A Study of the Middleware System for the Construction of u-Healthcare System

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u-Healthcare 시스템 구축을 위한 미들웨어 시스템에 관한 연구

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요 약

u-Healthcare란 건강관련 정보를 시간과 공간의 제약 없이 수집, 처리, 전달, 관리할 수 있게 해줌으로써 원격지 의료서비스를 제공하는 것을 말한다. 본 논문은 USN을 활용하여 원격에서 측정된 의료정보를 수집하여 서버에 전달하는 미들웨어 시스템을 시뮬레이션 했다. 헬스 케어기기에서 측정된 데이터를 USN을 통해 원격지의 서버로 전송하는데, 데이터의 전송에는 근거리 무선통신기술인 Zigbee를 사용하였다. 이러한 과정에서 헬스 케어기기와 서버사이에 미들웨어를 두어 측정된 이진코드 데이터를 텍스트데이터로 변환하여 서버의 헬스케어 시스템에 저장한다. 서버에 저장된 환자들의 의료정보는 의료진이 활용할 수 있도록 했다. 또한, 미들웨어 시스템에서는 데이터의 필터링을 통해 불필요한 데이터를 삭제해 서버의 부하를 줄여서, 외부 어플리케이션의 질의에 대한 정보제공을 용이하게 했다.

Key Words : u-Healthcare, RFID/USN, Middleware System

1. Introduction

In the present, Development of online or wireless communication technology makes possible various services. USN(Ubiquitous sensor Network) is particularly considered as a core technology that allows sharing information by wireless communication between sensor nodes and Readers[1].

USN, a technology transmitting tag data through RFID tag and Reader, has developed now to read environment data through sensor node and to make possible context awareness[5]. The problems of RFID system found in applied domains such as u-City, u-Healthcare, u-Museum are now being solved little by little like this[7].

The studies of USN have been focussed mainly on hardware such as sensor node, Reader and Router. But nowadays, there are growing interests in many applied systems and in Middleware System which supports contacting with various sensor nodes and collecting, controlling, managing of data[8].

This paper presents Middleware System that transmits the information obtained from healthcare equipment to Server through sensors and Zigbee system.

It shows the structure of Middleware System that supports different types of query for application and

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combines heterogeneous sensor network. It also shows how to control efficiently the sensing information by Middleware System.

The paper is divided into five chapters. Chapter one talks about the background and necessity of this study. Chapter two mentions preparative studies on Middleware System. Chapter three proposes the model of Middleware System. Chapter four includes a simulation followed by some problems to solve in the future.

2. Basic Technologies

USN, a basic technology of ubiquitous computing, carries out the functions of sensing and network by popularizing sensor and Tag throughout the overall life and industries such as logistics and manufacturing[6]. The existing network between men and objects now gives place to the network between objects and their environments, which makes possible collecting and managing information and its application in real time. This can be done by attaching electronic tag to the objects[4].

As <figure 1> shows, the sensing information obtained by sensor node is transmitted to Sink node. The transmitted data is then saved in Server via Gateway by Zigbee, radio communication.

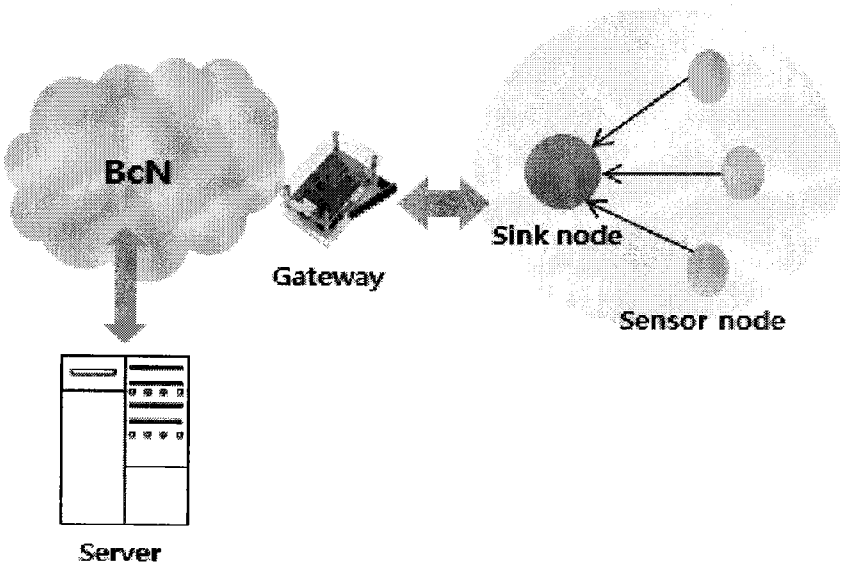
IEEE 802.15.4 undergoing supplementary standardization is now used for supporting wireless communication.

