

Disconnected operation method for recovering bioinformation in a digital patch system

Moon-Il Joo *, Jong-Seong Sim *, Tae-Gyu LEE **

* Institute of Digital Anti-Aging Healthcare, Inje University, Korea; cmki@nate.com, jssin93@naver.com

** Pyeongtaek University, 3825 Seodong-daero, Pyeongtaek-si, Gyeonggi-Do 17869, Korea

Corresponding Author: tglee@ptu.ac.kr, Fax: +82 31 659 8011, Tel: +82 31 659 8370

Abstract— This paper proposes an wireless disconnected transfer method which realizes the continuous data transfer of wireless digital patches in wireless bioinformation sensing networks. It describes a bioinformation sensing system and a bioinformation sensing method using mobile patches. It is a research on wireless sensing system and wireless gathering method based on information gathering interface using mobile patch. The unguided wireless channel generally shows link disconnections and propagation delays due to their low signal connectivity. Conventional wireless sensing network protocols did not consider any fault models about physical wireless link faults. Consequently, they have shown data transfer inefficiency for both data link control and physical wireless link control. To overcome these wireless digital patch environmental problems, this paper suggests a new wireless smart agent system, which provides wireless or mobile patches with previous transfer layer protocols compensated.

Keywords— Mobile system, Recovery, Patch interface, Wireless network, Disconnected operation

I. INTRODUCTION

With the development of various wearable devices, a method of monitoring a human body, analysing a bio-signal, evaluating a health condition of a user, and providing a healthcare service based on the evaluation has been continuously attempted. These efforts have had some fruitful consequences, and have become a future vision strategy that is important for the healthcare sector. In particular, the mobile patch is attached to the human body to collect a variety of biological information data is the next generation of research in the medical field [1]. Mobile patches are important for measuring bio signals and researching accurate data transmission. Sensors for measuring bio-signals have been researched and developed with various sensors including nano-sensors for measuring ECG and pulse and sticker sensors for easily attaching to all parts of the body to measure various bio-signals. Various biological data transmission technologies are researched and developed based on information protection technology and technology to transmit data without losing data.

This paper describes a bio-sensing system and a sensing method based on bioinformation collection interface using mobile patches. Especially, it is a research on bioinformation sensing system and sensing method based on information gathering interface using mobile patch which can be

transferred by the smart agent with disconnected operations [2-6].

As shown in Fig. 1, the mobile patch based on the mobile communication to collect the biometric data attached to the human body has a structure for transmitting the data measured in the sensor patch for measuring the biometric data to the smart agent using wireless communication. In order to transmit biometric data using wireless communication, various wireless communication technologies such as Bluetooth and Wi-Fi are available. Wireless communication can cause noise and data loss due to environmental influences. There is a need for recovery techniques to prevent or minimize the loss of wireless data transmission.

Until now, digital patches have been used as means and methods for collecting human body information. These efforts contributed to the collection of various bioinformation such as body temperature, sweat, humidity, respiration, pulse, and heart rate. Nevertheless, the types of sensors available for patching are limited and the amount of information that can be collected is limited because of frequently disconnected wireless communication channels [7]. These attempts should continue to develop new sensors, patch structures, and bio-signal analysis.

This paper aims to develop a mobile patch system based on biometric data collection interface. The mobile patch system firstly provides a mobile patch based on an information collection interface that can detect the degree of action of the applied drug and display it to the patient or user. Second, the mobile patch transmits biometric data with a minimum loss rate. Third, it is to provide an analysis and application interface model of the transmitted biometric data.

This paper focuses on the bioinformation wireless transmission collection interface that supports the accurate transmission of biometric data to develop mobile patch systems. The wireless sensing network system for collecting and analysing mobile patch-based biometric information may be composed of a foreground system and a background system. This paper focuses on the foreground system consisting of mobile patches and wireless smart agents.

