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Smart Home Activity Recognition System Through Various Approaches: A Review

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Abstract: ***Smart homes refer to the amplified residential scenarios that are equipped with sensors, actuators and other devices which are inhibited by the elderly or disables and operated by professionals and health services to enhance and improve the quality of life by prolong stay at home with technology-enabled assistance. In this paper, a review based on the topic smart home activity recognition system through various approaches or techniques is presented. Many researches has been made in the area of smart home automation and conflict resolution between the activities undergoing in a smart home environment. Some used Elgar framework via IoT, the rule- based approach, ambient assisted living (AAL) using non-intrusive sensors, sphere while some used other cloud-based systems for automatic feature extraction and activity recognition. Here, we have reviewed some of the approaches. Each approach has it's own merits, demerits and point of application. The level of accuracy varies accordingly for every approach.***

Keywords: IoT; Conflict Resolution; Complex Activity Recognition; AAL; Sensors.

I. INTRODUCTION

Human mind and his innovations are commendable in many facets which can be proved by the fact that we gather & use perceived information from the observation and use that information for the benefit of mankind. This challenging skill allows us to understand the requirements of others and hence, promotes collaboration and assistance. The background of smart home assistance is attention-grabbing from a data mining point of view. In fact, the smart home can be seen as a Big Data warehouse where HD information is congregated from a horde of sensing technology.

The produced sensor data from sensor-based monitoring are mainly time series of state changes and/or numerous parameter values that are administered through data fusion, probabilistic or statistical analysis methods and formal knowledge technologies for activity recognition. Under these tactics, sensors can be attached to an user under surveillance in the form of wearable sensors or smart phones, or objects that create the activity environment. But, we find that the approach is not aptly suitable for the elderly people that are naturally senescent and feeble to hold the devices in their everyday ADL. So, we have another solution for this problem identified as AAL.

Ambient assisted living (AAL) is one of the typical applications of IoT which aims to upkeep independent living and is inspired by the worldwide drift towards an aging population. The main reason for the persistent growth of AAL is to assist disabled and elderly people, and particularly those with prolonged diseases, to boost their health and aid independent living. The other aspect of the same is the resolution and identification of complex activities taking place in a smart home environment. Robust method is required to recognize kinds of interaction based on activity performed, they can be either individual, parallel or cooperative. Now, let us understand that what do these terms actually mean?

The 'individual' activity as the name suggests is the activity carried out by a single person. 'Parallel' is defined as more than one dweller are carrying out different activities at the same time but different location. While 'cooperative' is considered when more than one resident is performing the same activity at the same time and place. For an instance, eating food and watching T.V. by two different persons but at same place and time are the example of cooperative activity of multi-resident.

Activity recognition has been classified in the following ways:

1) Based on the types of sensor data

- Vision-Based
- Non-Vision-Based

a. Wearable Sensors b. Object-Attached Sensors

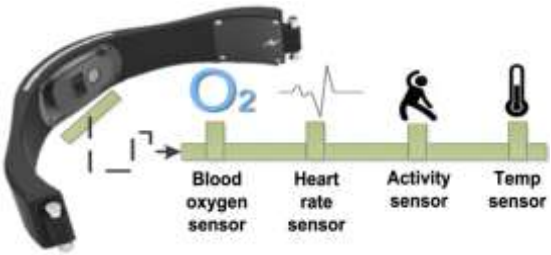

Fig. 1. An Example of Object-Attached Sensors

2) Based on the way data are analyzed

- Data-Driven Approaches:

Probabilistic reasoning and machine learning, example, Bayesian networks, stochastic sampling, etc.

- Knowledge-Driven Approaches:

Formal knowledge modelling, representation and reasoning, example, logics, ontologies, etc.

II. RELATED WORKS

A lot of work is done in this area, here we are discussing a few of them as:

A. IoT Based Activity Recognition Based On The Types Of Sensor Data Using Cloud:

Human activity recognition focuses on the recognition of Activity of Daily Living (ADL) performed by one or many humans in an augmented environment. It has become a masterpiece of ambient intelligence with the arrival of ubiquitous computing and the advances of smart environment.