2.1 USN Middleware

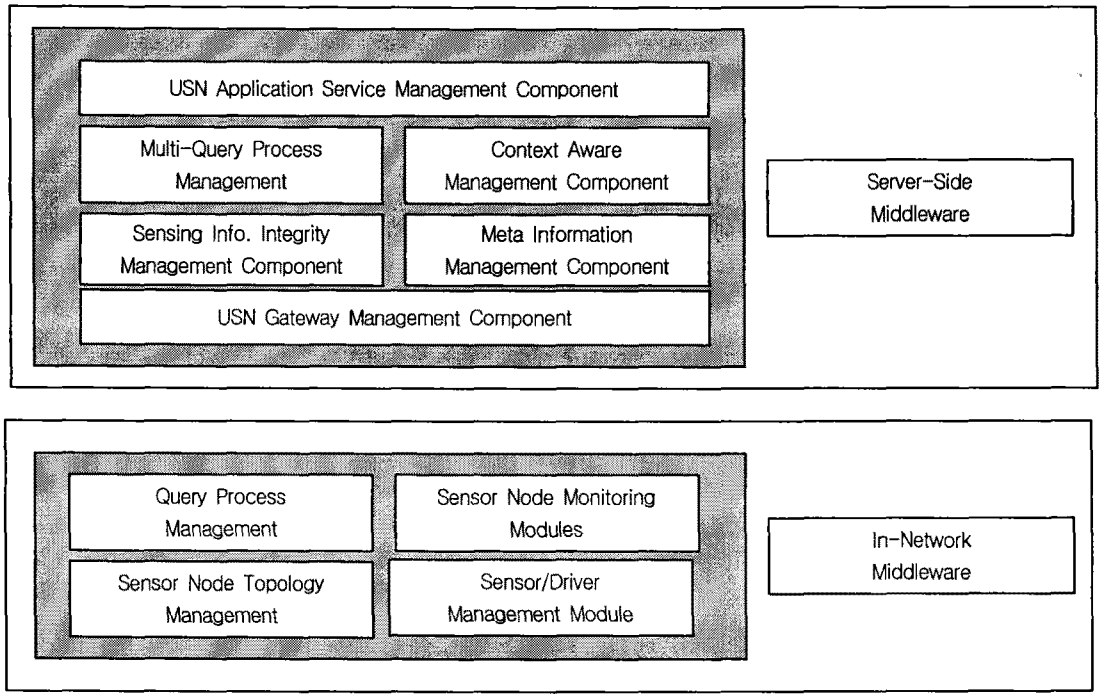
As <Figure 2> shows, USN Middlewares are classified into server-side Middleware and in-network Middleware according to the place of their installation. The former is set up in Server System, and the latter in sensor node[6].

Server-side Middleware takes care of various USN applied services and multi-questions derived from them. It also carries out efficient management of sensing and meta information. It consists of many components that combine sensing/ existing business information. There are also components that produce new environment information and carry out intelligence events demanded by applied services.

In-network Middleware consists of modules that take care of various tasks : 1) controlling queries in sensor node and sink node, 2) managing information for the network among sensor nodes and for the condition of sensor node, 3) controlling sensor and driver.



<Figure 1> USN System Diagram



〈Figure 2〉 Basic Structure of Middleware System

2.2 Preparative studies

USN service was originally applied to military purposes. Since then, various types of USN applied services have been developed along with the progress in related technologies such as sensor node, sensor network, and USN Middleware[10].

2.2.1 TiniDB(Berkeley)

(1) Characteristics

- Middleware based on DB. It considers WSN as virtual data base.
- Server-side / In-network Middlewares operate in cooperation.
- It operates in node equipped with TinyOS and supports SQL-like queries.

(2) Limits

- It is only available for sensor node based on TinyOS. Whenever new functions are added, query managing module found in every node must be changed.
- High cost for maintenance and for supporting sensor node changing frequently.

