Sensing and Modelling of Occupant Behaviour

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BACKGROUND

Building represents the largest end-use sector in EU and it accounts for 30-40% of the energy consumption amongst other sectors. Consequently, several systems have been developed to optimise this energy consumption through active and passive monitoring of building environments for automatic device controls (lights, HVAC) and for future estimation of building consumption by utilizing building simulations to obtain energy saving proposal for new or retrofitted buildings. However, these estimations often differs from the measured consumption because, most estimations are often based on device operational specifications and predefined occupancy scenarios or schedules (set points) [1] that should satisfy a generally acceptable comfort specifications (ambience, thermal and other well being). [2]

PROBLEM STATEMENT

"Occupancy profile is the driving factor behind discrepancies between measured and simulated energy consumption of buildings." [1]
Occupancy itself can be defined as all actions of the occupant (including presence) that affects building energy consumption. [2]. Several efforts have been made by researchers to quantify and model occupancy, however it can be observed that these efforts are usually over-fitted to a particular building context that includes several factors such as building design, location, orientation, the possibility of action it offers, it use, customs and habits of its users. Also the deployment of a monitoring system usually depends upon the purpose of measurement and the accuracy that is sought. Thus a change in any of these factors or such purpose can significantly alter occupancy behaviour and the kind of monitoring system or strategy respectively. Some application of occupancy sensing and modelling system as presented by researchers includes:

1. Presence and absence detection
2. Occupancy count
3. Occupant localization
4. Occupancy behavioural pattern extraction
5. Energy usage apportioning for occupants in private and shared spaces

These applications utilize different sensor modalities, instrumentations and sensing strategies. Also, different occupancy estimation and modelling strategies are employed to derive a near accurate occupancy models that are utilizable for energy simulation systems or smart building applications. Thus, it is essential to

1. determine which sensor modalities are relevant for a particular context (building, application)
2. develop methods that can combines these sensor modalities by determining how information provided by each sensor modality could be concurrent and/or complementary to yield accurate occupancy information and model.
3. determine what modelling strategy or a combination of strategies is sufficient for capturing occupancy behaviour based on information presented by identified sensor modalities.
4. perform occupancy prediction for spaces, building stories and buildings by utilising existing single and multi-label classification machine learning algorithms.

OBJECTIVE OF STUDY

To develop methods for occupant sensing and modelling that identify, characterize, and predict occupant behaviour.

METHOD:

Development of new occupant sensing methods combining several types of sensor modalities, low energy sensing infrastructures, and models for identifying, characterizing, and predicting occupant behaviour. The methods will be developed and evaluated in several real world cases as part of the Coordicy project.

RESULTS:

A software component that can forecast occupant behaviour based on current and historical occupant behaviour and combine different sensor modalities to improve the accuracy and scalability of occupancy sensing. The work will also contribute to the international efforts within IEA EBC Annex66 on occupancy modelling.

PROJECT PERIOD

1 September, 2015 - 31 August, 2018

SUPERVISOR

Associate Professor Mikkel Baun Kjærgaard

[1] Chang Wen-Kuei and Tianzhen Hong, "Statistical Analysis and Modeling of Occupancy Patterns in Open-Plan Offices using Measured lighting-Switch Data," *Ernest Orlando Lawrence Berkeley National Laboratory*, 2013.

[2] A Caucheteux, V Es-Sabar, and V Boucher, "Occupancy Measurement in Building: A Literature Review, application on an energy effieciency research demonstratd building," *International Journal of Metrology an Quality Engineering*, vol. IV, pp. 135-144, 2013.