

[Short paper] Reasoning Daily Activities of Single Life Using Environment Sensing and Indoor Location

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SUMMARY Recently, many studies about Activities of Daily Living (ADLs) recognition have been conducted, which can be applied to many real-life, human-centric problems such as eldercare and healthcare. However, those research remain many problems in deployment cost, privacy exposure and so on. To cope with the problems, in this paper, we propose an indoor ADLs recognition system by using environment sensing and indoor location technologies.

key words: Reasoning daily activities, Environment sensing, Indoor location, ADLs

1. Introduction

Recently, the increase in the number of unmarried people and late marriages leads to One-person households increasing rapidly. One-person households are expected to increase more in the future and to account for 37.4 % in 2030[1]. However, due to One-person households can not be obtained cooperation and care from others, such as family members, they are easily lost control their healthy life rhythm. According to [2], 2015, in Japan, 20-29 age group, both male and female have the highest rate of breakfast skipping. In addition, because being physically handicapped, some elderly may reduce the life motivation and disturb their life rhythm. As life rhythm is important to recognize the change in **Activities of Daily Living** (ADLs) of people. So, it is very important to monitor and keep a regular record of our ADLs.

Recently, with the rapid development of sensor technologies, recognition ADLs are attracting great attention. There are several studies using camera or microphone such as [3], [4]. However, such system intrusive too many privacy information, which make the user feel that privacy is violated. There are many studies using various sensors or positioning technologies to recognition ADLs such as [5], [6]. However, these systems require some extra equipment, which has a high cost of configuration and deployment.

To overcome the limitations in the mentioned relate works, we propose a reasoning ADLs system using environment sensing and indoor location. To achieve low deployment

cost and low privacy exposure, we use autonomous sensor box [7] which collect various typical environment data without intruding into too many privacy information and use an integration framework called WIF4InL [8] that can compatible with existing Indoor Position System (IPS) in user's house.

In the proposed system, we consider an ADLs reasoning model by applying a machine learning algorithm to environment sensors and people location logs collected in user's house. In order to obtain training dataset, we developed a tool (named Lifelogger) which records the begin and end time of activities. By integrating the sensors data, location log data and lifelog data, each sensor and location log be attached an activity label is extracted and stored as training data. Then based on training data extract feature value of each ADLs. Finally, construct a reasoning model for each of ADLs.

2. Related Work

From past few years many studies utilize various sensing technologies and machine learning algorithms to recognition indoor daily activity have been conducted. They can be roughly categorized into two methods based on type of collected context information: processing multimedia data taken by video cameras feed or microphone recordings, and time-series data taken by various sensors, such as accelerometer gyroscope sound and so on. Such first kind of data collection, inside a home, is considered intrusive to many, hence a situation recognition system using passive information becomes highly applicable. Recently, most current work in indoor living daily activity recognition use the second type of data collection.

Kusano et al. [6] proposed a system that derives life rhythm from tracking elderly movement by using RFID positioning technology. Reasoning life rhythm based on the indoor location and time data. However, it can not determine the exact behavior only by movement locus, so it can not recognize daily activities.

Pei et al. [5] combined the positioning technologies and phone sensors to capture human movements in natural environments and use the movements to study behavior. However, in the case of turning on motion-sensors Wi-Fi and GPS insight of smartphone simultaneously the battery drain rate is very high. Moreover, users in a home may not carry smartphone all the time with them, which makes it a partially

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available source of information.

To overcome the limitations in the aforementioned studies, we propose a ADLs recognition system using heterogeneous environment sensors and indoor location.

3. Experiment Setup

The proposed system recognizes indoor ADLs of the target group by machine learning time-series dataset that combines various environment sensing data with indoor location data of a user. In order to collect the two type of data, the target group's house should deploy two system as follows.

3.1 Indoor Environment Sensing System

A system that measures various indoor environmental data by using environment sensors included temperature, humidity, lighting intensity, atmosphere pressure, sound volume, human motion, and vibration. In addition, we developed an indoor environment sensing service using autonomous sensor box that can be easily deployed without cost-intensive infrastructure and configuration labor. Logger in sensor box, in every time of measurement, create data and modify to JSON format text, then upload to the web service. The service also provides some API which developer can easily obtain the stored time series sensor data and real-time data.

3.2 Indoor Positioning System

To collect indoor location data, target group's house should deploy an IPS. We propose a IPS called BluePin that measures position by using Bluetooth Beacon (BLE) technology. However, some users house may have been deployed an IPS. In order to minimal reduce deploy cost, we proposed a framework WIF4InL[8] which can integrate indoor location data obtained from heterogeneous existing IPS. Location data from various IPSs be converted into unified data schema. And WIF4InL also provides some location query service.

4. ADLs Reasoning Method

We propose a method of recognizing ADLs by supervised learning. The process of applying recognition method is composed of 3 main steps as follows.

- **Establish Training Data of ADLs:** For supervised learning, the system needs training data which have the correspondence between the ADLs and data in advance. To create training data, we developed a tool which records the start and end time of ADLs by manual operation. By integrating the sensors log, location log, and ADLs time log data, each sensor and location log be attached an activity label is extracted and stored as training data. Reference related studies [5], [6], we defined 8 types of main activities within one day: sleep, eat, cook, rest, study, clean and bath.
- **Extraction of Feature Value:** Feature value is a data

that is effective to identify the ADLs. In this step, we get the feature value from training data, as the following process. First, collecting dataset for each of living activities. Then, divide each dataset by a fixed time interval into samples. Finally, calculate the feature value for each sample which is required to machine learning.

- **Construction of Recognition Model:** Based on the feature value of every ADL, construct a machine learning model. There are some popular pattern recognition algorithms, such as SVM, Random Forest. To recognize more than two types of ADLs, we should construct a recognition model for each of ADLs and combine all the constructed models so that the given data can be classified into one of ADLs.

5. Conclusion

To overcome some limitations in most related works, we proposed a recognize ADLs system for One-person households by using environment sensing and indoor location in this paper. And briefly introduced the experiment setup and reasoning method. However, since the study is still in the primary stage, we should evaluate the system by experiment results in our future work.

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