2.2.2 Cougar(Cornell)

(1) Characteristics

- Based on DB. It supports SQL like queries.
- Server-side Middleware.
- It encourages the best quality.

(2) Limits

- Server-side Middleware.
- Optimizer must maintain all the information about WSN.

2.2.3 SINA(Delaware)

(1) Characteristics

- Middleware base on DB. It supports SQL-like queries.
- It controls neighboring sensor nodes combined as Cluster and obtains sensor data from specific Cluster.

(2) Limits

- Centralized like Cougar.

- Optimizer must maintain all the information about WSN.

2.2.4 DSWare(Virginia)

(1) Characteristics

- Middleware based on DB. It supports SQL-like queries.
- It has characteristics of Server-side Middleware and also In- network Middleware.
- It supports active group maintenance for sensor nodes.

(2) Limits

- It lacks function for overcoming heterogeneousness of sensor node H/W, and for managing mobile sensor node changing quickly.

2.2.5 Impala(Princeton)

(1) Characteristics

- Adaptation is available for services.
- It can change the function of node in operation, through mobile code technology available for responding to binary code.

(2) Limits

- Middleware that is dependent on Hewlett-Packard products.
- Abstraction of heterogeneousness of sensor node H/W is not supported.

We show main characteristics and limits of existing USN. In case of TinyDB and DSW are Middlewares, in-network/server-side Middlewares operate in cooperation. But the problem is that they are dependent on a sensor module and impossible to overcome heterogeneousness among sensor nodes[9].

Middleware System presented in this paper allows integration of different domains such as heterogeneous sensor node hardware, heterogeneous sensor network and various types of USN applied services. which can be done by distinguishing meaningful data from others.

They can be flexibly integrated without losing any independency. Middleware designed here also contributes to improving accuracy and efficiency of data, which can be done by distinguishing meaningful data from others.

3. Middleware System Design

Health information obtained from healthcare equipment is necessary for good operation of u-Healthcare System[2, 3].

The data, organically combined between sensor node equipments and sink nodes, is transmitted to remote u-Healthcare System. In this process, Middleware System allows integration of heterogeneous data.

It also keeps server from being overloaded and encourages effective management of data. Information derived from static equipment and mobile equipment is delivered to u-Healthcare System via USN Middleware. <figure 3> shows the data flow in u-Healthcare System.

3.1 Concept of System

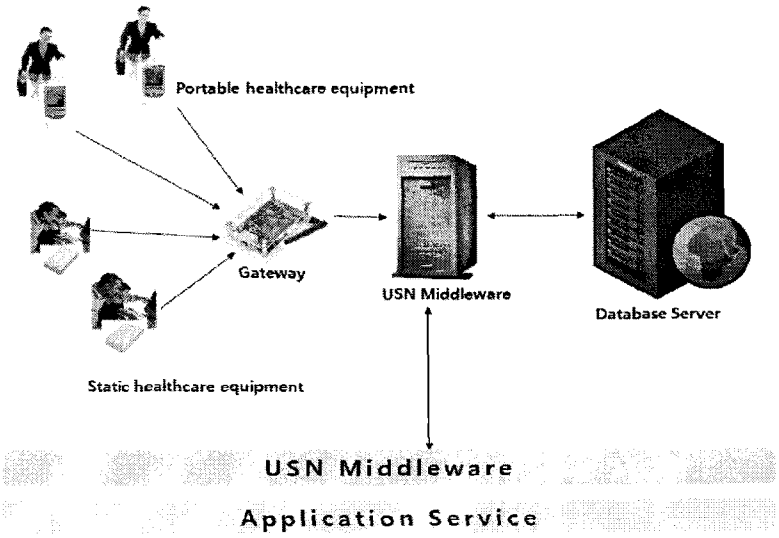
As <figure 4> shows, u-Healthcare System consists of H/W Layer, S/W Layer, and Application Layer. On H/W Layer, healthcare information obtained from static healthcare equipments and mobile healthcare equipments undergoes organic combination among transfer node, mobile node, queuing node and sink node. And then, the information is transmitted to S/W Layer where Middleware System filters unnecessary information to keep DB from being overloaded and to transmit meaningful information to Server. Finally, Application Layer applies the information saved in Server to remote medical part[9].

