

# Mobile Agent in the U-Medical and Education

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**Abstract** According to development of Information technology, people are now enjoying a life that is more comfortable and convenient. In particular, as the automatization is becoming standard in the medical field, especially in the large hospital, the demand for system that can handle various information and data are now more than ever imperative. As such, EMR (Electronic Medical Record), CPR (Computer-based Patient Record) and HIS (Hospital Information System) are deployed in the hospital with the aim of managing medical and patient information. This paper aims to design agent system that is mobile based and decentralized, and that can provide and administer basic medical information. Its main objective is to move away from high cost centralized system to low-cost based system corresponding to small to mid-size medical information that can be effectively utilized and administered.

**Keyword:** Mobile, Patient, Ubiquitous

## 1. Introduction

With the improvement in information technology and the rapid adoption of automatization at both work and home, people are now enjoying a life that is more comfortable and convenient. In particular, as the automatization is becoming standard in the medical field, especially in the large hospital, the demand for system that can handle various information and data are now more than ever imperative. As such, EMR (Electronic Medical Record), CPR (Computer-based Patient Record) and HIS (Hospital Information System) are deployed in the hospital with the aim of managing medical and patient information [1]. Aforesaid medical information system involves storing every sort of information and patient examination records and transmitting necessary medical prescription of diagnosed patients to relevant department through network system [2].

This system is not limited to mere administration of patient registration, examination, payment and other essential data, it is also critical in the sense that it unifies and facilitates all administration functions of the hospital[3], [4].

However, this system was developed with hospital-focused on mind and as a result, its system became more centralized, resulting in a system that connected all patient and hospital information into one. This type of system necessitates large-scale database and as such, it involves high cost in development and maintenance. Consequence of this is that it is limited to hospitals that have adequate resources to pay for the system.

This paper aims to design agent system that is mobile based and decentralized, and that can provide and administer basic medical information. Its main objective is to move away from high cost centralized system to low-cost based system corresponding to small to mid-size medical information that can be effectively utilized and administered.

## 2. Preparation

### 2.1 Hospital Integrated Information System

Hospital integrated information system automates medical examination administration and information provision system and stores various types of medical information and patient information into database and after doctor's diagnosis, it transfer the prescription to pertinent medical departments through network.

The information system not provides registration, examination, payment, and other data; it is a comprehensive system that facilitates all administrative functions [5]. Although it is very effective system, as it is designed for hospital and patient administration, it is appropriate only for hospital or medical institute that requires large-scale works.

### 2.2 Ubiquitous Examination System

U-healthcare service is shown in figure 1 below. It is largely divided into patient, communication device, and medical service center that diagnosis and prescribes, medical specialist, patient DB and emergency medical treatment center. On days scheduled for regular exam or any occurrences of medical problems while on monitor, the message via PDA, mobile phone or notebook will be relayed to corresponding medical institutes. Institutes in turn will utilize patient database and connect to doctors in charge and give out diagnosis and prescription. If the patient is in need of emergency care, it will be connected to 911 centers and will be provided with immediate medical services.

As such, patients in the U-healthcare environment can check their conditions anytime and anyplace, and receive appropriate medical services, whereas, medical institutes can constantly monitor the patients' conditions, resulting in a service that is dynamic and efficient. Aforesaid ubiquitous medical examination system can be utilized for various uses but due to specified devices required and high cost of maintaining centralized system, as well as the expensive equipment needed to develop the system, its system is limited to those that could afford it.

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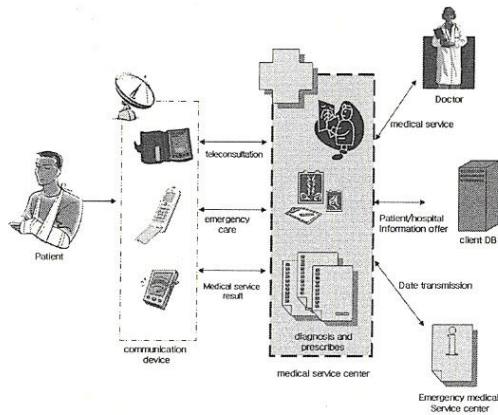


Fig. 1. U-healthcare System

### 2.3 Mobile Agent

Mobile agent is the next generation human-computer interface concept, through the usage of mobile instruments and a sensor; it seeks to understand the intention of users and executes the specific matter in optimal fashion. Furthermore, the technology is proposed to utilize the agent through Internet, resulting in more diverse and efficient services. In particular, by seizing the distributed agents in network, its objective is to provide improved service by finding necessary information automatically.

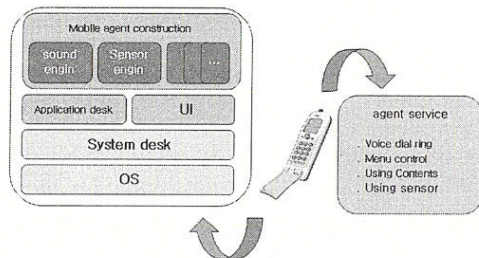


Fig. 2. Mobile agent construction

Mobile agent construction follows figure.2 below. It is constructed so that mobile devices can send and receive sound, sensor, location information and it is structured so that the unnecessary complex process is eliminated and thus streamlined, making interface simple, enabling easy accessibility of information [6].

### 3. Patient Specific Mobile Agent Proposal

This chapter proposes model that enables patients to receive improved medical service based on patient-focused approach. In particular, it aims to design agent system that will provide convenient service through the usage of mobile devices.

