PhD Seminar Talk on

IoT Solutions for Home Energy Management

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Abstract

Smart scheduling of domestic appliances based on user demand is an important aspect of a smart home energy management system. Such a demand driven operation can be performed only by accurately detecting the presence and the location of users in their residence. Internet of Things (IoT) and other enabling technologies can transform a smart home into an energy aware entity by judicious utilization of the available data. This talk provides a discussion on diverse occupancy detection and localization schemes to decide their suitability for occupancy-driven operation of appliances in a home energy management system. Wireless technologies have been historically employed for detecting unknown targets in indoor environments. The pervasiveness of WiFi access points in urban buildings render it as a preferred candidate for occupancy detection and localization. Design of device-free sensing techniques, using commercially available WiFi routers can offer an affordable solution with minimum disturbance to the inhabitants. Detection accuracy maybe enhanced by combining wireless techniques with smartphone inertial sensors and other passive detection schemes that utilize smart energy meters or environmental sensors. Several challenges must be addressed for occupancy detection in a building energy management system. The impact of these design challenges are investigated and feasible solutions will be considered.

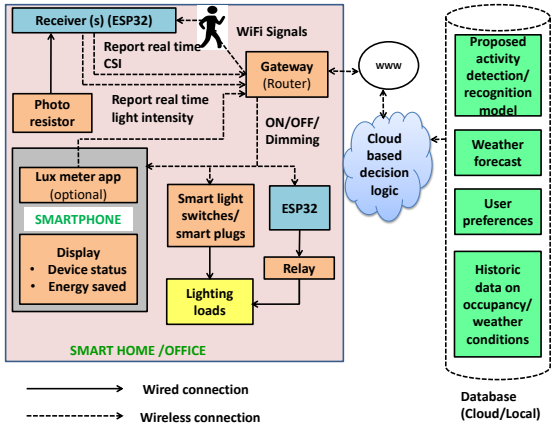

Figure 1: IoT driven smart lighting strategy using proposed HAR model

Human activity recognition (HAR) constitutes an integral part of occupant centric smart services, such as health monitoring and building energy management. In this talk, we also discuss a simple and cost effective solution to HAR through passive sensing of WiFi channel state information (CSI). WiFi CSI extracted from ESP32, a low cost embedded IoT device, was utilized to classify four different human activities, using ensemble machine learning models. A mean accuracy of 83.39% was achieved using gradient boosting classifier with Haar wavelet based denoising, in spite of using a single transmission link and in presence of coexisting wireless devices. The proposed model can be employed for the development of an IoT enabled smart LED lighting system, with minimal infrastructure changes. In this strategy, the illuminance level of LED lighting fixtures is adjusted according to the predicted occupant activity, thereby reducing power consumption, without compromising visual comfort. This method offers a potential energy savings of up to 36.42% and 29.45% per month, for a typical office and home scenario, respectively. The possibility of supplementing activity sensing with daylight harvesting, is also explored. An additional energy savings of up to 18.26% may be obtained using this method, during daytime. An evaluation of the annual electricity cost shows an estimated reduction between 29.43% and 62.13% using activity recognition and daylight harvesting.