North South University

Department of Computer and Electrical Engineering

Microprocessor Interfacing & Embedded System
CSE331L
Section: 7
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Group: 1

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Project Proposal : Smart Room Comfort Index

Project Overview:

The Smart Room Comfort Index system is designed to monitor indoor environmental conditions, evaluate human comfort, and intelligently control room outputs. It integrates multiple sensors to measure temperature, humidity, and occupancy, computes a Comfort Index using the Heat Index formula, and provides both visual indicators (OLED + LEDs) and automated actuation (servo motor for door/window control).

The primary goal is to build an intelligent, real-time, low-power embedded system that enhances comfort awareness and demonstrates smart control actions in response to environmental changes.

Required Hardware and Sensors:

- DHT11 Temperature & Humidity Sensor – Measures ambient temperature and relative humidity.
- IR Sensor (Passive Infrared, PIR) – Detects presence/occupancy in the room.
- Ultrasonic Sensor (HC-SR04) – Detects movement or distance of objects for activity monitoring.
- 0.96" OLED Display (I^2C) – Shows real-time readings and comfort index.
- 3 LEDs – Comfort level indicators:
    * Green → HIGH comfort
    * Yellow → MEDIUM comfort
    * Red → LOW comfort
- Servo Motor (SG90 or MG90S) – Controls room door/window movement when comfort level is LOW.
- STM32 Microcontroller – Central control and processing unit.

Functionalities:

Environmental Monitoring:

- Read temperature & humidity (DHT11).
- Compute Comfort Index (Heat Index approximation).

Occupancy Detection:

- Detect presence using IR sensor.

- Detect movement using HC-SR04 ultrasonic sensor.

Comfort Evaluation & Visualization:

- Classify comfort into HIGH / MEDIUM / LOW based on thresholds
- Show comfort state and sensor values on OLED display (only when occupied).
- Illuminate corresponding LED to indicate comfort status.

Automated Comfort Control:

- If comfort is LOW → Activate servo motor to open door/window.
- If comfort improves (HIGH or MEDIUM) → Return servo to closed position.

Low-Power Design:

- OLED turns off automatically if no occupancy is detected (power saving).
- System remains active but minimizes sensor polling when unoccupied.

System Design Plan:

Input Stage:

- DHT11 → STM32 ADC/Timing pins (Temp + Humidity).
- IR Sensor → STM32 GPIO interrupt (occupancy detection).
- Ultrasonic Sensor → STM32 trigger/echo pins (movement detection)

Processing Stage:

- Compute Heat Index (HI) from temperature & humidity.
- Classify comfort:
  * HIGH → HI ≤ 27°C
  * MEDIUM → 27°C < HI ≤ 32°C
  * LOW → HI > 32°C
- Occupancy-based control logic.

Output Stage:

- OLED Display (I²C): Show Temp, Humidity, Comfort Level (if occupied).
- LED Indicators: Green/Yellow/Red reflect comfort status.
- Servo Motor (PWM):
  * LOW → Rotate to 90° (open door/window).
  * Otherwise → Rotate back to 0° (closed).

Control Flow:

- If no occupancy → OLED off (low power)
- If occupancy detected → Show comfort data and readings.
- If occupancy detected → OLED on, show live data.
- Comfort evaluation:
    * HIGH → Green LED on, servo closed.
    * MEDIUM → Yellow LED on, servo closed.
    * LOW → Red LED on, servo rotates to open door/window.

Reason Behind Choosing the Design:

This design was chosen because it enhances indoor comfort awareness through a simple, quantified index, optimizes power consumption by disabling the display in unoccupied rooms, and demonstrates real-world embedded system integration by combining multiple sensors, an actuator, and intelligent control logic. Additionally, it provides practical smart home automation features with clear visual feedback, making it both efficient and user-friendly.

Topic Relevance:

This project directly applies concepts from the “Microprocessor Interfacing and Embedded Systems” course, including:

- Sensor Interfacing: DHT11 (Temp/Humidity), PIR (occupancy), HC-SR04 (distance).
- Communication Protocols: I²C (OLED), PWM (servo motor).
- Data Processing: Comfort index calculation using Heat Index formula.
- Low Power Design: OLED power control via occupancy detection.
- Embedded System Integration: Coordinating multiple modules with STM32 firmware.