A Review of Life Log Systems and Applications

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Abstract. Lifelogging is recording a person's entire life. Using lifelog data, they provide healthcare services, social network services, intelligent mirror services, and personalized recommendation services. Furthermore, most companies use lifelog systems in order to extract important and valuable information in improving their products. In this paper, we review the techniques used in lifelogging systems. We also propose a bus information system making use of lifelog data.

Keywords: Lifelog, Wearable computer, Smartphone, Bus information system.

1 Introduction

Lifelogging is recording a person's entire life. Recorded information types include internet search history, online shopping history, smartphone GPS location information, and so on [1]. Using lifelog data, we can create precious services. For example, Yoshihara et al. [2] introduced a healthcare system that collects lifelog data from elderly persons, analyzes the data to recognize their states and sends their states to healthcare staff and family members. Gelogo and Kim [3] also proposed a u-Healthcare Monitoring System consisting of wearable monitoring devices, a smartphone application, and a medical records storage. The system patient's lifelog data using the wearable monitoring devices.

Yamada and Takami [4] presented an intelligent mirror system that coordinates user's fashion based on his/her clothes lifelog data. Park and Cho [5] used lifelog data in order to construct mobile social networks. Using social networks, the system sends messages like "Your friend is near here. Why don't you make a phone call to him?" to the user.

Most companies are interested in lifelogging because they can find out customers’ needs and create valuable new services by analyzing lifelog data. In this paper we review existing lifelog systems. Wearable devices can be used to collect lifelog data and they are considered to be within the scope of our study.

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2 Related Works

In this paper, we review lifelog systems. Services based on lifelog data, techniques and devices used in the lifelog field, and security methods proposed for lifelogging will be discussed in this section.

Yoshihara et al. [2] proposed a healthcare system for elderly people. The system collects lifelog data using sensor networks installed at home and through smartphones. Collected data is stored at the database system. The system analyzes the collected data to extract useful information and displays the information on users' terminals. Types of useful information include sleeping, taking shower, watching TV, having a meal, fell down on the floor, and so on. Family members and healthcare staffs are users of the system. The healthcare system includes a home network consisting of Kinects, wireless optical oscillo-sensors, robot partners, and so on. A Kinect is an input device that can sense motion. A wireless optical oscillo-sensor is placed under the bed and can detect the state, sleep, rollover, cough, and none, of the person on the bed. A robot partner consists of a smartphone, a servo motor, a mobile base and a micro-controller. When the elderly person is not active, the robot try to communicate with the person by asking "What are you doing?".

As computer human interfaces have been enhanced by augmented reality and the ubiquitous service has been realized, many researches to develop practical services using lifelog have been conducted. Yamada and Takami [4] presented an intelligent mirror system that coordinates user's fashion based on his/her clothes lifelogs. In the clothes lifelogs, pictures of clothes, how often clothes are worn, types clothes belong, how comfort clothes are, occasions clothes were worn, and so on are included. Considering the condition of the day, the intelligent mirror recommends the best suit clothes to the user. The algorithm employed by the intelligent mirror calculates similarities between the condition of the day and the conditions recorded in the life log.

As mobile devices such as smartphones and PDAs rapidly spread, almost everybody carries one all the time. Moreover, mobile devices are equipped with powerful processors, a large capacity memory, and quite accurate sensors. Therefore, many researchers use mobile devices as lifelogging devices. History of inbound and outbound phone calls and messages, history of application use, and values collected form sensors are included in mobile lifelog data. Park and Cho [5] constructed mobile social networks by analyzing mobile lifelog and high level log such as activities and emotion. Using social networks, the system sends messages like "Your friend is near here. Why don't you make a phone call to him?" to the user.

There are many lifelog devices that take pictures of daily life. The amount of lifelog data is huge when it is collected by these video devices and retrieving interested part of the lifelog is extremely difficult and necessary at the same time. Ishiguro and Rekimoto [6] proposed GazeCloud that evaluates the degree of importance of video content taken by the lifelogging device, in real-time. If the degree of importance is high, then GazeCloud takes pictures often and generates a large thumbnail. For information retrieval, GazeCloud displays thumbnail images so that users can select interested one.

One of the purposes of communication is to share feeling each other. Suppose that the sender wants to express his joyful feeling to the receiver. Further suppose that the
receiver was joyful when he obtained his first son. Considering the receiver's experience, the best way for the sender to express his joyful feeling to the sender would be "I am as joyful as I was when I obtained my first son." The sender's and the receiver's experiences are recorded in their lifelogs. Mochizuki et al. [7] presented a method to compare two life logs, to find comparable experiences and to communicate efficiently by using comparable experiences.

Shimomura et al. [8] proposed a lifelog aggregation system architecture in which lifelog data is logically aggregated by Smart TV. Types of log data include pulse, eye movement, brain waves, etc. from sensor devices, usage records of services, and histories of telephone call, short message service, web browsing, etc. from smart devices. By aggregating lifelog data from various sources, they claimed that we can create a new service that is much more useful than existing services.

Mobile devices are widely used for lifelog. Lifelog data collected from mobile devices is huge. In order to extract some meaningful information from huge amount of data, they usually apply data mining techniques. Most of data mining techniques requires similarity of collected data. An et al. [9] proposed to use TF-IDF weight in order to improve accuracy of similarity. Then, they proposed a method to map the similarity to Euclidean space.

They defined the raw frequency of the term \( t \) in the document \( d \), denoted by \( f(t, d) \), as the number of times \( t \) appears in the document \( d \). Then, they defined the term frequency, \( TF(t, d) \), as:

\[
TF(t, d) = \frac{f(t, d)}{\max \{f(w, d) : w \in d\}}
\]

The inverse document frequency factor (IDF) was defined by:

\[
IDF(t, D) = \log \left( \frac{|D|}{|d \in D : t \in d|} \right)
\]

Finally, they defined TF-IDF as:

\[\text{TF-IDF}(t, d, D) = TF(t,d) \times \text{IDF}(t, D).\]

Makino et al. [10] introduced a vibration sensor that can be attached under a fingernail and identifies what kind of thing the user is touching and manipulating. They proposed to use the vibration sensor as a lifelog device. In the lifelog a sequence of the touched things is recorded. One of the advantages of touch-based life log is guaranteeing private life.

Lifelogging is recording a person's entire life. Recorded information types include internet search history, online shopping history, smartphone GPS location information, and so on. Companies try to collect and analyze more lifelog data in order to extract information needed to improve their products. In this process, personal information can be opened to public. Tanimoto et al. [1] extracted risk factors of lifelog services and proposed countermeasures for these risk factors. Then, they finally quantitatively evaluated effects of the countermeasures.
Sharing life logs each other is beneficial not only to each member of society but also to the society itself. Rawassizadeh and Tjoa [11] discussed dangers occurred by sharing lifelog data and introduced a sharing model in which sharing is no longer allowed when expiration time is reached. In addition, they discussed security methods that reduce the causes of threatening security.

3 Conclusion

We learned that smartphones are widely used as lifelogging devices. If we collect smartphone sensor values from bus passengers and drivers, then we can identify the current location of buses. Current locations of buses are the key information we need to implement bus information systems. We are developing lifelog based bus information system as our further work.

References