Here, we are reviewing the vivid approaches of the field and how they evolved through the last few years. The standard branches of research on human activity recognition own some of the defects that bound their real-world applicability. Many researchers are creating hybrid solution in order to draw the benefits from each branch. So, let's first bring more clarity to the concepts of ADLs recognition inside a smart home.

Before studying the mechanism of ADLs, it is necessary to understand that what is the need of activity recognition and how it is beneficial for different individuals? As it is shown in the figure 2, the person who is young and physically fit is able to stay at home alone though he can use the smart technologies for his own convenience and luxury. The transitioner on the other hand is an elderly person who is heading towards an old age and is less capable of performing various activities while the struggler is the one who is physically or mentally disabled and needs the assistance with daily tasks.

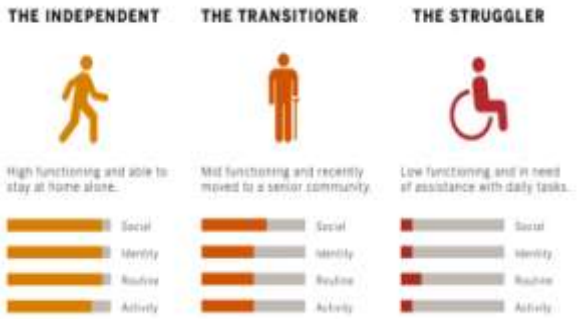

Fig. 2. The Need of Activity Recognition Through ADLs for Elderly People and the Disables

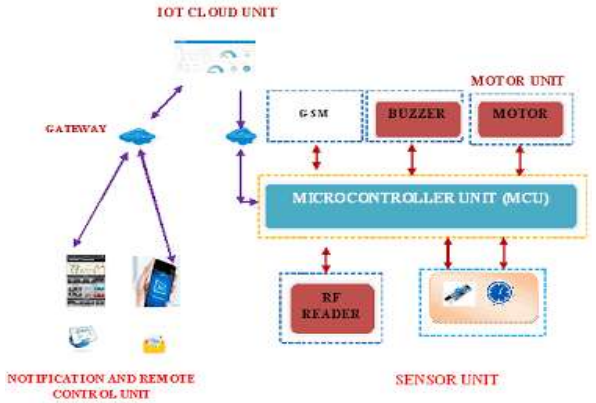

Fig. 3. Activity Recognition Using Cloud

Fetching data from sensors can be done in myriad ways using the IOT technology using Cloud computing. Several ways to connect devices to cloud in present time are give above:

- Sensor to Cloud over Ethernet
- Sensor to Mobile-Phone Network to Cloud
- Sensor to long-range radio to the cloud
- Sensor to Wi-Fi router to cloud
- Sensor to Mobile Phone to cloud

The above block diagram shows the working of mentioned myriad ways of fetching and sending data from sensors to IOT device using cloud. Sensors, or things, sense data and typically act locally. A trigger is used to enable the sensor, instruments, and websites to send data to the cloud where it is stored in either a private or a public channel. Here private channel stores the data without sharing to other while on the other hand public channel stores the data with sharing facility with others. Once the data is in a channel, you can analyze and visualize it, calculate new data, or interact with social media, web services, and other devices.

B. Ambient Assisted Living in Smart Homes by Cloud based Recognition of Complex Activities:

A cloud-based architectural design of the system is proposed in this. A user activity log is maintained for future reference, reviewing studies and examining based on the sensed activities. Lastly, the system gives recommendations based on the activity classification. On the detection of an unnatural or possibly harmful activity, the system generates an alarm and informs the designated person about the potential threat. The cloud-based approach is preferable over local processing for the reason that, the deployment is simplified and only the basic minimum of hardware resources are deployed locally. While, local processing and classification would complicate the architecture and increase the cost. Another reason being, it simplifies collecting and integrating data from various places, constructing general models and finding global patterns.

