IoT Based Activity Recognition among Smart Home Residents

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Abstract —*Activity recognition in smart home environment is actively pursued for accessing changes in physical and behavioral profiles of home dwellers. Various activity recognition solutions have been previously proposed to implement a system with wearable sensors and smartphones. Although such solutions are widely integrated, the availability of the activity data in seamless way still poses interesting research challenges. Internet of Things (IoT) is seen as new paradigm, revolutionizing consumer electronics by extending Internet connectivity to many physical objects associated with consumer's daily life. In this paper, an Internet of Things (IoT) based activity recognition framework is proposed for activity monitoring within consumer home network. Our proposed Elgar framework handles management of activity recognition via IoT services in an IoT environment with multiple devices. The performance evaluation done pointed that the proposed system can robustly identify the activities using IoT in smart home environment with high accuracy. Hence, this system could be reliably deployed into a consumer product for the usage of home dwellers*

Index Terms — Internet of Things (IoT), Smart Homes, Activity Recognition, Elgar Framework

I. INTRODUCTION

In recent years, activity recognition systems gained importance and pursued proactively in the field of smart home environment [1]. These systems are deployed to recognize user activities for many different applications that automate their daily tasks. Recent advancement in consumer electronics and home networking prompted rapid development of various activity recognition systems. Smart home environment, being heterogeneous in nature poised with many significant challenges for tracking and recognizing activities of daily life for the comfort of home dwellers. By recognizing the daily activities, the home environment could function as an augmented smart space by responding to the needs of home dwellers. Consequently, activity recognition in smart home environment has become one of the active investigation areas with significant interest [2-3].

The Internet of Things (IoT) is a communication model that specifies smart objects of daily life equipped with intelligence and connectivity, enabling them to communicate with one another and consumers, becoming essential part of the Internet. IoT would enable seamless discovery of activity patterns, and deriving models for analytics with large chunks of activity data. It is important to note that activity data generated in smart home environment is enormous, intensive and surmounting due to rapid usage of numerous consumer devices. Hence, IoT will nurture the development of a number of smart home services that optimizes the heterogeneous activity data generated by these devices. In this paper, an IoT based activity recognition system for smart home environment is proposed based on wearable sensors. The proposed system with Elgar framework has been deployed in a prototype system and tested with a group of participants. The rest of the paper is structured as follows: Section 2 describes the system implementation. Section 3 illustrates the experimental results and performance. Finally Section 4 concludes this paper.

II. EXPERIMENTAL SETUP

The outline of the proposed IoT based activity recognition systems is presented in Fig.1, with core components on based on wearable units. These wearable units consist of tri-axial accelerometer sensors, integrated with IEEE 802.11 unit on one single board, acquiring real-time activity recognition data and time stamp information. Using on board analog to digital converter (ADC), the activity data are captured and transmitted to the MCU board for processing. The acceleration signal is processed and transmitted wirelessly to the IoT cloud server for the purpose of storing and analytics. The entire system is complemented with web dashboard for real-time monitoring of activity data.

The activity data collection was performed using tri-axial accelerometer sensor with sampling frequency of 20Hz and the output range was ±6g. The wireless aggregator unit attached to the MCU board communicated with a configured IoT cloud server to store and analysis the activity data. Outputs of accelerometer based units are usually indicated by their

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placement and position on subject's body. In practice, these units are placed on the body to detect movement on wrist, thigh, arm, etc. In this paper, the focus of the work are related to the daily living activities of home dwellers, hence the wearable accelerometers are placed at a position that generates walking, sitting, climbing and running activities. To recognize dynamic activities generated by the wearable units, a machine learning classifier was trained to produce a classification model. A Naïve Bayes machine learning package was installed in the IoT cloud server, providing a collection of machine learning algorithms for activity recognition. Default parameters associated with the classifier was used. In addition, a conflict resolution module was also included to detect and rectify activity conflicts generated by the wearable units. The activity data generated by the wearable units will be delivered to the IoT cloud server and subsequently displayed in remote dashboard.

