PART III

APPLICATIONS OF IoT

Unit Eight

Applications of IoT in the Health Domain

Passage A. Personalized Healthcare

With the advancement of IoT technologies, personalized healthcare is no longer a luxury idea for the general public.

Personalized health capability is limited to the available data from the patient, which is usually dynamic and incomplete. Therefore, it is presenting a critical issue for knowledge mining, analysis and trending. Internet of Things (IoT) is the result of the efforts to provide connectivity and intelligence to convert small devices and common things into Smart Objects. These Smart Objects present high capabilities to integrate and transfer enriched data from environmental sensors, parking, activities, behaviours and clinical devices from mobile health and Ambient Assisted Living (AAL) environments.

This huge and enriched data is what defines the Big Data. Big Data brings a lot of opportunities for a wide range of application areas. Particularly, we focus on the personalized healthcare, which enables patients to monitor their own environments, i. e. the deployment of custom remote monitoring (remote assistance) and mobile health solutions. This offers the capability to send alerts, predict possible anomalies in real time, and transfer the collected data to an information system, in order to allow the subsequent study of patients and even, thanks to the large amount of data collected may help future researchers improve treatments for diseases or finding new cures. These systems and solutions require more intelligent physiological sensors.

A variety of technologies are making it feasible to identify sense, locate, and connect all the people, machines, devices and things surrounding us. These new

capabilities for linking Internet with everyday sensors and devices, forms of communication among people and things, and exploitation of data capture, define an extension of the usual Intranet of Things to a more Internet of Things.

Ambient Assisted Living (AAL) is a promising area for both health researchers and practitioners. AAL encompasses technical systems to support elderly people and people with special needs in their daily routine. The main goal of AAL is to maintain and foster the autonomy of those people and, thus, to increase safety in their lifestyle and in their home environment. The necessity for such applications arises from the demographic change in industrialized countries where life expectancy is on the rise and the birth rate is in decline. These circumstances require innovative and cost-effective solutions to keep the health care expenditures within the bounds of economic possibility.

AAL applications include services, products and concepts to increase the quality of life, wellbeing and safety of elderly people. The main goal of AAL is to achieve benefits for the individual (increasing safety & wellbeing), the economy (higher effectiveness of limited resources) and the society (better living standards). The fields of needs for elderly people in AAL applications are:

- Health,
- Safety/Security,
- Peace of mind,
- Independence,
- Mobility and,
- Social contact.

The scope of applications in these fields is very broad. For this reason AAL environments are structured in three levels: Hardware (sensing, wireless networks), Middleware (data capture, data safety, IT integration) and Services (biosignal processing, application-orientated processes, community services).

AAL has a strong relationship to "Ambient Intelligence", which is one technology leading to the IoT. To enable increased safety and wellbeing in one's home, the home has to become intelligent with the help of smart items, which is the vision of Ambient Intelligence.

An AAL scenario is characterized by being connected, context-sensitive, personal, adaptive and anticipative. The IoT is supposed to being capable of providing all characteristics necessary for an ambient assisted environment. With respect to the fields of needs for elderly people it is possible to accomplish all fields through the IoT.

The monitoring of chronic illnesses (health), on-demand provision with fresh food (safety), alarming systems(security), reminder services (peace of mind) and enabling people-to-people communication for instance with relatives (social contact) without recognizing the technology behind it are just a few mentionable applications of AAL through the IoT.

The commission of the European Union encourages this hypothesis by saying "The scope of IoT applications is expected to greatly contribute to addressing today's societal challenges".

Keep In Touch (KIT) has been developed as a technology for collecting and forwarding necessary (health) data for chronically ill and elderly people to monitor the health status and compliance in therapy. KIT is based on RFID in combination with Near Field Communication (NFC) and mobile phones. NFC is a wireless connectivity technology based on magnetic, inductive coupling and works in the free frequency band of 13.56MHz. It enables short-range communication between smart objects just by bringing them close together.

With KIT NFC equipped mobile phones are capable of collecting application-specific data just by touching the respective object, which is also equipped with an RFID tag or NFC technology. The mobile phone, thereby, becomes a universal communication terminal for several medical devices or smart objects. The paradigm of touching medical devices in the home environment has been evaluated concerning patients with Congestive Heart Failure (CHF) in a home-monitoring scenario.

The benefits of NFC in such scenarios are:

- No manual interaction (data entry via keypad) on the mobile phone is necessary.
- The effort for maintenance and management of devices in comparison to other methods (e.g. Bluetooth) is low.
- It additionally provides access to data stored on RFID tags.

Closed Loop Healthcare Services take use of KIT technology and are capable of processing relevant data and establishing communication channels between elderly people and their environment and different groups of care-givers (physicians, relatives, mobile care providers) (See Figure 1). Through the combination of KIT and Closed Loop Healthcare, a central AAL paradigm can be realized through the IoT, where the elderly live in their homes with smart objects, thus smart homes, communicating to the outside world in an intelligent and goal-orientated manner.

