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IPParis HPDA/PDS Master projects 2022-2023
Balancing Energy Consumption and Comfort in Smart Spaces using the IoT
September 12, 2022

Project Description

More than half of the energy consumed in homes is for heating and air conditioning [1]. In buildings, HVAC along with lighting accounts for more than 60% of the energy consumption [2]. Thus, substantial energy savings can be achieved by optimizing HVAC and lighting control. However, there is a clear tradeoff between energy savings and the building inhabitant's comfort. Existing efforts have been proposed to leverage Internet of Things (IoT) devices/sensors in smart spaces to deal with the balancing of energy consumption and comfort [3].

This project aims to introduce a fair middleware-based system that leverages existing IoT devices and infrastructures to reduce energy consumption in smart buildings while taking their inhabitants comfort preferences into account.

Project Objectives

The selected team will be working on the following tasks:

- Design building domain models that relate building information (room capacity, occupancy, etc) to IoT devices and sensors in the space, energy consumption models, and comfort concepts (e.g., thermal preferences of people).
- Design solution to solve the multi-objective problem of selecting a specific HVAC configuration such that: (i) Increases thermal comfort of the people located in the space; (ii) Decreases energy consumption; (iii) Avoids bias when providing thermal comfort.

Skills & qualities

- Fluent in English
- Good knowledge of Object-oriented programming (preferably Java) and data structures.
- Preferably, but not compulsory, familiarity with IoT devices (e.g., their APIs and protocols like MQTT), and/or Semantic Web (e.g., ontologies, knowledge graphs).

Contact

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References and Additional Reading

[1] Energy use in homes:. `https://www.eia.gov/energyexplained/use-of-energy/homes.php`.

[2] HVAC Energy:. `https://www.environment.gov.au/system/files/energy/files/hvac-factsheet-energy-breakdown.pdf`.

[3] Eun-Jeong Shin, Roberto Yus, Sharad Mehrotra, and Nalini Venkatasubramanian. Exploring fairness in participatory thermal comfort control in smart buildings. In *Proceedings of the 4th ACM International Conference on Systems for Energy-Efficient Built Environments*, pages 1–10, 2017.

[4] Roberto Yus, Georgios Bouloukakis, Sharad Mehrotra, and Nalini Venkatasubramanian. Abstracting interactions with iot devices towards a semantic vision of smart spaces. In *Proceedings of the 6th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation*, pages 91–100, 2019.

[5] Omid Ardakanian, Arka Bhattacharya, and David Culler. Non-intrusive techniques for establishing occupancy related energy savings in commercial buildings. In *Proceedings of the 3rd ACM International Conference on Systems for Energy-Efficient Built Environments*, pages 21–30, 2016.

[6] Ronald Fagin and John H Williams. A fair carpool scheduling algorithm. *IBM Journal of Research and development*, 27(2):133–139, 1983.

[7] Marco Pritoni, Kiernan Salmon, Angela Sanguinetti, Joshua Morejohn, and Mark Modera. Occupant thermal feedback for improved efficiency in university buildings. *Energy and Buildings*, 144:241–250, 2017.