Self-Information Project: A Study on Context-aware and Proactive Supports Based on Semi-Automatic Activity Logging and Predefined Schedules

Hiroshi KANASUGI, Tsuneki SAKAKIBARA, Ryosuke SHIBASAKI
Center for Spatial Information Science, the University of Tokyo
4-6-1, Komaba, Meguro-ku, Tokyo, 153-8505, Japan
{yok, sakakibr, shiba}@iis.u-tokyo.ac.jp

Abstract: Advancement of Information Technology has contributed to the enhancement of not only efficiency and quality in services but also productivity. In both fields, there are a lot of preceding researches for personal activity support based on accumulated personal activity data and contexts, however, provisions of actual service are rarely implemented. In addition, since lately consumers' activity information is fragmentarily distributed and managed in individual service providers, personal preference analyzed by insufficient activity data may not lead to successful service provision. In Consequence, in order to enhance quality of an activity support, it is required to gather Self-Information, which is high-reliable contexts and activity information by oneself, and to provide activity supports based on the collected self-information. This paper describes brief concept of self-information, and development of self-information platform that semi-automatically gathers self-information which is consisted by personal contexts and activity information from wearable sensors and various existing applications such as FeliCa, GPS, and MEMS sensors embedded in a mobile phone or other mobile devices, and consults predefined schedules by a user.
Keywords: Self-Information, Context-Aware, Proactive, Wearable, Schedule, Activity Support

1. Introduction

Advancement of Information Technology has contributed to the enhancement of not only efficiency and quality in services but also productivity, and to the advancement of mobile devices about the size and the performance. As the result, consumers have been able to use a lot of services without taking account of the location and the time. Especially, in these years, expectation to context-aware services which support user's activity or life has been increasing in accordance with getting mobile devices small and highly efficient. In consequence, there are a lot of researches for personal activity support based on accumulated personal activity data and contexts obtained from such mobile devices, however, provisions of actual service are rarely implemented. On the contrary, although respective service providers estimate users' preference and tendency based on accumulated and analyzed personal information of users such as a history of service usage, an operation history on the service web site, a purchase history, and so on, they cannot gather enough amount and quality of uses' information because recent troubles about disclosure and loss of personal information. Moreover implementation of the law of personal information causes users' anxiety to privacy protection. Therefore, since users' insufficient activity information are fragmentarily distributed and managed in individual service providers, personal preference analyzed by such insufficient data may not lead to successful service provision.

Consequently, our project makes the concept of "Self-Information", comprehensive personal information accumulated by users themselves, and envisions new service architecture that a user requests a service provider to implement context-aware services based on the accumulated self-information. By letting a user collect his/her own information, reliability and completeness of information can be improved considerably. Subsequently, users can grasp the initiative of information management and receive appropriate and quality services by providing accumulated self-information, whereas service providers can reduce the database resources for personal information management and enhance services and commercial products. In fact, in order to implement this architecture, there are five necessary issues: (1) development of a platform to accumulate and analyze self-information, (2) development of a framework to model personal activities into user model based on accumulated data, (3) standardization about data format and interface between mobile devices and the platform, (4) standardization about data format and interface between the platform and service providers, and (5) discussion about an impregnable security management of self-information. Conclusively, we aim to realize highly sophisticated information society based on self-information as new paradigm.

This paper especially describes the development of prototype of self-information platform mentioned above. The platform is based on a scheduler type application because the platform can provide consistent and arranged activity data according to the time series. Although the platform can edit not only schedules but also activity logs, manual input is inefficient for users. In consequence, we implemented the function that automatically records activity logs from predefined schedule data based on the sensor data and location reference database.

Next section firstly describes related works about self-information and the platform development. Section 3 presents the

general representation of self-information platform including fundamental concept, and Section 4 explains the architecture of automatic activity logging. Finally, Section 5 concludes this paper and suggests further researches.

2. Related Works

As an aspect of self-information research is to implement enriched and convenient services and supports based on a variety of accumulated data of users' activities. Actually, user's activities are detected and gathered by using various wearable sensors and mobile devices. Accordingly, researches in relation to context-aware and Life-Log applications have a relationship with self-information research.