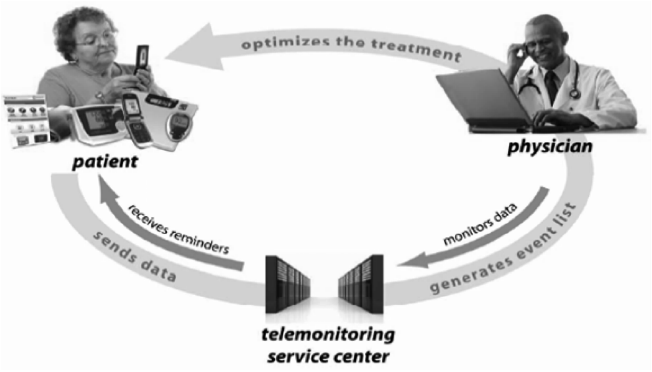

Figure 1 Closed Loop principle in healthcare. The data collected by the patient is sent to a server center, which is a accessible by the treating physician. The physician monitors the health status of the patient and may give telemedical advice, if necessary, and thus improve the treatment.

Passage B. Sleeping Quality Monitoring Via IoT Technologies

IoT technologies are changing the way we live. For example, it is well known that the quality of sleep has a great impact on daily life and on the performance one can obtain at work, in sports, etc. Daytime somnolence can be the cause of serious incidents at work or while driving. Further, many researchers have proven how sleep deprivation or a bad quality of sleep for prolonged periods could be related to the rise of hypertension, cardiovascular pathologies, obesity, diabetes and to a decrease in the efficiency of the immune system.

For all those reasons, an indication on the sleep quality may really constitute a good parameter for prevention also in healthy subjects. However, the usual tool for a complete sleep evaluation is the polysomnography that requires a well-equipped laboratory in a sleep clinic and specialized medical personnel. Thus only people with well-defined symptoms are assigned to such an evaluation, which is not indicated for prevention because of its costs, the need of at least one night in the clinic, and the limited number of sleep centers.

Devot et al. (2007) present a home device for the continuous monitoring of sleep and investigate its reliability regarding sleep evaluation(See Figure 2). The system has been particularly designed for healthy people and for preventive purposes. It is not obtrusive and therefore can be used every night without impeding sleep in itself and without interfering with the normal way of life. The signal used for sleep evaluation is

Figure 2 Recording system integrated into a normal bed

the HRV derived from the ECG recorded by means of a sheet and a pillow.

Patients in a sleep lab and healthy subjects at home were monitored during sleep with the textile system, while also standard ECG and respiration were recorded. For the textile ECG sensor, coverage of the signal on a beat-to-beat basis ranged from 47.9-95.8% of the overall night for the healthy subjects, with a mean coverage of 81.8%. In the group of sleep laboratory patients, the mean coverage was lower—64.4%—although even in this group the coverage of a single night ranged up to 98.4%. After frequency analysis, the spectral parameters used for sleep staging and derived at the same time from standard and textile ECG signals were compared. The trends along the night are very similar, indicating the possibility of using textile HRV for sleep evaluation.

Ⅰ. Important Terms And Expressions

Terms & Expressions	Chinese Translation	Your Own Notes
Ambient Assisted Living (AAL)	环境辅助生活	
ambient intelligence	环境智能	
anticipative	预期的	
application-orientated processes	以应用为导向的流程	
big data	大数据	
biosignal processing	生物信号处理	
cardiovascular pathologies	心血管病症	
chronically	慢性的	
context-sensitive	情境敏感的	

续表

Terms & Expressions	Chinese Translation	Your Own Notes
diabetes	糖尿病	
ECG signals	心电图信号	
European Union	欧盟	
health care expenditures	医疗保健支出	
hypertension	n. 高血压	
immune system	免疫系统	
impending sleep	即将到来的睡眠	
intelligent physiological sensors	智能生理传感器	
Keep in Touch (KIT)	保持联络,一种持续监控技术 注: KIT 技术基于 NFC 和移动通讯技术	
knowledge mining	知识挖掘	
Near Field Communication (NFC)	近场通信 注: NFC 是一种无线连接技术,基于磁性、感性耦合(工作在 13.56MHz 的免费频段)。它使智能对象之间只要把它们靠拢就能短距离通信	
obesity	n. 肥胖症	
obtrusive	adj. 有侵扰的	
polysomnography	n. 多导睡眠图	
prolonged periods	长时期	
sleep deprivation	睡眠剥夺	
Smart Objects	智能物体	
somnolence	n. 睡意	

Ⅱ. Questions and Discussions

Q1. What benefits can IoT-based healthcare services bring to the patients? Please elaborate in your own words.

Q2. What potential challenges would IoT-based healthcare services bring to the patients, the health care providers and the society? Why?

Q3. How do you interpret the following statement from EU in passage A:

"The scope of IoT applications is expected to greatly contribute to addressing today's societal challenges".

Q4. What other potential applications can you think of after reading these interesting applications of IoT technologies in the health care area?

Ⅲ. Exercises

Write a short essay of less than 1000 words discussing the potential and challenges related to IoT-based health care services. Organize your thoughts in a logical and structured way. Use formal citation styles.