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Dynamic Configuration Method of Process Design in Bio-sensing Information Computing System

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Abstract

The existing process configuration of biometric information system that is defined in the initial performs the same process without changing statically and consistently after the system is running. However, this static process configuration appears an inefficient performance to the applications of the mobile biometric information system in the mobile computing environment. This work proposes the dynamic process design and execution method as a way to overcome these inefficient processes.

Keywords: *Dynamic configuration, bio-sensing computing, process design, bio-information architecture*

1. Introduction

Recently, the interest toward human longevity free from diseases, *etc.*, is being focalized along with the development of free mobile computing environment, diversification of remote medical system and aging society. Moreover, the tendency of such social interests being converged as one system frame is getting accelerated.

Among such converged systems, there is a bioinformatics system which senses and gathers health conditions and various bio-information of mobile users to set up and utilize medical information. The information devices to monitor the bio-information of mobile users are being diversified and sophisticated according to their used purpose such as wrist type, necklace type, glasses type, garment type and shoe type, etc. The sensing information gathered through such mobile bio-information devices configure different information processing system depending on the sensing method, transmission channel, storing and filtering process as well as analysis and evaluation method, *etc*. This study places interest on the bio-information sensing architecture and bio-information sensing process as principal factors of bio-information system.

Until now, the bio-information system has been gathering individual bio-sensing information through personal type bio-information and devices to transmit such information through infrastructure interworked communication network including the internet through various existing wireless networks such as 3G/4G global wireless network, WIFI, Zigbee and Bluetooth, *etc*.

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Also, the role of monitoring and managing the bio-information of each individual user has been performed through personal computer or bio-information server located at the infrastructure network.

The form of bio-information transmitted here is the analog bio-information signal data or digital conversion code date as raw data. Otherwise, the filtering data of source bio-information data has characteristics of specific peak data, specific interval data or specific event data.

This paper is described as the following process. First, chapter 2 describes the dynamic bio-information sensing architecture. Chapter 3 describes the dynamic bio-information sensing process. Chapter 4 describes the bio-information computing issues. Finally, chapter 5 describes the conclusion.

2. Related Works

The sensing information process of bio-information system is composed of raw sensing, data transformation, data filtering, data transmission, data saving, data analysis and statistics of the sensing device [7].

The existing bio-information system structure and the characteristics of process aspect are examined as follows. [1] supports an XML based client server web architecture. It supports a transparent process based on XML document regardless of the architecture configuration. The system structure and process flexibility are improved while computing memory space and transmission performance are lowered. [3] improves the performance of bio-information specialized individual process as the agent technique supporting individual functions including the multi-agent technique is supported but shows the characteristics of lowering system structure and operation ability. [5] has described the structural issues of data mining which supports various bioinformatics workloads. Especially, the characteristics of memory hierarchy structure considering the execution time, extensibility and bottleneck conditions have been analyzed. [6] has presented the necessity of implementing a software system supporting large scale framework, distributed computing engine, sequential analysis module, microarray analysis module, etc for biological data and processing. [7] configures six phases for the knowledge discovery of bioinformatics process. Such analysis process is selectively and adaptively used depending on the system requirement or circumstances. Such analysis method can be restrictively used at the global station or open station where the analysis server is located. [8] The necessity of an architecture which considers user access method, performance scheduling, load balancing, QoS and fault tolerance has been presented.

The existing bio-information process performs static and identical process without changes after being defined as default and optional process at the initial stage of system configuration. However, such static process indicates ineffective execution in the application of mobile bio-information system performing mobile computing. Especially, an inconvenient duty of having to perform initialization of new definition and execution is accompanied during the process configuration of bio-information system and change of method.

This study attempts to propose a dynamic process design and execution method as a plan to fundamentally solve this problem. This paper describes the basic bio-information sensing architecture and the dynamic process configuration method for setting up the dynamic process.

3. Bio-information Sensing Architecture

The following Figure 1 shows an example of digital bio-information structure. The example in the figure shows the process of gathering bio-information using the hospital bed mat of a hospitalized patient as a form available at hospitals or recuperation facilities.