3.2 Scenario

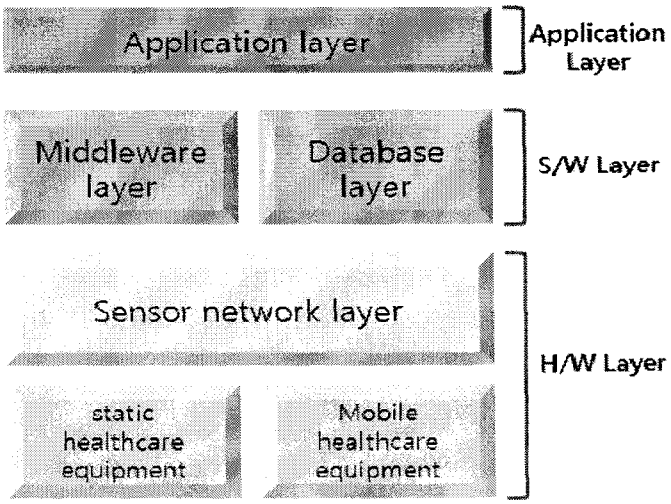
u-Healthcare System transmits patient's health information which is obtained from healthcare equipment equipped with bio sensor, to Middleware through Zigbee.

u-Healthcare System is designed to invite the manager's quick reaction to emergency information transmitted to Middleware through special signal. Middleware carries out various functions such as code conversion, recognition of priority, filtering of unnecessary data, and saves the data in DB Server.

The role of middleware is very important in the



〈Figure 3〉 Middleware data flow diagram of u-Healthcare System



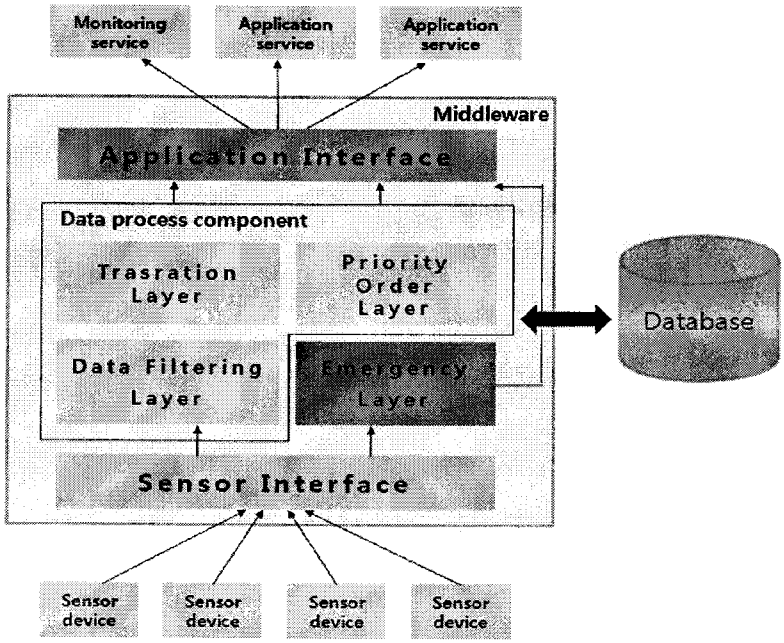
〈Figure 4〉 The layers of Middleware System

operating sequence of u-Healthcare System : it controls health information delivered by heterogeneous sensors and treats urgent data. In fact, Middleware takes charge of efficient process of the System from sensing health information to its transmission to DB Server.

Middleware takes various functions such as efficient Interface, managing data, and coping with emergency environment. Firstly, Interface has two different functions : combining health data obtained from heterogeneous sensors through abstraction, and coping with various application problems. Secondly, managing data includes filtering of unnecessary data and transition of binary code data into utilizable one, and also deciding priority among data. Lastly, it copes with emergency environment by alarm signal.

3.3 Design of Middleware System

<Figure 5> shows the structure of Middleware System proposed in this paper. Middleware performs



〈Figure 5〉 The Structure of Middleware

abstract function for various sensors through sensor Interface, because of different transfer method for each sensor equipment. And emergency data is immediately transmitted to Application Layer via Emergency Layer.

In Data process component, Data Filtering Layer filters unnecessary information in order to prevent the DB from being overhead. Translation Layer transforms binary code data into utilizable one. Priority Order Layer efficiently reacts to urgent requests by priority query queue. Application Layer takes charge of communication between Application Service and Middleware.