This study has the following contributions. The mobile patch based on the proposed biometric information collection interface can operate with disconnected operations for transfer recovery, it is easy to shorten transfer recovery time and reduce transfer time. And, such mobile patch using biometric

information collection interface can measure the degree of action of the drug and induce removal of the patch when out of the threshold range. Additionally, it can transmit the biometric information of the patient to the outside and transmit the action information of the internal medicine of the patch used for the treatment to the outside, so that the transmitted data can be easily browsed.

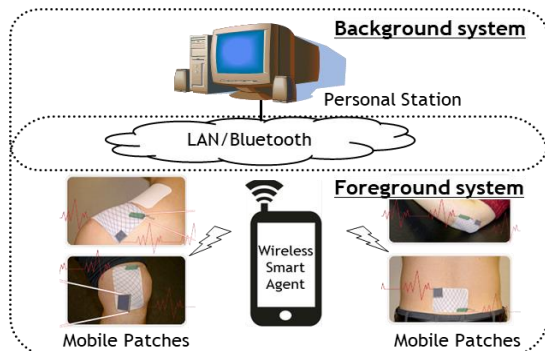


Figure 1. Mobile bioinformation system in wireless sensing network

Accordingly, the patient, the caregiver or the user (physician) can conveniently check the patient status, and can transmit a patch removal message or the like when the medicinal threshold of the mobile patch attached for the patient treatment is out of the range. Finally, the wireless sensing system using the mobile patch based on the proposed bio-information collecting interface receives the biometric information transmitted from the mobile patch and transmits the biometric information to the registered communication smart agency when the biometric information is out of the threshold range, is.

II. BIOINFORMATION SENSING ARCHITECTURE AND DESIGN OF MOBILE PATCH SYSTEM

In this study, a mobile patch attached to a patient and measuring the biometric information signal of a patient and transmitting it to the outside, and an active terminal connected to the mobile patch, transmits an activation signal to the mobile patch, and receives the biometric information signal as shown in Fig. 2. This mobile patch constitutes an information collecting interface based mobile patch sensing system with disconnected operations.

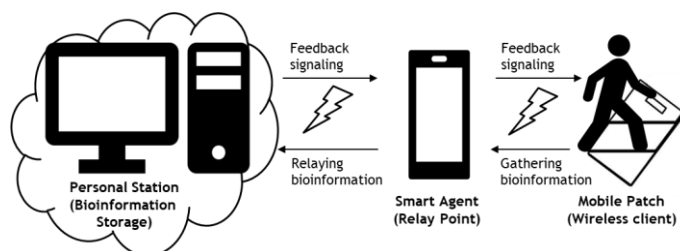


Figure 2. Bioinformation Sensing system with wireless patch interface

In addition, the expansion system may further include an external server connected to the active terminal in a wireless or wired manner, and the external server may include a mobile

information collection interface-based patch sensing system capable of receiving a biometric information signal of a patient from an active terminal acting as a mobile agent.

Here, as shown in Fig. 3, the mobile patch constitutes three layers of partial modules from the bottom to the top as follows. The first lower layer constitutes the drug application and biosensing layer on which the drug is formed on the lower surface which is in close contact with the skin of the patient. The second wireless transfer layer is a supporting module formed on the upper part of the lower drug applying layer, and includes a bioinformation collection module for measuring a biometric information signal of a patient and a drug action detection sensor module for generating a drug action signal by gathering the degree of the drug acting on the patient do. And a power supply module for operating the built-in circuit. The third layer includes a display interface module formed on the upper part and a control module for generating a patch removal inducing signal corresponding to the drug operation signal when the drug action signal is out of a predetermined threshold value range and transmitting the signal to the display module.

The wireless sensing data transmission structure of the mobile patch system is as follows. First, the smart agency performs an activation process to send an activation signal to the mobile patch attached to the patient. Second, a mobile patch that transmits activation signal from the active terminal proceeds with a bioinformation sensing step of sensing drug and human body information. Third, the mobile patch consists of a feedback step of feeding the sensed drug and human body information to smart agent. Finally, the smart agent constructs a wireless transfer process for storing the sensed drug and human body information in the internal memory.