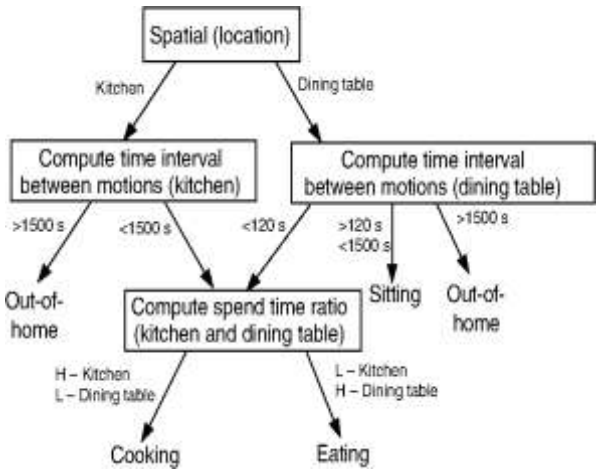

Fig. 4. ADL Recognition for Elderly People

Ambient-assisted living (AAL) has been broadly regarded as a favorable tactic to address some of the issues allied with assisting the ageing population. As we can see in the figure given below, there is a high need of assistance to the struggler and the transitioner as compared to the independent person.

As we can see in the figure 4, which illustrates the concept of recognition of Activity of Daily Livings (ADLs) inside a smart home for the assistance of elderly people. The figure depicts the procedure of recognizing an activity done by a person in a smart home environment who is less functioning than the independent persons. The sensors collect the data from the motion of a person and sense the location first. Here, it is shown by two locations i.e. kitchen and dining table. It computes the time interval between motions to identify the activity of the person in the kitchen if the location is kitchen. If there is no motion observed for more than 1500 seconds then that means that the person has gone out of home. On the other hand, if the person is around dining table the same approach is followed of computing the time interval between motions on dining table and recognizing the activity. The same interpretation is made in this case also if there is not any motion for more than 1500 seconds i.e. out of home while if the time interval is between 120 sec. to 1500 sec. then the activity interpreted is that the person is 'sitting'. Combinely, in both the cases otherwise, it computes the spent time in the kitchen and on the dining table. If the time spent in kitchen is more than the time spent on dining table then it means that the person is 'cooking' else he/she is 'eating'. In this way, the activities are recognized in daily living. Some other approaches can also be used to predict the activities. Many scientists use different models in artificial intelligence like the Hidden Markov Model (HMM) etc. to implement the recognition of ADLs.

Fig. 5. An Example of Activity Recognition Through Motion Sensor

An approach like this enhance the quality of life of older people. The conception of smart homes, namely residential environments augmented with sensor technology and assistive services have developed as a leading realization of the AAL approach. Normally, SHs function in a "bottom-up" process in which sensors monitor an inhabitant's activities and environment. Then the data from these sensors are collected and processed to identify activities of daily living (ADLs), such as washing clothes or drinking water.

In this way, it is possible to detect difficulties in task completion, consequently letting assistance to be offered through the SH services. As such, SHs allow older people to live longer independently, with a better quality of life, in their own homes.

III. CONFLICT RESOLUTION USING RULE BASED APPROACH

Within the multi-resident environment, the conflict of interactions can occur in the complex activity recognition encompassing the individual activity, parallel activity and cooperative activity. The 'individual' activity as the name suggests is the activity carried out by a single person. 'Parallel' is defined as more than one dweller are carrying out different activities at the same time but different location. While 'cooperative' is considered when more than one resident is performing the same activity at the same time and place. For an instance, eating food and watching T.V. by two different persons but at same place and time are the example of cooperative activity of multi-resident. The rule based approach identifies the conflict in supervise learning and treat types of interactions as new additional labels in the datasets. Essentially, the things that are considered to define the type of interactions are the activity type and the performer which are the main subjects to be considered in this approach.

Rule-based Algorithm:

A rule-based service customization policy employs a semantic distance-based rule matching technique for context-aware service decision making and a Rough Set Theory-based rule generation method to administer the service customization. The simulation study reveals the trend of the algorithm in time complexity with the number of rules and context items. A model smart home system is implemented based on smartphones and commercially accessible low-cost sensors and embedded electronics. It shows prodigious potential in employing the proposed strategy for context-aware automation and decision support in smart home applications.