2.1. Context-Aware Applications

Since the proposal of ubiquitous computing, researches in relation to context-aware have advanced in accordance with raising expectation for its implementation and advancing miniaturization of mobile devices. User's location can be given as a general context, and car navigation system is lately represented by location-based services (LBS), however, LBS-related systems initially detect whether a user stayed nearby an infrared-ray devices like Active Badge Location System[8]. Subsequently, with the enhancement of positioning accuracy by GPS, outdoor location information was also used for various LBS applications such as CyberGuide[1] and NEXUS[3], and became popular in location aware researches. Moreover, with the advancement of small and cheap MEMS sensors, a user wore several sensors, which were represented by accelerometer, magnetometer, and so on, and detected own contexts from them[6][7][11]. Especially, ContextDitillery[2], which was a framework for development of context-aware applications and was developed by K. Fujinami and et al, is the most associated research with the development of self-information platform. However, ContextDistillery stores user information from physical space like sensor data and cyber space like WWW into external server computer, whereas self-information platform accumulates all information about a user and his/her ambient into own device.

2.2. Life-Log Applications

Although Life-Log researches aim to store all lifetime activities, implementation was difficult due to the data amount. Nevertheless, with increasing capacity of a hard disk in recent years, it has been getting a grip on reality. Actually, researches associated with Life-Log mostly focus on the efficient retrieval from a lot of data and reproduction[5][9], and provisions of actual service are hardly implemented. Also, there are few examples that focus on the spread as concrete infrastructure like self-information. There is relationship with self-information research in a way of recording user's activity data using mobile devices like tiny sensors.

3. Architecture of Self-Information Platform

3.1. Fundamental Concept

By accumulating personal activity data at a user, a user can grasp the initiative of his/her personal information management, which is now taken by respective providers, however, data amount must be large because the data obtained from various sensors and receipts are comprehensively accumulated at a user. In order to utilize the large amount data efficiently, a platform, which automatically arranges accumulated data and certainly provides consistently formatted data according to a request from an adapted module, is required. Therefore, in case of analyzing accumulated data, the platform could keep the consistency of platform architecture by appending process as an external module, and accumulated data can be utilized without taking account of detailed processing in the platform. In addition, preparing visualization components for displaying accumulated data directly or reviewing analyzed data would facilitate the development of external modules. Abovementioned concept of self-information platform is assembled and shown in Fig 1.

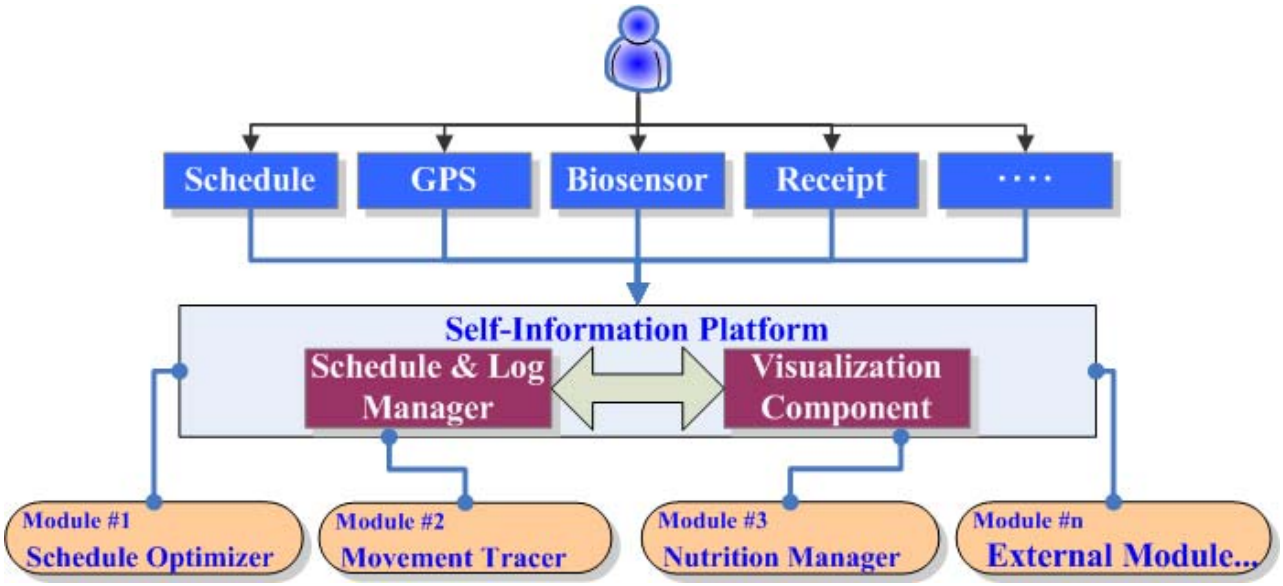
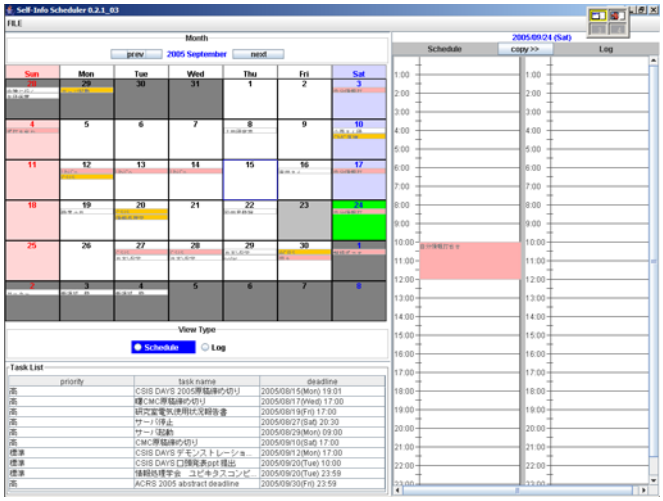