4. Simulation

Healthcare data obtained from sensor node is transmitted to Middleware through Zigbee.

Middleware transforms sensing information into digital one and transmits it to Server.

Sensor node is equipped with Atmega 128L, 8bit MCU and also Chipcon 2.4GHz supporting Zigbee System. This paper shows all this process.

The operating system adopts Windows 2003 Server SR2. Visual Studio 2005 adopts for a development tool, and C# .NET, C, C++ for a development language. For DB, it takes MS-SQL 2005 available for managing data in real time.

4.1 Algorithm

<Figure. 6> shows the process of managing and saving data. The data introduced at Gateway is controlled in Middleware to be finally saved in DB.

4.2 Middleware Simulation

<Figure 7> is a scene that shows transmitting sensing data from Gateway to Middleware. Healthcare data obtained from healthcare equipment is transmitted to Gateway, and then to Middleware in the form of binary code. Middleware transforms the code and saves the data in DB. System managers or doctors can monitor the data saved in DB.

As <Figure 8> shows, they check into the information on each patient's case by monitoring DB.

In emergency environment, they also can take quick measures by alarm system.

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Middleware Algorithm :
    Repeat
      Receive current data(D(t)) from Gateway
        Apply Data Process Algorithm
          Storage TD(t) to Database

Data Filtering Algorithm:
    D(t) decoding is TD(t)
    Return TD(t)
    If(D(t) == Correct)
        Definition D(t) is Correct
        D(t) decoding TD(t)
        return TD(t)
    Else
        Definition D(t) is Throw data
        Return TD(t)

Priority Order Algorithm:
    D(t) decoding is TD(t)
    Return TD(t)
    D(t) Storage Que
    If(D(t) = Max)
        Definition D(t) is Priority
        D(t) decoding TD(t)
        Return TD(t)
    Else
        Definition D(t) is Nomal Data
        Return TD(t)

Translation Algorithm:
    D(t) decoding is TD(t)
    Return TD(t)
    If(D(t) = binary)
        Definition D(t) is Health Data
        D(t) decoding TD(t)
        Return TD(t)
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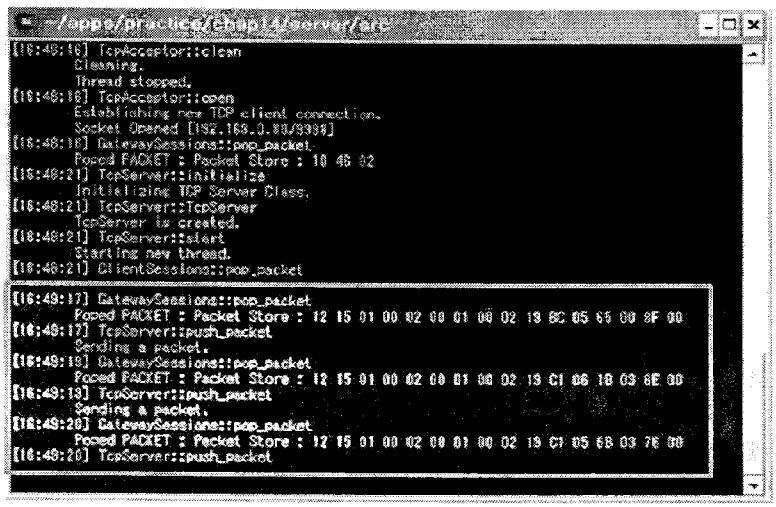
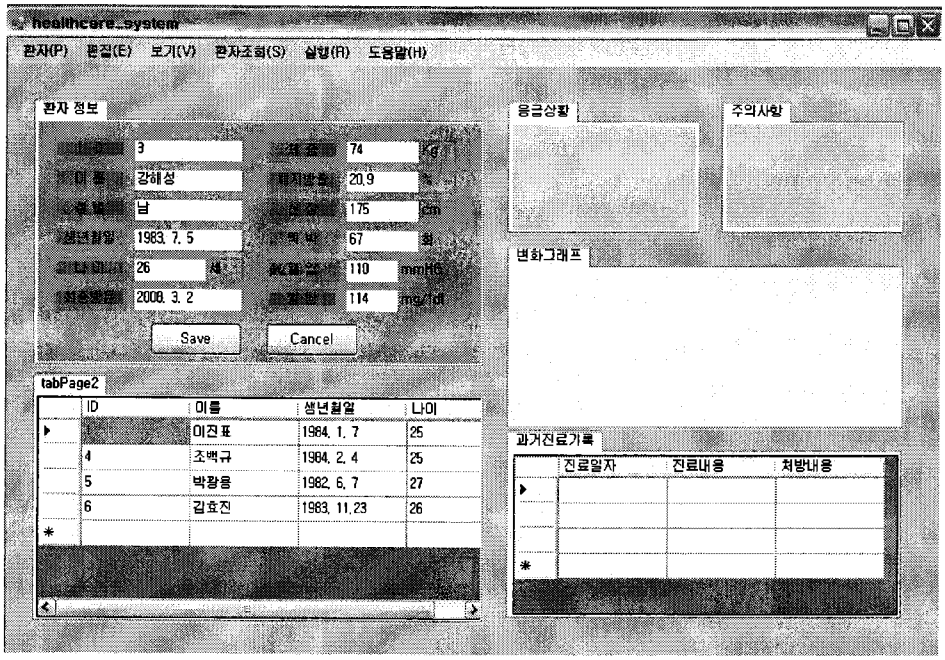
〈Figure 6〉 Middleware Algorithm