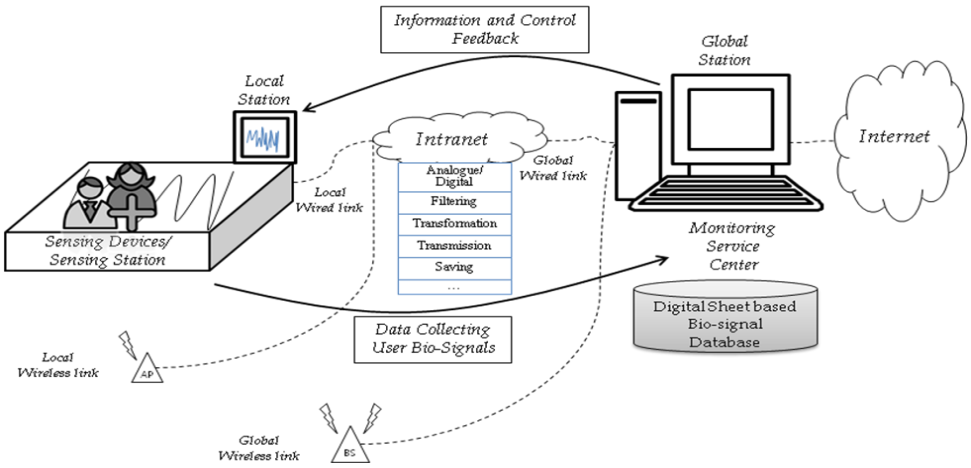

Figure 1. Example of bio-information System Structure

The bio-information sensing architecture of this bio-information system gathers the bio sensing information of each individual patient through a personal-type bio-information device while gathering the bio data on such information after configuring a local infrastructure network using wire networks such as LAN and PSTN or wireless networks such as WIFI, Zigbee and Bluetooth as well as transmitting the bio data using an internet interworked network through wire IP network or wireless 3G/4G global network. Also, the role of monitoring and managing the bio-information of each individual user has been performed through personal computer or bio-information server located at the infrastructure network. [1, 3, 4]. The sensing information gathered through such mobile bio-information devices configure different information processing system depending on the sensing method, transmission channel, storing and filtering process as well as analysis and evaluation method, *etc.*, [5, 6].

The following describes the bio signal information processing components based on bio-information devices.

1) Configures the bio signal data gathering process of bio-information device users.

   - Defines the method of gathering the bio signal data such as body pressure level and body pressure distribution of users along with the data format.
   - Defines the method of gathering the respiration bio-signal data and the data format.
   - Defines the method of gathering the user physique analysis data and the data format.
     - ◆ Definition of user posture, location model and pattern
     - ◆ Definition of user movement, location model and pattern

- Defines the user identification information of bio-information device and the authentication process.

2) Configures the process to save, analyze and evaluate the user's health condition and bio signal data.
   - Presents a user bio-information signal based user health condition model.
     - ◆ Definition of threshold value function and values to classify Satisfactory/Warning/Danger, etc
     - ◆ Definition of bio information device condition management process
     - ◆ Definition of digital sheet identification system and status information management
     - ◆ Definition of individual user unit statistical analysis and evaluation model
3) Configures the information guide process and the control process for bio-information device users.
   - Design of a user health analysis information display interface
   - Outbreak of danger and warning signals on the user
   - Display of real-time health information analysis
   - Display of respiration and health related signals
   - Display of physique status analysis information
   - Sets up a bio-information device usage statistics model of each individual user.
4) Defines the bio-information device informatization system and converged development process.
   - Definition of table and process on the bio-information device development support issue
   - Presentation of definition and guide on the important convergence points

Such bio-information system structure and components closely interact with the bio-information sensing process described in Chapter 3. Especially, an execution environment for bio-information sensing process is provided.

4. Dynamic bio-information Sensing Processes

The system bio-information process of Figure 1 gathers various bio-information of a patient using piezoelectric sensor and respiration sensor at the bio-information device. The bio-information gathered this way gets sampled or transformed as various digital bio-information such as peak information, amplification information, location information or body type information, etc. Such process is called the *forward collection process*. This interacts with the *backward control process* such as the clinical trial for controlling and guiding the bio-information devices and the bio-information patients or analysis, evaluation and feedback of gathered health information.

The bio data gathered and transmitted at such bio-information system build up different bio data process depending on the optional configuration of analog and digital data format, various optional transmission channels or the saved location and data processing method. Furthermore, different bio-information process is shown depending on the analysis, evaluation and feedback method of detailed clinical trial and gathered health information.

The form of bio-information transmitted here is the analog bio-information signal data or digital conversion code date as raw data. Otherwise, the filtering data of source bio-information data has characteristics of specific peak data, specific interval data or specific event data [2].

