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A Conceptual Definition of Quantified Self Technology

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Abstract. In this paper, we present a conceptual definition of a quantified self technology as a machine learning based technology which helps to understand and maintain individual balance states (physical/mental). It can track a person's lifestyle (living body, activity, habit data, etc.) by using wearable smart devices. Moreover, we suggest a technical approach to develop quantified self-technology for individuals using wearable smart devices. We also describe how to develop life-logging, life-tracking, and life-monitoring technologies.

Keywords; component; Life logging; Life tracking; Life monitoring; Quantified self; Wearable device

1. Introduction

Quantified self is a campaign named and started by Gary Wolf [1]. It targets self-discovery through personal data tracking with the slogan "self-knowledge through numbers". Quantified self allows you to monitor and analyze all the physical and mental states that you can quantify about yourself in your daily life. The industry of quantified self applies to lifelogging, personal sensors, surveillance response, biohacking, user activity tracking applications, wearable computer, IoT, etc. Quantified self-related devices among wearable devices are technologies that accumulate contents of human life as data. Life-tracking tools for health, well-being, and productivity can automatically record and analyze data about individual's daily activities and physical condition. For example, the Fitbit [2] quantifies and collects information about user's physical activities in the form of a wristband. Since the wristband includes the user's necessary information, location tracking device and motion sensor, it can analyze various information

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such as numbers of walking, distance, walking time, speed, calorie consumption, exercise intensity for one day. Such wearable smart devices for quantified self can be used as a sensor for recognizing user activity, and it is possible to track user activity through lifelogging in daily life.

There is an increasing interest in physical and mental quantification of individuals using wearable devices. Chronic diseases are rapidly increasing, and social problems are getting bigger due to population aging. Some countries (USA, China, Japan, and Denmark) have established healthcare-related activation policies. The wearable IoT market is expected to explode by 2020, reaching $ 60 billion [3]. Besides, the healthcare products and services market will account for 70% of the total (recorded by IMS Research). Funding related to quantified self-start-up in the world is 438 million dollars (2014) in 43 areas. The wearable global market is expected to grow at a CAGR of 35.4% from $ 6.6 billion in 2015 to $ 30 billion by 2020 [4]. The wearable fitness and personal health device market are expected to grow to $ 5 billion by 2016. Moreover, the global mobile healthcare market is projected to reach $ 23 billion by 2017 [5-6].

The National Health Insurance Corporation (NHIC, Korea) has provided a nationwide PHR service for 2012. This service includes health checkups for the past five years, hospital treatment details for the past one year, drug information, and big data-based national health alert (about 2.7 million in 2014 and about 4.3 million in 2015). Also, the domestic production of the Korean wearable device industries is estimated at around 250 billion (won) in 2015 and is expected to grow at a CAGR of 30% until 2020 (valued at about 3% of the world). Accordingly, technological areas for collecting and analyzing user quantification data will be expanded. They will utilize intelligent IoT and big data technologies.

In this paper, we conceptually define a quantified self technology as a machine learning based technology which helps to understand and maintain the balance state (physical/mental) of a person. It can track an individual's lifestyle (living body, activity, habit data, etc.) by using wearable smart devices. The proposed research contributes to the development of user activity recognition using big data of individuals. Also, the proposed research suggests a new architecture for recreating convergence industry by linking sports, rehabilitation, and healthcare applications.

2. Technology for Quantified Self

To develop the life logging technology for the quantified self, we need to consider following approaches.

1. Data fusion according to the characteristics of inputted data

- Develop user-centered fusion which is suitable for characteristics of self-quantification data collected from sensors

- Develop a semantic information (e.g., user's position, direction, object of interest, and surrounding
- environment) extraction

2. Real-time fusion
    - Develop a real-time fusion method applying moving window on the time axis
    - Establish a time buffering method that stores input data and manages the history of data
3. Process of quantifying all states of self
    - Develop a technique to analyze oneself by tracking an individual's physical condition (physical information, behavior pattern, eating habits and exercise status, consumption and expenditure trends) and mental state (emotional state, etc.): e.g., biosensor application technology, body feature extraction through social network analysis
4. Self-data logging
    - Develop techniques for quantitatively sensing personal status (emotional, health, activity, social relations, etc.) using wearable devices: e.g., biometric information collection SmartWare, WBAN-based bio-signal transmission technology
    - Develop an intelligent data logging technology: e.g., real-time life log automatic collection, collected data storage, and mining processing

To develop the life tracking technology for the quantified self, we need to consider following approaches.

1. Decision-making process design
    - Develop machine learning-based personal states analysis and a decision-making technology
    - Develop personal bio-condition analysis by single/multimodal methods using contact or non-contact sensors
    - Improve decision-making process that extracts low-level data from heterogeneous sensors and extracts high-level semantic information
    - Design reuse of quantified data and reconstruction of inference rules using self-quantification history

2. User Activity Recognition

- Develop deep-learning based user activity inference technology in wearable device environments
- Develop machine learning based personal states analysis and decision-making technology
- Develop real-time self-tracking and reviewing technology
- Develop data mining and clustering analysis for activity recognition and tracking

To develop the life monitoring technology for the quantified self, we need to consider following approaches.

1. Light weighted wearable middleware design

- Develop adaptive data fusion to dynamic sensor environments
- Develop quantified data synchronization between multiple objects
- Create a cooperation structure between various domains/wearable devices/user groups/applications
- Design a self-quantification middleware model based on PHR (Personal Health Record)

2. Life monitoring technology

- Develop long-term self-activity evaluation technology through quantified data logging and data mining
- Improve body data monitoring and self-management technology based on intelligent data technology

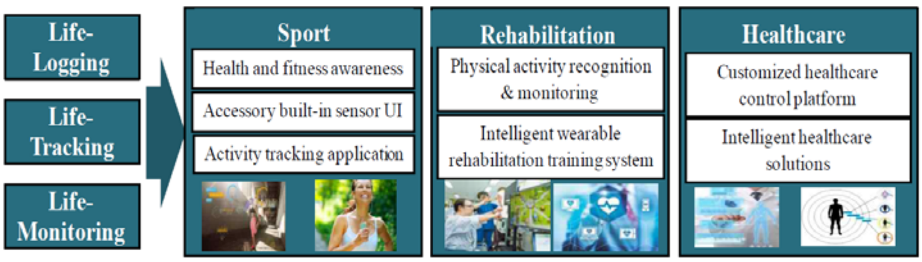

Fig. 1 Industry Applicable Technologies

3. Conclusion

In this paper, we defined a quantified self for the balance state of an individual by tracking the lifestyle. The proposed research suggests the technical approach to develop quantified self-technology for individuals using wearable smart devices. We presented how to develop life-logging, life-tracking, and life-monitoring technologies. In the near future, the proposed research can identify technological difficulties of adaptively inferring various kinds of quantified data in the user domain. Besides, the proposed research can contribute to research fields of intelligent services in wearable smart device environments.

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