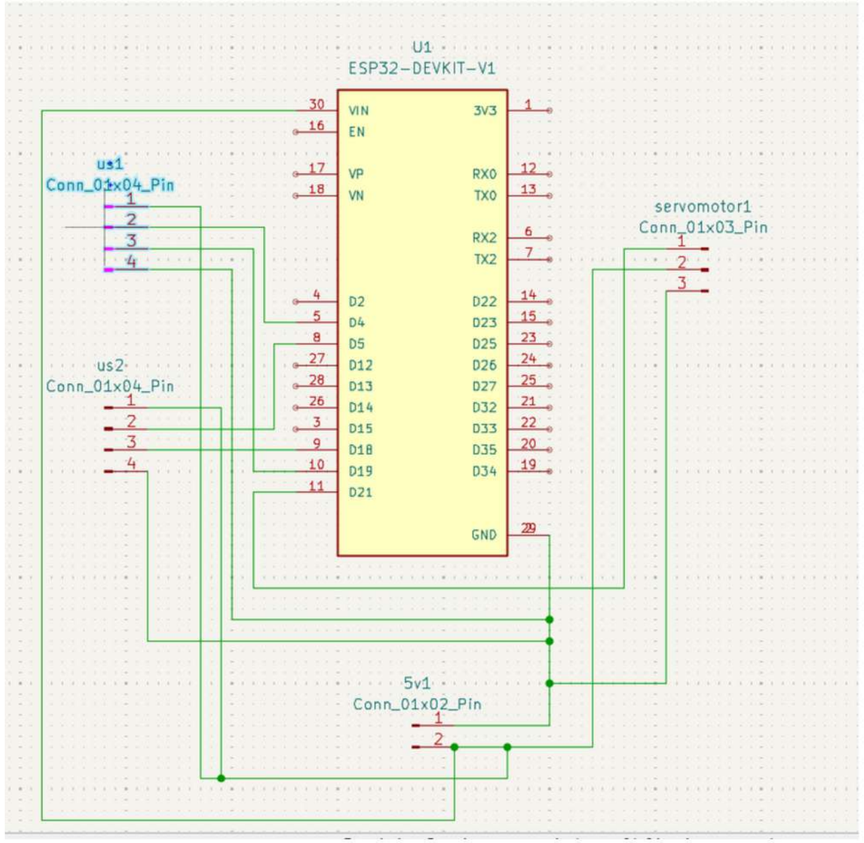
The key feature of code is:

Real-time servo-based tracking of a person using two ultrasonic sensors.

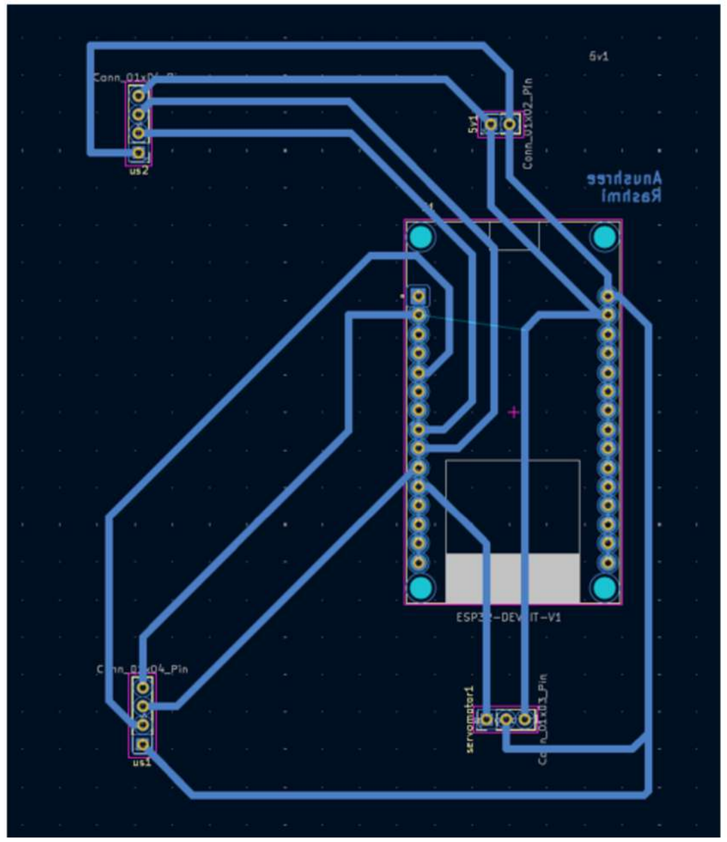
1. Dual Ultrasonic Sensing – Measures distance on the left and right to detect a person's position relative to the servo.
2. Proportional Servo Control – Calculates a target servo angle based on the difference in distances, allowing the servo to "follow" the person smoothly.
3. Smooth Movement – Uses incremental steps (servoStep) to move the servo gradually, avoiding abrupt or jerky motion.
4. Distance Thresholding – Only reacts if a person is within a defined maximum distance (distanceThreshold), preventing unnecessary servo movement.