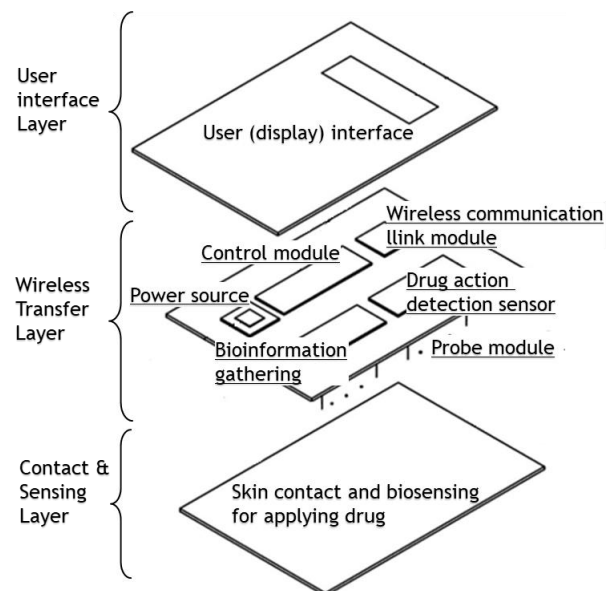


Figure 3. The Layered Architecture and Components of Digital Patch

Further, the drug information and the human body information stored in the active terminal can be further expanded to an external transfer process for transferring and

storing the drug and the human body information to a database of the external server.

III. DISCONNECTED OPERATIONS AND ALGORITHM OF DIGITAL PATCH SYSTEM

This paper splits a total set of link connectivity to three classes as successful connection links, temporary disconnection link and permanent disconnection link [8]. The “*Successful Connection Link (L_S)*” means that the connection status of the physical link is good at a specific time. The “*Temporary Disconnection Link (L_T)*” indicates that the connection status of physical link is temporarily disconnected during the transient time. The “*Permanent Disconnection Link (L_P)*” is permanently to break the connection status of physical link. Here δ_o is to short threshold value and δ_n to long threshold value. This is shown as:

$$\begin{aligned} L &= \{L_1, L_2, L_3, \dots, L_i, \dots, L_n\} = \sum_{i=1}^n L_i \\ L_S &= \{L_i \in L, \text{if } \text{Timer}_i \text{ of } MP_i \leq \delta_o\} \\ L_T &= \{L_i \in L, \text{if } \delta_o < \text{Timer}_i \leq \delta_n\} \\ L_P &= \{L_i \in L, \text{if } \delta_n < \text{Timer}_i\} \\ L &= \cup \{L_S, L_T, L_P\} = \{L_S \cup L_T \cup L_P\} \end{aligned}$$

As shown in Fig. 4, each smart phone SP_i has the transmission agent to support data transfer caching and buffering. The default transfer agent is initially executed for setup as the real-time transmission agent in each smart agent. The transmission agent TA_i of each smart agency supports an agent buffering module and roaming forwarding module dependent on disconnection variable and recovery reconnection location of mobile patch MP , respectively as follows.

Firstly, network disconnection is a condition for which the mobile patch which receives the real-time packet does not appear in wireless cell before time delay shorter than critical threshold value (δ_n) after it disappears without disconnection commands. This research proposes agent buffering techniques to minimize the real-time transmission packet loss by the disconnection of the wireless sensing network as Figure 4.

The agent buffering module selectively supports for transmission efficiency and prevents packet loss which appears via network discontinuation of the radio smart agent. In the case that the mobile patch which exists in wireless smart agent was discontinued, a transmission agent selectively operates the two buffering techniques of SKIP mode (buffering off mode) with loss permission and SUSPEND mode (buffering on mode) with loss prevention about the transmitting packet. From mobile patch to smart agent, the real-time upload transmission packet loss of UDP-like transmission modules for transmission efficiency on the OSI 4th layer occurs, which is identical with SKIP modes without buffering. The 4th layer TCP-like transmission with the reliable channel demands the many confirmation messages. It appears the problem that the transmission efficiency comes to be bad suddenly. We support SUSPEND modes with buffering to overcome this problem during a network disconnection.