Table 1. Rule-Based Algorithm in Conflict Interaction of Complex Activity Recognition of Multi-Resident

RULE BASED ALGORITHM

```
While event(s) received from system(s)
 Do
     The received events will be checked based on conflict rules to meet condition.
   If activity RA == activity RB | activity RB == activity RA if Type activity RA == Type activity RB | Type activity RB == Type activity RA
                    result = 'Cooperative'
 else
                    result = 'Parallel'
  else
                    result = 'Individual'
 End
 End while
```

The vital components to a rule-based system are the 'knowledge base' and the 'inference engine'. The knowledge base is a relational database where the rules are generated entirely by experts. However, machine learning techniques can be used instead to extract that same knowledge. The inference system is traditional one where rules have a weight to establish a priority in the case that many can be fired at the same time.

Active databases are categorized by their Event-Condition-Action (ECA) rules. They are intended to react to incoming information and have the following syntax:

ON <Event>, IF <Condition>, DO <Action>

The event part specifies the signal that triggers the rule whereas the condition must be filled in order to react. If the condition is met, the action part is executed. However, in smart home, events present uncertainty due to the lack of precision from sensors. There is also such uncertainty in the condition part and in the relation that links both.

IV. SUMMARY

In this paper we have discussed that automatic recognition of complex activities can help in finding correlations between the daily habits of people and their health state, and can further lead to early detection of diseases or accidents. One could extract robust and reliable features, using a systematic and automated feature extraction and selection process that facilitated in building influential classification models. The work described here is introductory but demonstrates that ubiquitous, simple sensor devices can be used to recognize activities of daily living from real homes. Internet of Things (IoT) is seen as new paradigm, transforming consumer electronics by extending Internet connectivity to many physical objects associated with consumer's daily life. But every coin has two sides, with the benefits in technological advancements, the risks of them also come side by side. So, this is another side of research that are we able to cope up with the risks associated with the use of sensors and automation systems in the case natural disasters like fire?

Fig. 6. Comparison Between the Different Generations of AAL

The development of AAL in assistance has occurred in a significant manner as we can see in the figure 6, with the following advantages:

- Integration of home sensors and wearable devices.
- Prevention, monitoring and assistance.
- Less obtrusive(noticeable)

But along with it we need to study the risk factors involved in it and find out their appropriate solutions in order to prevent the loss of lives and property in the nearby future which is another area of research.

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V. REFERENCES

[1] Liming Chen, Member IEEE, Jesse Hoey, Chris Nugent, Member IEEE, Diane Cook, Zhiwen Yu, "Sensor-based Activity Recognition", SMCC-11-08-0375: IEEE SMC-C Trans.

[2] Serge Thomas Mickala Bourobou and Younghwan Yoo, "User Activity Recognition in Smart Homes Using Pattern Clustering Applied to Temporal ANN Algorithm", Department of Electrical and Computer Engineering, Pusan National University, Sensors 2015.

[3] Thinagaran Perumal1, Chui Y.L2, Mohd Anuaruddin Bin Ahmadon, Shingo Yamaguchi, "IoT Based Activity Recognition among Smart Home Residents", 2017 IEEE 6th Global Conference on Consumer Electronics (GCCE 2017).

[4] Raihani Mohamed1, Thinagaran Perumal1, Md. Nasir Sulaiman1, Norwati Mustapha1, Mohd Norhisham Razali1, "Conflict Resolution using Enhanced Label Combination Method for Complex Activity Recognition in Smart Home Environment",

2017 IEEE 6th Global Conference on Consumer Electronics (GCCE 2017).

[5] Aleksandra Zdravevska, Ace Dimitrievski, Petre Lameski, Eftim Zdravevski, Vladimir Trajkovik, "Cloud-based Recognition of Complex Activities for Ambient Assisted Living in Smart Homes with Non-Invasive Sensors", IEEE Eurocon 2017, 6-8 July 2017, Ohrid, R. Macedonia.

[6] Joseph Rafferty, Chris D. Nugent, Jun Liu, Liming Chen, "From Activity Recognition to Intention Recognition for Assisted Living Within Smart Homes", IEEE Transactions on Human-Machine Systems 2016.