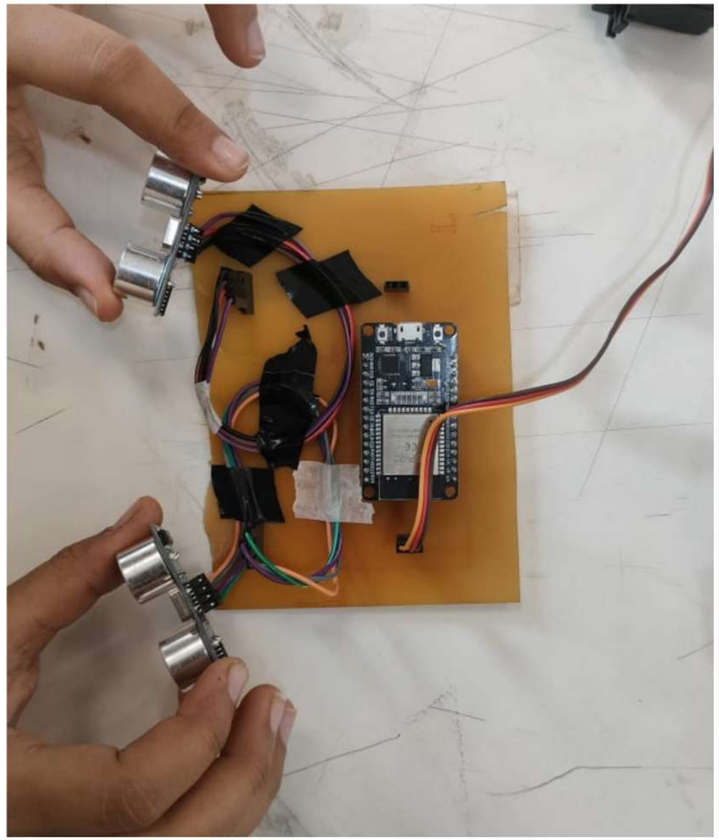
PCB Circuit Design & Fabrication



Schematic Deisgn



PCB layout



Assembly

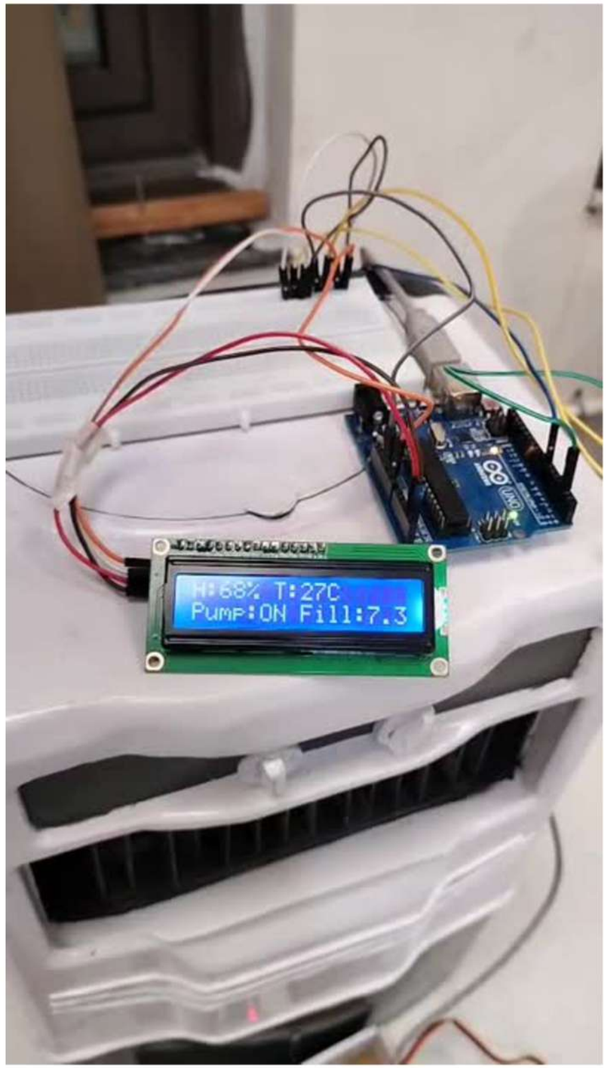
App design

This app was created to automate the operation of a cooler, enabling smart control based on environmental conditions. It simplifies user interaction while optimizing energy efficiency.

FlowIQ

Our smart cooler redefines comfort by automatically tracking the user and angling airflow accordingly, while an integrated humidity sensor intelligently controls the water pump—turning it on only when needed and monitoring water levels to prompt refills. It ensures cooling is efficient, adaptive, and hassle-free, reducing both effort and water waste