〈Figure 7〉 Transmission of data to Middleware



〈Figure 8〉 Practice monitoring of u-Healthcare manager

5. Conclusion

This paper described the concept of USN and its operating process. And it simulated u-Healthcare System combined with healthcare service. Nowadays, the development of communication and medical technology leads to extensive studies to meet higher expectations of consumers. However, the studies on managing data in Server-side Middleware fall relatively behind in spite of enormous progress in this field.

This paper focuses on reconstruction of meaningful information through managing data in Middleware, rather than on overall function of Middleware. By focussing on data management, however, the paper becomes necessarily a partial simulation performed with extreme simplification of medical service.

While it is urgent to develop middleware implemented with more sophisticated functions, the studies on interaction between In-network and Server-side Middleware are not fully developed yet. Therefore, the studies on intelligent Middleware that controls sensor node and responds to multi-applications are really needed now.

Reference

[1] Castro, L. and Wamba, S.F.(2007), "An Inside Look at RFID Technology", Journal of Tech- nology Management & Innovation, Vol.2, Issue.1, pp.128-141.

[2] Cheng, C.Y. and Prabhu, V.(2007), "Per- formance Modeling of Business Processes Enabled by RFID and Web Services", International Computer and Information Science, pp.718-723.

[3] Cho, D.W., Kim, B.H.(2008), "The Imple- mentation of u-Health Home Services Environment", Korea Information Processing Society, Korea Information Processing Society Review, Vol. 15, No. 1, pp.62-70.

[4] Dong, L., Wang, D. and Sheng, H.(2006), "Design of RFID Middleware Based on Complex Event Processing", Cybernetics and Intelligent Systems, 2006 IEEE Conference on, pp.1-6.

[5] Hoag, J.E. and Thompson, C.W.(2006), "Architecturing RFID Middleware", IEEE, Internet Computing, Vol.10, Issue.5, pp.88-92.

[6] Kim, Y.C., Park, M.S.(2007), "Develop- ment of

middleware System for the Logistics Information Awareness using the RFID", Global e- Business Association, The e- Business Studies, Vol. 8, No. 3, pp.281-299.

[7] Salem, H., and Nader, M.(2006), "Middle- ware Challenges and Approaches for Wireless sensor Network," IEEE Distributed System Online, Vol.7, No.3.

[8] Tamura, T., Togawa, T., Ogawa, M., and Yoda, M.(1998), "Fully automated health Monitoring system in the Home." Med. Eng. Phys., Vol 20, No 8, pp.573-579.

[9] Whang, H.J., Lim, Y.S.(2008), "Case Study of Emergency Medical Information System based on RFID", Korea Information Process- ing Society, Korea Information Processing Society Review, Vol. 15, No. 1, pp.90-98.

[10] Wilson, D.H., Long, A.C. and Atkeson.(2005), C., "A Context-Aware Recognition Survey for Data Collection Using Ubiquitous sensors in the Home", In Proceedings of CHI 2005: Late Breaking Results, pp.1865-1868.

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