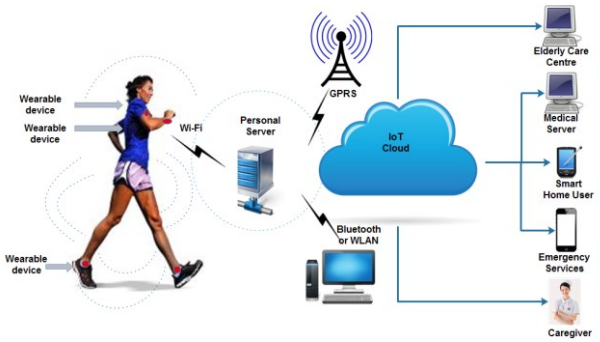

Fig. 1. System architecture of the activity recognition system

III. Performance Evaluation

The average response time taken to detect and recognize an activity is 30ms. A first peak of response with 46ms was measured during system initialization. A total of 200 samples of activity were measured to compute the total time taken in completing a single activity detection transaction time. Fig.2 below depicts the response time measured during system operation of activity recognition system.

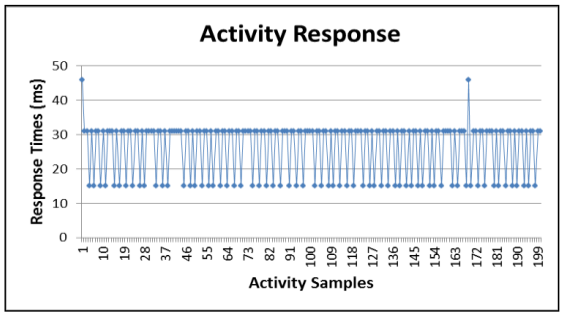

Fig. 2. Response time of activity recognition system

The activity datasets gathered by each subject was then trained and organized for test sets accordingly. The activity data then are pushed to the IoT cloud server and then used to build new classification models. In this work, Naïve-Bayes classifiers are deployed to generate new or refined model based on the user preferences. The activity data generated by home dwellers are then filtered and stored in the IoT cloud server as previous data.

Once the entire the operation is complete, the optimized model is sent back to the user via web-based dashboard. Thus, this new or updated activity model can be used home dwellers for real-time classification. A set of the obtained activity data is illustrated in web-based dashboard as shown Fig.3 below.

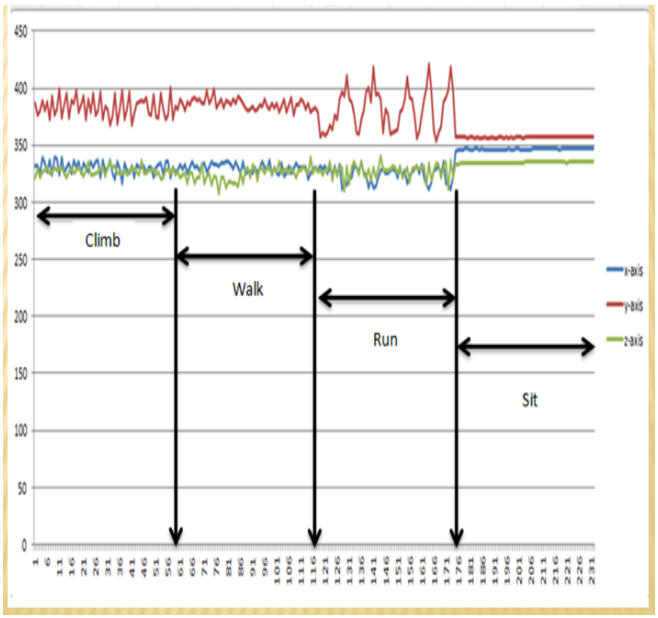

Fig. 3. Pattern of the collected activity data displayed on web dashboard.

IV. Conclusion

In this paper, an IoT based activity recognition systems based on wearable units was proposed, implemented and deployed successfully for activity detection using consumer home networks. By using information fusion of accelerometers, the activity types generated from activities of daily lives could be gathered seamlessly. Internet of Things (IoT) could ensure continuous gathering of activity data in real-time that results in huge amounts of data, especially if many users are involved. The proposed system achieved a high accuracy of 72% and could be deployed in any consumer-centric daily task monitoring system to examine activities of elderly as well as disabled citizens in smart home

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