Secondly, the reconnect operation in a wireless network is a condition for which a specific mobile patch appears in a smart agent before delaying more than threshold value (δ_n) after disappearing from the smart agent. This research provides the predictive pre-fetch technique to minimize the time delay of the real-time packets which occur in the re-connection process.

The prediction pre-fetch module is a process that brings succeeding packets in advance from the application server because of the fact that the mobile patch MP will reconnect in the near future as it reconnects the changed access point after it disconnects in the middle while it receives packets.

In addition, biometric information of the patient can be transmitted to the outside, and action information of the internal medicine of the patch used for the treatment can be transmitted to the outside, so that the transmitted data can be easily browsed. In this study, a smart agent as an agent smart phone can use a WIFI or Bluetooth network or the like, and thus can connect to an external server using such a communication network.

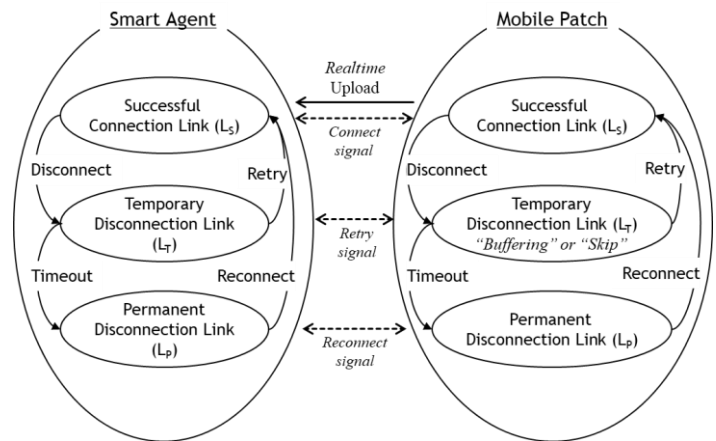


Figure 4. State Transition between Smart Agent and Mobile Patch

Important permanent data is operated based on TCP-like protocol, and daily monitoring and data collection can be performed based on UDP-like protocol.

In addition, the smart agent and the external server can store the subscribed patient information. At this time, the patient information may be stored through one of the smart agent or the external server and shared with each other. In other words, when stored in the smart agent, the stored bioinformation is transmitted to the external server and stored in the external server.

Here, the reference health information may be classified according to the patient's age, sex, body shape or the like or pre-set reference health information (for example, blood pressure, pulse, blood glucose level, etc.).

This standard health information can be used by backing up the data stored in the existing hospital database for the recent health condition information and medical history information. If necessary, the patient can receive the data from the treated hospitals and store it on the smart agent phone or the external server is.

This is an extended feature of the wireless sensing system using the mobile patch based on the information gathering interface of the present invention, so that it is possible to manage the health and medical information according to each user, thereby enabling more efficient additional service support.

The following is a wireless disconnected sensing method using mobile patches based on the bioinformation recovery interface. Fig. 5 is a wireless disconnected sensing operations for each mobile patch and smart agent based on the wireless information transfer interface.

```

Disconnect Smart Agent Process: {
  if(Receive(Response_MPi)=='SUSPEND') {
    Keep Successive_data into Temporary buffer;
  } else ! 'SKIP' mode
    Reset Temporary buffer;
};
if(Link_Status == 'Connect') {
  Transfer Successive_data from MPi to SP;
};
if(Timer <  $\delta_o$ ) {
  Link_Status := 'Connect';
} else if(Timer <  $\delta_n$ ) {
  Link_Status := 'Temporary Disconnection';
  Save Successive_data into temporary buffer;
  Send TAK to SP;
} else
  Link_Status := 'Permanent Disconnection';
  Reset Temporary buffer;
  Send FAK to Server;
};
End.

Disconnect Mobile Patch(MPi) Process:
  if(Link_Status == 'Reconnect') {
    Send Recovery_message to the SP;
    Upload Successive_data of MPi to the SP;
  };
  if(Send(Data Source)=='Complete') {
    Send ACK_MPi to Server;
  };
};
End.

