Performance Evaluation in Built Environment

Instructor: Ph.D Nguyen Hop Minh
Team Measurement

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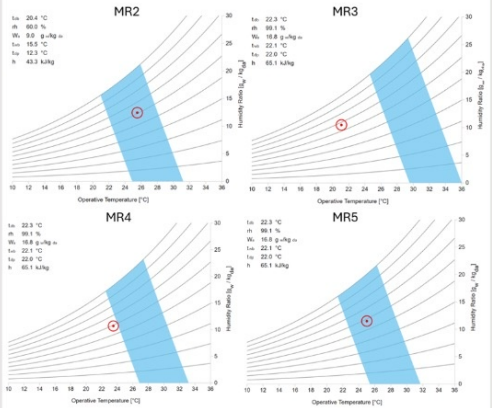
Project brief

The study focuses on thermal comfort on Fulbright campus, noting challenges from centralized AC and a lack of benchmark data. To address this, the team developed a sensory toolkit to monitor factors like temperature, humidity, and air velocity for automated analysis.

Input values in CBE Thermal Comfort Tool

Input	MR2	MR3	MR4	MR5
Clothing Level (Clo)	0.57			
Metabolic Rate (Met)	1.05			
Air Speed (m/s)	0.1	0.16	0.1	0.1
Operative Temperature (°C)	25.5	21.1	23.5	25
Relative Humidity (%)	60.8	67	59.1	58

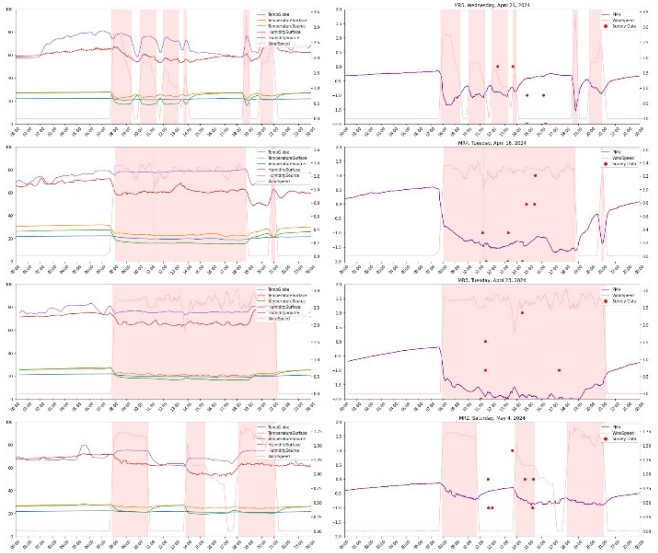
Comparison between our calculated PMV values and ASHRAE Standard 55-2023



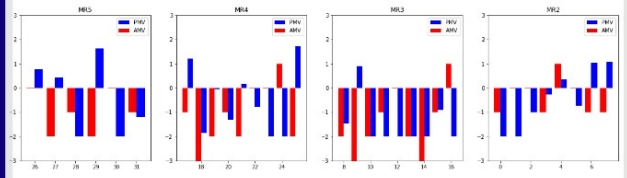
Data & Results

A 24-hour dataset in 4 meeting rooms

PMV calculations and estimations based on survey findings



Comparison between PMV and AMV in 4 meeting rooms

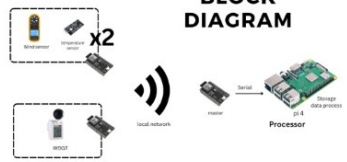


Comparison of PMV and AMV with simulation results

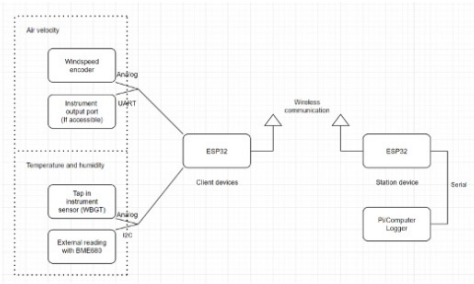
Sensory toolkit design

Hardware setup:
Slave 1: Attached at the inlet supply air vent
Slave 2: Placed centrally in the room, at 1.2 – 1.5 meters above the floor

BLOCK DIAGRAM



Data communication:
Data packet: UID of sent ESP + <param name> + <value> + <next param name> +<next value> + ...



Discussion

Correlations of air velocity with other factors:

- Air temperature and humidity: Supply air velocity during operating hours is crucial as it brings cool air from the HVAC system into the room.
- PMV values: Active supply air velocity raises air temperature and humidity, keeping PMV values in a cooler range (-1 to -2). However, in MR3 and MR4, constant supply air velocity leads to PMV values that do not meet ASHRAE Standards.
- Simulation results: The PMV values from CFD simulations match those from measurements in MR3 and MR4 (constant), but differ in MR2 and MR5 (inactive at times).

Room size matters:

- Smaller meeting rooms, MR3 and MR4, which consistently receive supply air, are the coldest based on PMV and AMV data.
- Temperature and PMV comparisons: Despite similar air velocity ranges, smaller rooms maintain cooler temperatures. MR4 (14 m3) has 2°C higher and PMV twice as large as MR2 (57.8 m3). MR3 (1.7-3.0 m/s) has 5-7°C higher and PMV 2.5 times larger than MR5 (25.4 m3).

Integration with survey findings: Of the 31 AMV survey data points, 17 contradict our PMV calculations (using the pythermalcomfort library per ASHRAE Standard), likely due to incomplete information on respondents' clothing levels, prior activities, and duration in the room, introducing subjectivity and affecting accuracy.

Limitations:

- Experimental setup limitations: Different positions within rooms produce varying thermal comfort levels, making it subjective to assess overall comfort with only 2 sensory toolkits.
- Data accuracy concerns: Lack of evidence for constant supply air in MR3 and MR4 versus periodic supply in MR2 and MR5, and absence of references to validate measured data, may cause differences between the PMV values calculated by the measurement, observation, and simulation teams due to potential percentage errors.