A Cognitive IoT Monitoring and Support System for Elderly Care*

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***Abstract*— Ubiquitous computing and the Internet of Things (IoT) are enabling the possibility to provide remote health-care services through networks of environmental and personalized sensors. We present an e-health system, which collects real-life sensor data through motion, door and pressure sensors installed at elderly households. Daily activity and health status are extracted from raw sensor signals. We present different ways to detect abnormal behaviors, based on which personalized health-care services can be provided. Such systems minimize user input and interaction, thus could offer a long-term practical service.**

I. INTRODUCTION

Exacerbations of chronic conditions associated with aging lead to adverse events, and hospitalization, which prevent elderly people from living independently. Tracking health status and identifying early signs of illness can provide efficient care solutions, thus offers healthy independent living possibilities for elderly citizens.

Due to privacy and usability reasons, passive low-level sensors are often used, such as: passive infrared motion sensors (PIR), capable of detecting movement, room presence; door open/close sensors, installed on the main entrance to detect visiting and outing activities; and pressure-based bed and chair sensors, to track sleeping and resting patterns.

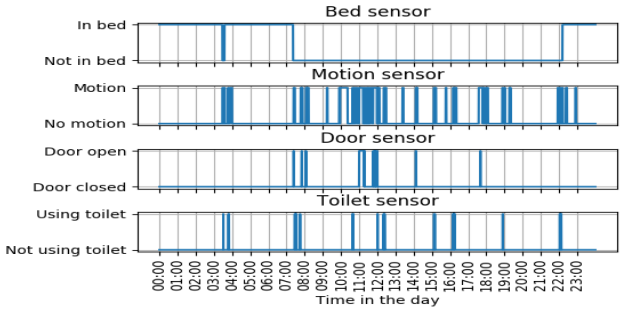

Figure 1. Raw sensor signals of a user collected on Jan. 11th 2019

Our system use a MQTT WI-FI protocol to transfer sensor data to local server. Anonymized and encrypted data is fed to cloud-based data analytics engine through a secure gateway. Analytic results are send back to the server through secure web service, which are then fed to the patients, caregivers, care- and case-managers, as well as concerned family members, by various interaction strategies. Privacy and ethical concerns are compliance with European regulations.

II. METHODS

Raw sensor signals (Fig. 1) from multiple devices are inferred into meaningful knowledge of users' activities [1, 2]. Activity routine (Fig.2), which reveals a user's typical daily activity patterns, is inferred as the probabilities of daily activities at different times in a day. By clustering multiple users' activity models, we can observe groups of different behavior patterns. A user's change of routine can be observed by tracking the activity patterns over time.

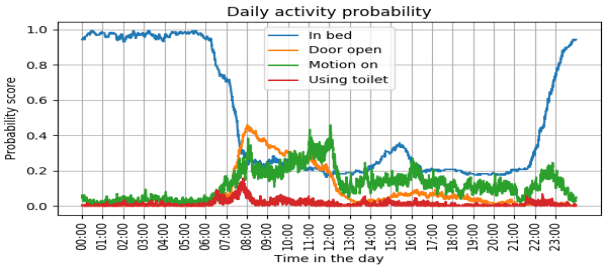

Figure 2. Probability of daily activities during a day

Anomalies are considered as sudden changes of behaviors, which are referred to as activities that are difficult to be predicted from the typical routine. Daily abnormal scores can be measured as deviation from the learned routine, use cross-entropy measurement. Anomalies can also be detected as outliers, once daily activities are represented in an event-based feature space. Due to the lack of labels in real-life data, unsupervised or semi-supervised algorithms, such as one-class SVM, Isolation Forest, and auto-encoder are applied.

III. DISCUSSION & CONCLUSION

Our goal is to provide an efficient elderly care system that is conveniently deployed for long-term use. Our service can make care-giving more effective by personalized early symptom assessment and intervention. Our system is being tested at real-life elderly homes.

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