A Review on Data-Driven Methods for Human Activity Recognition in Smart Homes

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EXECUTIVE SUMMARY

The smart home is one application of intelligent environments, where sensors are equipped to detect the status inside the domestic home. With the development of sensing technologies, more signals can be obtained with heterogenous statistical properties with faster processing speed. To make good use of the technical advantages, data-driven methods are becoming popular in intelligent environments. On the other hand, to recognize human activity is one essential target to understand the status inside a smart home. In this chapter, the authors focus on the human activity recognition (HAR) problem, which is the recognition of lower levels of activities, using data-driven models.

INTRODUCTION

With the rapid development of intelligent technology, including sensing and communications, smart homes have obtained growing attention over the past few years, due to the demand of people in assisted living services. Smart home is a common term, defined as a house that integrates various digital devices and automation

systems to assist the users to live in a convenient and safe environment with a high quality of life. The concept of smart home has also evolved a lot, especially from the concept of "intelligent environment". With the information interaction and collaboration of multiple devices and systems, smart home aims to provide automatic assistance such as home appliance control, lighting control, telephone remote control, indoor and outdoor remote control, anti-theft alarm, environmental monitoring and programmable timing control, to improve home safety, convenience, and comfort (Galinina et al., 2015; Jiang, Liu, & Yang, 2004; Tsai, Wu, Sun, & Yang, 2000; Wilson, Hargreaves, & Hauxwell-Baldwin, 2017). It increases the quality of life of home inhabitant in term of security and safety, and takes care of the basic life of people with poor independence. This results on the study of smart home technology.

Overall, the current research on the field of smart home is extremely extensive, and mainly associated with Internet-of-Things (IoT) technology (El-Basioni, El-Kader, & Abdelmonim, 2013; Jie, Pei, Jun, Yun, & Wei, 2013; Malche & Maheshwary, 2017; Stojkoska & Trivodaliev, 2017) and artificial intelligence (AI) (Arriany & Musbah, 2016; Bakar, Ghayvat, Hasanm, Mukhopadhyay, & Systems, 2016; Do et al., 2018; Munir, Ehsan, Raza, & Mudassir, 2019; Zhong, Han, Lotfi, Cangelosi, & Liu, 2019). The IoT technology is a promising solution for advanced connectivity of anything in smart home to form a home network. It contains several communication schemes and interfaces to achieve smooth connection between devices. Using the speedy communication from IoT, AI, or data-driven methods, is the ability of a computer or computer-control machine to perform tasks by learning the model by the data the system previously got, which is similar human intelligence obtain experience (or prior). Smart-home-based data-driven technology including semantic understanding, human activity recognition (HAR) and smart robots, plays an important role to create a home with self-thinking and solving skills.

Depending on the needs of users, the smart home system is expected to perform some of the following tasks: perceiving, understanding and automatic assisting. In this chapter we will focus on the second part: understanding. In the smart home scenario, to recognize human activity, or HAR, is the key step to realize its basic functions. As an active research topic in machine learning areas, HAR is an important part of smart home. In order to develop the most appropriate and accurate methods and approaches of human activity, new approaches and algorithms based on advanced sensing technologies will be reviewed in this chapter. A perfect HAR system usually combines various hardware devices configured in the IoT and suitable algorithms in the smart home to predict the user's activities of daily living (ADL) like leaving house, cooking, toileting, showering, sleeping, etc., so that the home network can provide users with necessary services to avoid complicated operations. Specifically, the implementation of HAR can be subdivided into three subtasks. Firstly, to select

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