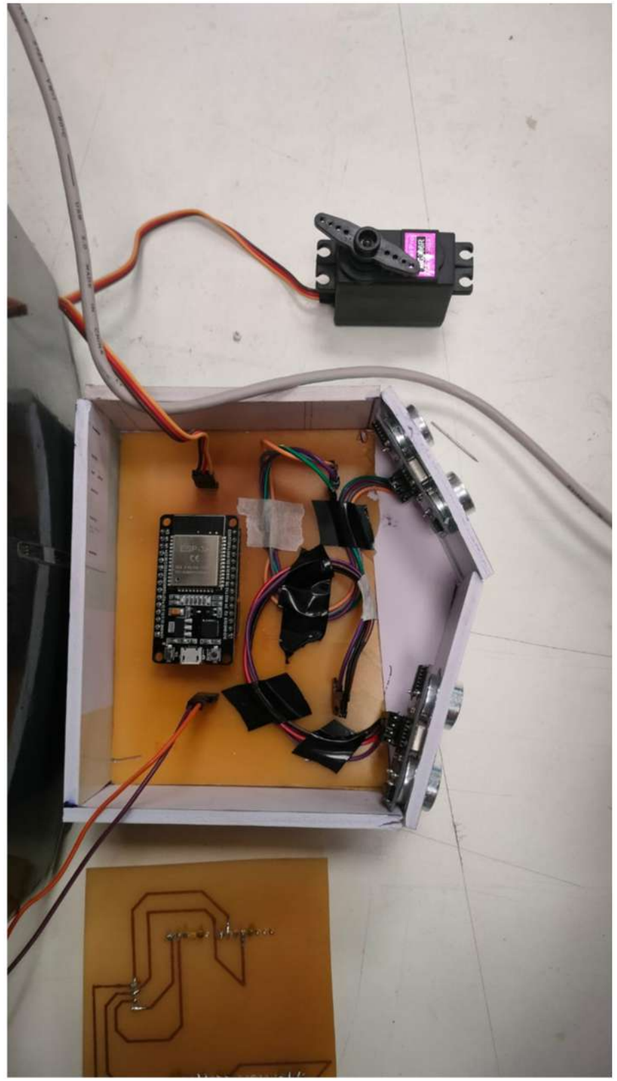
Final working prototype



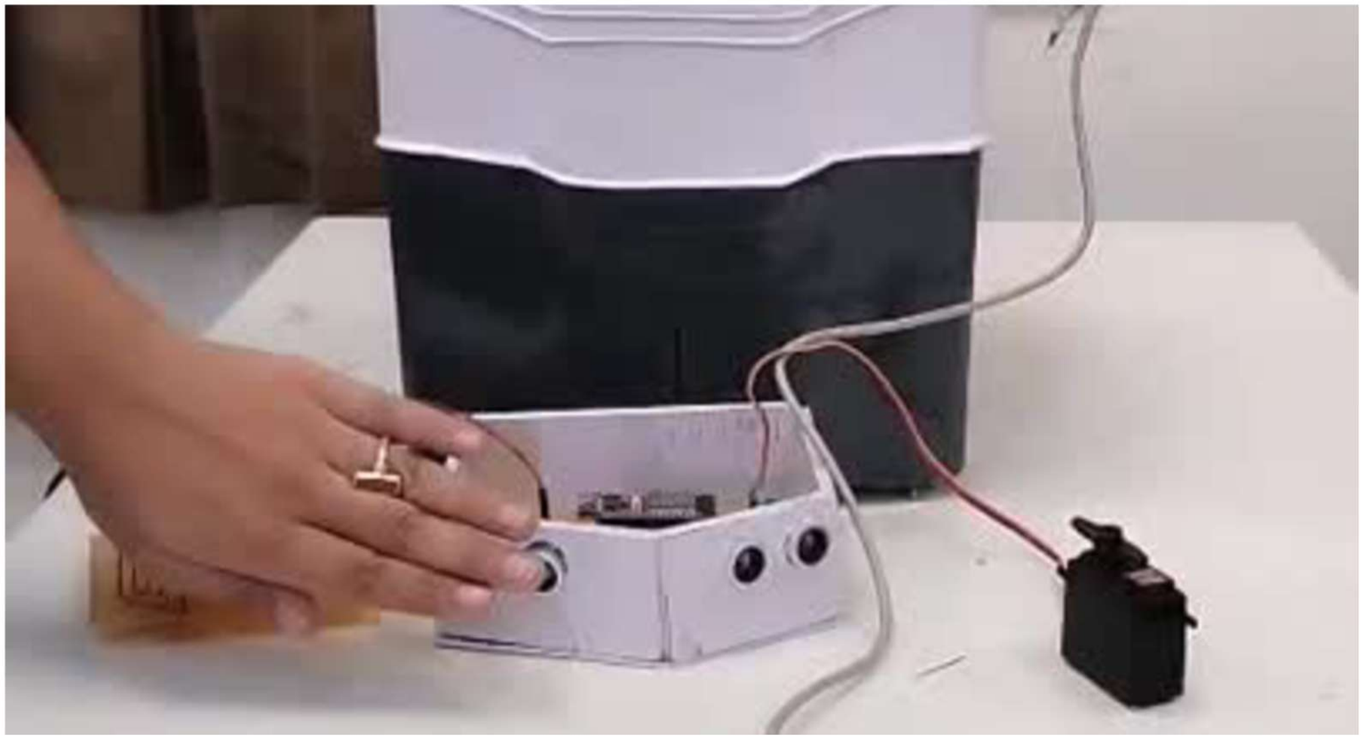
Displays real-time information from the system.

Performs actionin response to sensor detection

Final working prototype



The servo motor rotates to follow the position of a person or object, based on distance readings from the left and right ultrasonic sensors.



THANK YOU