CHPB-46-2019: A smart user-interactive system for optimal indoor environment and HVAC control of commercial buildings

Objective:

- Develop a smart user-interactive system to close the gap of human-building interaction, building optimal control, occupant satisfaction and energy use through machine learning and IoT.

Problem

- Smart features with humans-in-the-loop are costly, difficult to manage and have not been deployed at scale.
- Existing buildings: significant occupant dissatisfaction and energy waste.

Approach: A smart user-interactive system that:

- Infers occupant needs and their response to energy use information from their direct feedback or behavior. (Task 1)
- Optimizes HVAC energy consumption based on model predictive control. (Task 1)
- Utilizes a cost-effective wireless sensor network (WSN). (Task 2)
- Integrates web-based user applications via personal devices with high usability. (Task 3)

Impact:

- An autonomous smart system to foster two-way interactions among users, IoT, existing HVAC and BMS with significantly reduced cost and low maintenance.
- Buildings with optimal energy use and occupant satisfaction.

Expected Results/Schedule

1. On-line active learning and distributed Approximate Dynamic Programming (ADP) algorithms **(Q1)**
   - Occupant utility and optimal control policy functions based on Gaussian process
2. Cost effective WSN **(Q1, Q2)**
   - Low-cost sensors, nodes, local sever
   - Automatic configuration and maintenance software
3. Web-based user application with Django framework written in Python, HTML,CSS, JavaScript and D3.js **(Q3, Q4)**
   - Multiple users, e.g. occupants, admins
   - Environmental/energy use information visualization

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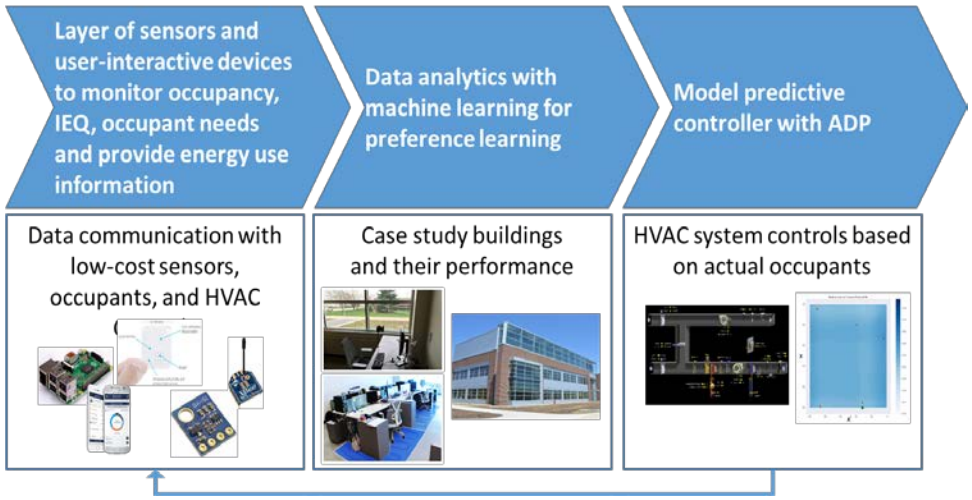
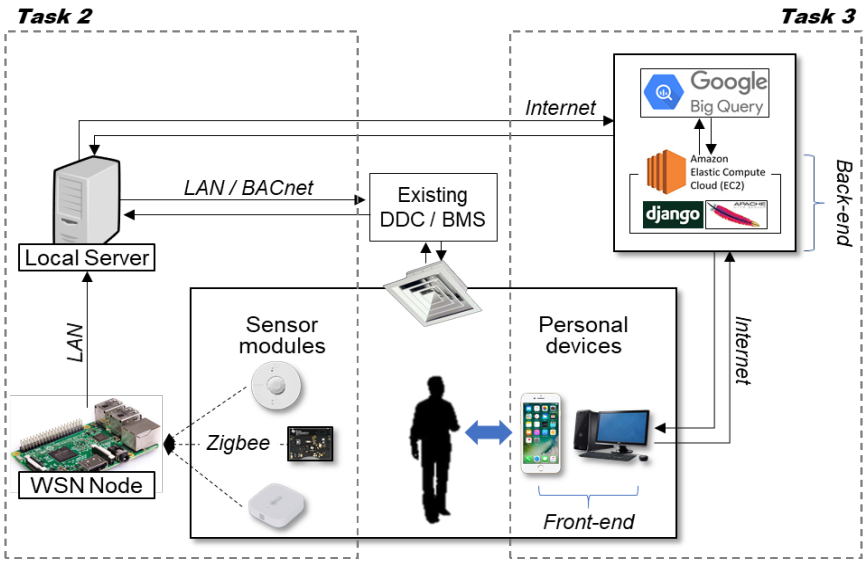


Features of the user-interactive smart system



Smart system architecture

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