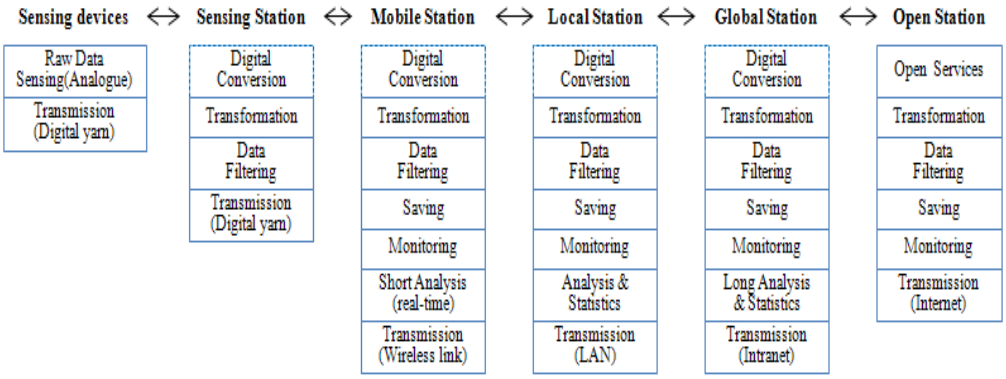

Figure 2. Sensing Information Process in Bio-information System

The sensing information process of bio-information system is composed of raw sensing, data transformation, data filtering, data transmission, data saving, data analysis and statistics of the sensing device as shown in Figure 2.

The existing bio-information process performs static and identical process without changes after being defined as default and optional process at the initial stage of system configuration.

However, such static process indicates ineffective execution in the application of mobile bio-information system performing mobile computing. Especially, an inconvenient duty of having to perform initialization of new definition and execution is accompanied during the process configuration of bio-information system and change of method.

This study proposes a dynamic process design and execution method as a plan to fundamentally solve this problem. Figure 2 shows the overall process of bio-information system. Such bio-information process may be executed after being dynamically selected depending on the system configuration environment. The method of selecting dynamic process can be classified as horizontal selection and vertical selection.

First, the horizontal selection is selectively operating the station by each stage depending on the necessity of applied environment. As an example, the mobile bio-information system based on the wearable bio sensing of wireless network environment

performs process by selecting the third mobile station. In case of the wire based bio information system, the third mobile station process may be skipped. As another example, the elimination of processes at the open station which is the last station becomes required in order to perform an exclusive intranet service. As another example, the instance of connecting a local wireless network at the third mobile station selects the fourth local station while the instance of connecting a wireless wide area network performs the process as the fifth global station after skipping the fourth local station.

Next, the vertical selection is the process of optionally selecting and disabling some computing processes at the stations of specific stage. For example, the instance of performing digital conversion at the sensing station disables the digital conversation process at the follow-up stations, in other words the mobile station, local station and global station. Then as the sensing data gathered at the first sensing device is sent so that the data filtering process can be performed selectively depending on the method of usage from the second sensing station to the last open station.

5. Analysis of Bio-Information Sensing Computing Issues

The proposed dynamic process configuration can select each computing station dynamically depending on the mobile user's environment.

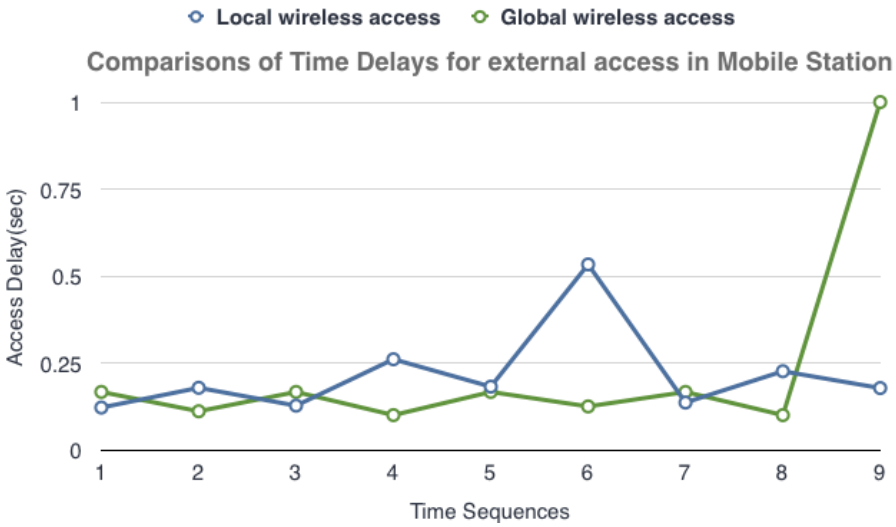

Figure 3. Comparisons of Access Delay in the Mobile Station

Figure 3 is a comparison of the access delay of the selective wireless access paths between local-wireless WIFI-Cable Internet connecting to the local station and the global wireless 3G connecting to the global station when the mobile station accesses external wireless links in Figure 2. We can confirm the fact that the access delays of two paths may not influence the total computing performances because of random delay processes.