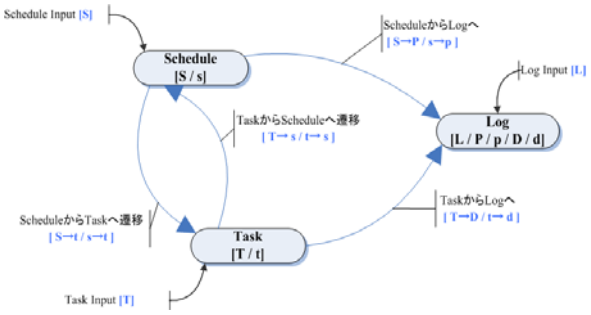
Fig 1. Conceptual Diagram of Self-Information Platform

3.2. Schedule & Log Manager

Fig 2(a) shows the screenshot of schedule edit window of self-information platform. The platform bases scheduler type application because data along to the time series enables to disambiguate the relationship among several kinds of accumulated data. The point of difference from usual schedulers is that the platform includes the activity log editor beside the schedule editor. All data such as sensor data, schedules, activity logs, purchase logs, and so on, are stored as XML file format, and metadata file, which is also XML format, manages all data files. As an example of stored data, Fig 2(b) shows a transition diagram between predefined schedule element and activity log element. Nine IDs defined in the diagram indicate whether the element is schedule or log.



(a) Screen Shot of the Platform



(b) Transition Flow Among Event Elements

Fig 2. Prototype of Self-Information Platform

3.3. Location Dictionary Subsystem

Time and location information of activity occurrence is essential parameter to analyze approximate area of user's movements and time zone of activity, however, letting user input detailed location information like standard nomenclature and exact address is definitely troublesome, causes incorrect input, and becomes burden for a user. Therefore, by preparing user's original dictionary for referring detailed location information, especially about a place putting in a long time such as home, school, office, and so on, intrusive manual input could be removed. Furthermore, the dictionary is also available to automatic activity logging mentioned in next section.

When logging a trajectory of movement, especially in an urban area, a user sometimes enters unavailable area of GPS positioning like transportation or indoor. Consequently, public dictionary for referring landmark location information like station and bus stop is developed on server-side database, and is used for translating boarding station and exiting station into detailed location information like latitude, longitude, and altitude. In addition, the server-side dictionary also includes railway networks, and can approximately complement a halfway between boarding station and exiting station.

3.4. Sensor Logging Subsystem

In order to accumulate personal activity data automatically and continuously, utilization of tiny sensors embedded in a mobile device is a functional method. Subsequently, subsystem for recording sensor data according to the format of self-information platform is shown in Fig 3. The subsystem just provides a function to store user's location information detected by GPS and user's approximate condition detected by pedometer.

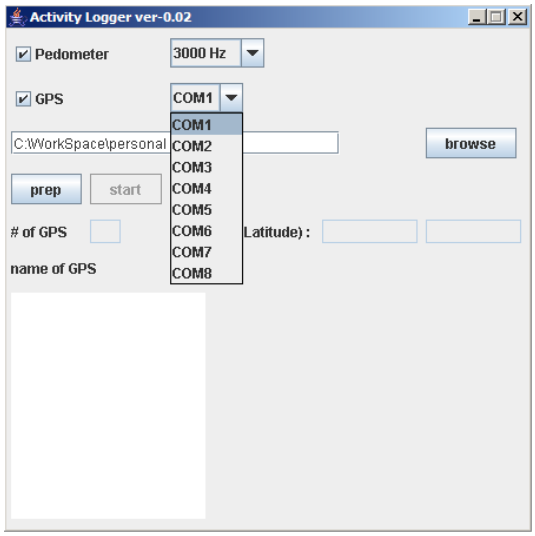


Fig 3. Sensor Logging Subsystem

4. Architecture of Semi-Automatic Logging

When a user actually records activity logs, it is not efficient method to input manually, and a user may be give up from the troublesomeness of input work. Therefore, we implement the architecture that only the data recorded as a schedule automatically transit to activity log by using continuous location information obtained from GPS, the user's location dictionary, and server-side location dictionary. This section describes the overview of the architecture.

