Introduction

Smart homes are beginning to emerge and we continue to witness the rise of digital devices around us. A wide variety of smart home sensors monitor different aspects of resident’s life. In general, sensors’ data encompass raw or minimally processed data, which need to be analyzed for feature extraction, inference and learning that ultimately enables better smart home services to the residents. The key purpose of a smart home is to use technology to provide residents with comfort and convenience, security, and efficiency in management of various home resources such as electricity and water. To achieve these goals, there has been extensive research in using data analytics and adaptive algorithm design to learn and predict the habitual behaviors of the home inhabitants and predict their future needs. In this thesis, we focus on prediction models in the smart home and their applications in designing various smart home services. One category of prediction models in smart homes focuses on occupancy and mobility prediction of inhabitants, which plays an important role in applications such as resource management, home automation, intruder detection and security, and health monitoring.

In this thesis, we specifically focus on this category of prediction models and adopt a sequential prediction technique based on text compression algorithms for predicting the occupancy and mobility of the smart home residents. In order to evaluate the performance of the proposed solutions, a flexible small-scale smart home is constructed using motion sensors and a microcontroller. Several movement scenarios are designed and the data has been collected by programming the microcontroller and the physical components. To increase the size of the data sets for evaluation of the algorithms, we have also synthesized movement data streams of inhabitants based on various movement scenarios.

Approach and problem statement

Our focus in this thesis is on prediction models in smart homes and their applications in designing smart home solutions. In this thesis, we started by reviewing various prediction algorithms that have been used in smart home applications. We also reviewed the design and architecture of smart homes developed by several research teams and the applications of their approaches on various aspects on these environments. After this review, we identified algorithm as a prediction model for the occupancy and mobility of residents, which performs well for sequential prediction and specifically allows us to incorporate additional information for improving prediction accuracy by modifying the process of breaking down the data sequence into patterns and building the prediction trie. This allowed us to consider patterns that depict natural inhabitant behavior such as interrupted patterns and activities based on time of the day. In parallel to these activities, we worked on designing and developing a small-scale smart home as well as models for synthesizing mobility data that are similar to the real data by simulating patterns to depict the natural human behavior in order to test and show the improvements in the prediction model after the applied changes. Finally, we have explored the services and applications for smart homes that can be designed using the prediction provided by such sequential prediction models. This final component is to close the loop to the smart home platform by enforcing control or management that uses the predictions based on the collected data from the smart home.