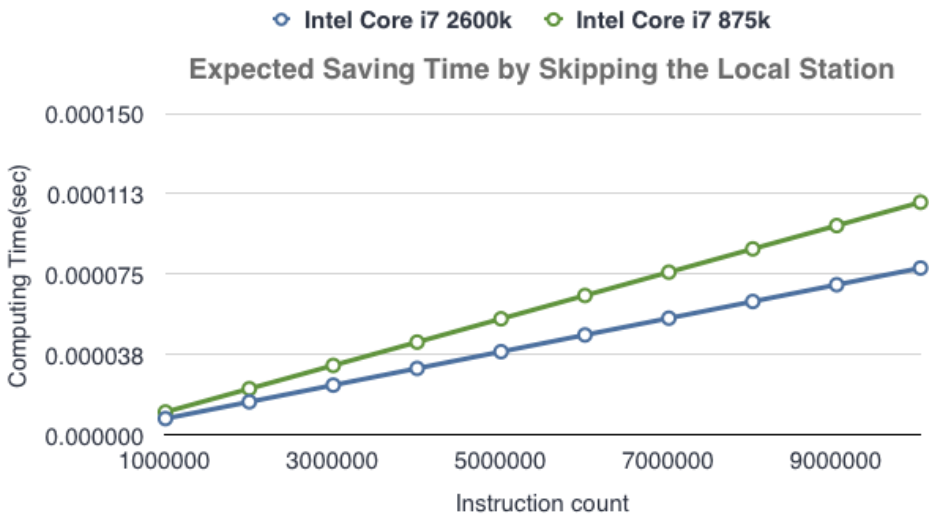

Figure 4. Expected Saving Time by Skipping the Local Station

Figure 4 illustrates the expected saving computing times depending on the processor specifications (for examples, Intel Core i7 2600k and Intel Core i7 875k) of the local station when the mobile station accesses by skipping the local station in Figure 2.

Various phased computing processes are required from the sensing of digital bio-information to the evaluation and statistical analysis. This chapter attempts to analyze the factors that having impact on such bio-information computing system performance and efficiency.

The following are the principal interest factors of the bio-information system having impact on the bio-information computing.

1) Durability of sensor device: A sensor structure to guarantee durability and signal safety of a bio-sensor configured as Ag/AgCl electrode is required.

2) Data filtering: Selectively performs the signal filtering to guarantee the quality of sensing bio-signal or the significant data range.

3) Data sampling: Able to sample the bio signal selectively according to the used purpose of sensing data in the process of transmitting data in stages from the sensing device to the server of global station.

4) Location of digital transformation: Transforms the analog data as digital data selectively according to the performance of station by each stage, margin and the location of used station while sending the analog bio signal gathered from the first sensor through the station by each stage.

5) Bio-analysis algorithm: The development and improvement of bio-analysis algorithm to indicate by analyzing the bio-characteristics of user using single sensing and combined sensing data of ECG, Heartbeat, Respiration, Body-motion and Accelerator, etc.

6) Bio-information transmission performance: The bio-information transmission method is implemented according to the transmission resource conditions including the level of real-time oriented demand, transmission memory and channel in order to maximize the transmission performance of the bio-information gathered from the sensor.

7) Battery of Mobile Station: The battery status of mobile station for gathering and monitoring the bio-information of mobile users is dynamically managed according to the user requirement and environment.

8) Event definition: The default event and option event are defined according to the system or user requirement.

9) Sampling cycle and storage size: The storage size is defined according to the sampling size and sampling count for the real-time logging of bio-information.

10) Interface design: The bio-information input/output interface required for controlling and monitoring bio-information is defined.

11) Definition of bio-information controlling factor: The bio-information controlling factors are selectively defined according to the dynamic situation of user and the requirements of system control conditions.

12) Feedback control structure and logic: Controls the hardware of bio-information users at a remote area according to the analyzed result of bio-information or defines the bio-information sensing of user and the station software logic by each station.

6. Conclusion

This paper has proposed a dynamic process design and execution method to overcome the problems followed by static process configuration of bio-information system. This has proposed the basic bio-information sensing architecture and the dynamic process configuration method as methods for setting up the dynamic process.

Such dynamic process configuration carries an advantage of supporting the adaptability followed by change of system environment such as user environment, bio-information gathering type and method, etc without initialization process or cutoff of system execution while executing the system.

Such dynamic bio process configuration must be proposed as function or method of bio-information system and platform in the future. Especially, the decentralized computing for analyzing and evaluating bioinformatics may be considered to maximize the bio signal analysis or usability of bio information.

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