4.1. Matching by Geographic Coordinate

When a user notes a schedule, the place in relation to the schedule is usually recorded simultaneously. Consequently, the latitude and the longitude of the noted place are firstly acquired by referring the user-original location dictionary. If the place does not exist in the user dictionary, it asks whether there is any location information where suits the noted place, and the user's dictionary is updated. In this way, the information on the position which activity might occur is acquired.

Subsequently, when a user stays around the scheduled location, the schedule is recorded as its activity log by observing the continuous location information. Moreover, elapse time of activity can be approximately estimated by stable GPS data. Since this method uses the position information on GPS, being used in an outdoor environment is desirable. However, based on the data from mobile devices, it will be possible to record the context of activity with high precision.

4.2. Result of Experimental Logging

We experimentally examined whether this method could actually leave an activity log accurately. In the places where the measurement accuracy of GPS was able to reliable, the activity log can be recorded comparatively well, whereas the results recording incorrect activity are obtained in the case of the data with large errors. In order to store the log with high accuracy, other wearable sensors like accelerometer would be necessary to aid position detection and activity detection.

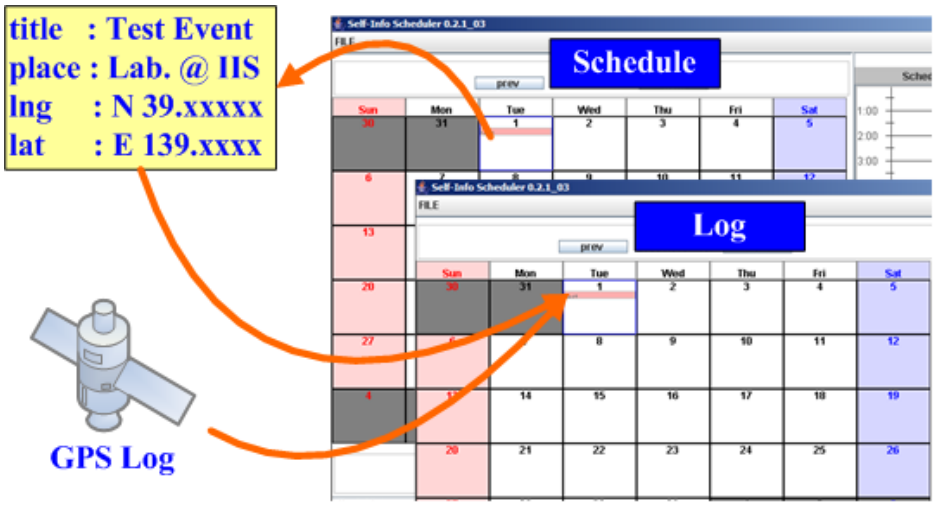


Fig 4. Experimental Result of Automatic Logging

5. Conclusion and Further Researches

In this paper, after outlining about the new paradigm of self-information, the prototype of the self-information platform for accumulation and management of self-information is implemented. Furthermore, in order to increase the efficiency of an activity recording by a user, the function which semi-automatically records activity logs from preliminarily defined user' s schedule is developed, and is examined through the experimental input. According to the result of the experiment, since incorrect recognition occasionally occurs in accordance with the error of sensor data, the tendency of individual activity should be acquired from further accumulated data, and will be useful to improve accuracy of activity recognition.

Furthermore, construction of a user model representing the certain user more accurately would be attained by constant accumulation of self-information. Based on the model, a user's requirements are analyzed on real-time, and a user can receive exact context-aware services from service providers or a user oneself. In addition, since the receipt which current provision is mainly analog is also regarded as the activity data of the user's purchase, it is necessary to accumulate such data with investigating the technique of digitalization.

As the other usage of the accumulated self-information, it may be realizable to receive a more exact diagnosis at a hospital based on the accumulated cardiac beats. For that purpose, it is necessary to establish the interface for providing self-information outside, and to make it spread generally.

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