```

Figure 5. Disconnect operations with Buffering and Skip

In Fig. 5, the disconnected sensing process used in a mobile patch and a smart agent is as follows. Smart Agents and Mobile Patches monitor their wireless channel status. If the wireless channel disconnection timer is less than the threshold (δ_o), it is defined as a 'Connect' state. If it is less than the threshold (δ_n), it is defined as a 'Temporary Disconnection' state. If it is greater than the threshold (δ_n), it is defined as 'Permanent Disconnection' state. The mobile patch 'MP' selectively supports 'SUSPEND' mode which performs buffering to support the transmission recovery process and 'SKIP' mode which ignores loss information when disconnection.

Fig. 6 is the recovery process of buffering bioinformation received from a user mobile patch to a smart agent.

In Fig. 6, the smart agent initially activates the mobile patch with a reconnect signal. If they are reconnected, the smart agent waits for receiving the bioinformation and the user's biometric information from the mobile patch. If a feedback signal is detected, it stores the received information in its storage space. Then, as a recovery process, the mobile patch uploads buffered Successive_data during a temporary or permanent disconnection.

```

Reconnect Smart Agent Process: {
  if(Receive(Recovery_MPi)=='Reconnect') {
    Upload Recovery_message into the SP;
    Request RAK_SP with the last data sequences to SP;
  };
  if(Link_Status == 'Connect') {
    Receive Successive_data since the last data sequences to the SP from MPi;
  };
};
End.

Reconnect Mobile Patch(MPi) Process: {
  if(Link_Status == 'Reconnect') {
    Send Recovery_message to the SP;
    Upload Successive_data of MPi from the SP;
  };
  if(Send(Data Source)=='Complete') {
    Send ACK_MPi to SP;
  };
};
End.

```

Figure 6. Reconnect Operations for transfer recovery

At the same time, real-time biometric information can be continuously collected through a wireless channel independent from the mobile patch.

IV. CONCLUSION

This study first proposed a mobile bioinformatics system. This work minimizes packet losses up to a zero ratio by an smart agent based buffering method considering the mobile patch position in spite of frequent disconnection and roaming of mobile patches on wireless sensing networks. Concurrently, a forwarding method embedded in the smart transfer agent has enlarged data traffic efficiency.

Accurate data transmission is important in mobile biometric information systems. The mobile patch proposed in this paper can secure the reliability of information by transmitting accurate biometric data. In addition, anytime, anywhere can check the emergency situation of the patient and user due to the acquisition of biometric data.

In the future, this study intends to expand the scope of research by constructing a distributed multi-digital patch system.

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Moon-Il Joo received the PhD degree in computer engineering from Inje University in 2018. He is currently working as a research professor at the Institute of digital anti-aging healthcare, Inje University, Korea. His research interests are in software engineering, human computer interaction, smart phone programming, and component based development.



Jong-Seong Sim received the bachelor's degree in computer engineering from Inje University in 2018. He is getting a master's in the Institute of digital anti-aging healthcare, Inje University, Korea. His research interests are in human computer interaction, smart phone programming, and component based development.



Tae-Gyu Lee (BSc'92–MSc'96–PhD'06) He received the B.Sc. degree from Kunsan National University, Kunsan, Korea in 1992, the M.Sc. degree from Soongsil University, Seoul, Korea in 1996, and the Ph.D. degree from Korea University in 2006. He is currently a Professor in the ICT convergence Division, Pyeongtaek University, Gyeonggi, Korea. He has been a Professional Researcher in Advanced Convergent Technology R&D Group, Korea Institute of Industrial Technology (KITECH), Ansan, Korea for 2009-2013. He has also been a President in the JIGUNET Corporation, Seoul, Korea, from 1999. His research interests are in distributed systems, ubiquitous computing, middleware, networks, wearable and robot computing.