The system entails distributed environment where each users can receive patient specific medical information service tailored to their needs. Patient specific mobile agent follows the structure as indicated by Figure 3 below.

**Mobile Agent** The mobile device that users carry have all relevant information, including personal information, as well as medical information, location information, sensor information and others that will be generated and managed in real time. Moreover, the agent receives information from agent information center, and in turn, will provide latest information back to agent information center.

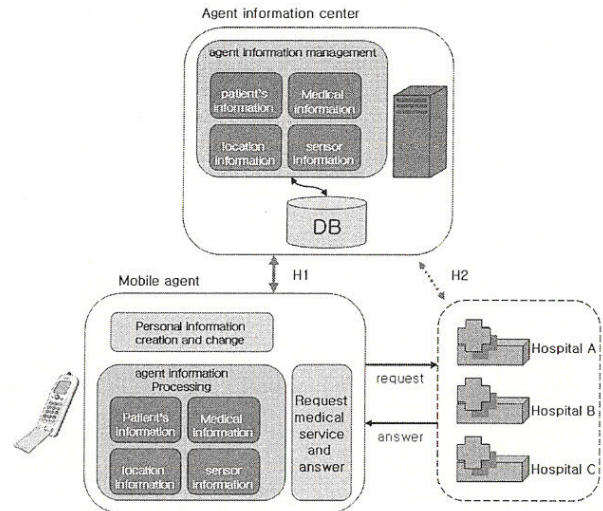


Fig. 3. Mobile agent Model

**Agent Information Center** Mobile agent information center plays an essential role in analyzing data provided by a mobile agent and through close interaction with medical environment and via patient specific information and mobile devices; it stores vital data, including examination information, location information and sensor information. Information center also alleviates the calculation and memory limitation of patient-focused mobile agent, increasing the efficiency of the system. In addition, it processes mass size data through integrated information system and information linkage (H2) of ubiquitous medical system, which was not possible with the mobile agent alone.

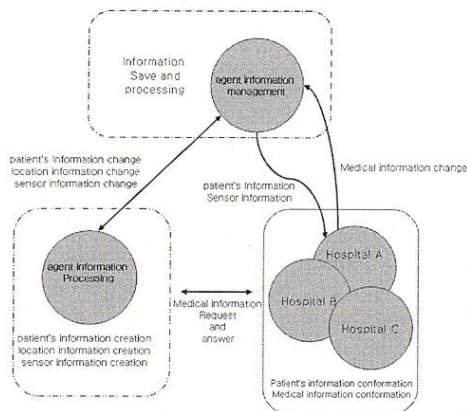
### 3.1 Patient-focused Mobile Agent Information Classification.

Classification	Define	Example
Personal information	When the patient request medical service and their personal information	name, sex, age, address, phone number..
Medical information	Patient's health.	Relevant Medical information, Medical schedule, x-ray, Embryo picture
Location information	User's position information	GPS position information
Sensor information	Sensor information that is collected in Mobile device	Body temperature, pulsation

Patient's personal information, medical information, location information and sensor information are separated and administered. Saved information is managed in such way that if patient needs examination, it is immediately provided with appropriate medical service, resulting in highly efficient and convenient service. To administer the basic information efficiently in patient-focused mobile agent construction, the characteristics are divided as shown Table 1.

**Table 1.** Patient-focused mobile agent

Personal information creation and change When the patients request medical service and their personal information do not initially exist in the mobile device, pertaining to service requested by the patients, the personal information will be generated in the device by the provision of agent. Following the requests of the services, patient information will be changed accordingly. Medical information creation and changes When the medical service is needed, the relevant medical information, such as patient diagnosis, progress and others will be provided by agent. Additionally, depending on the circumstances, services will be changed accordingly. Location information creation and change Upon request by the medical service, it will provide the information on the whereabouts and the changes in the location. Sensor information creation and change Specific purpose sensor observes the conditions and changes in the patient's surroundings and upon the request by medical services; it outputs the most relevant information. Additionally, depending on the circumstances, its criteria will be changed accordingly.



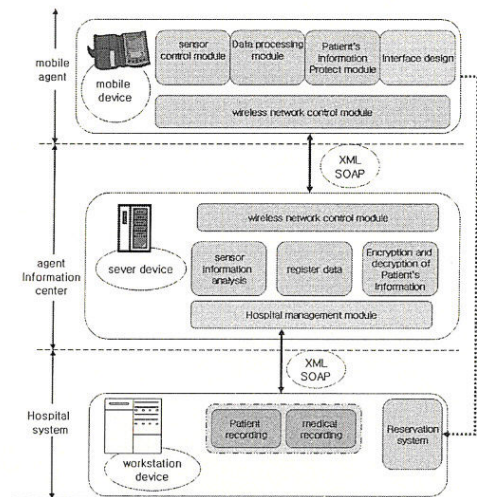
**Fig. 4.** Mobile agent information cycle

The patient-focused mobile agent information cycle is shown below in Figure 4. It occurs largely in agent information administration, agent information management and between hospitals. Individual information and patient's location and sensor information is managed real time by agent information management and after transmission and analysis by agent information administration, pertinent information is changed accordingly. In case of hospital, after checking out the availability of patient's information, it sends necessary information to agent information administration and subsequently, its information is changed accordingly. Furthermore, agent information administration provides immediate changes in the individual and sensor information to relevant hospital, resulting in data that is most up to date and accurate.

## 4. Mobile Agent Design and Evaluation

### 4.1 System Design

This paper proposes system design as shown in Figure 5 below,



**Fig. 5.** Proposes mobile agent system design

Proposed system is divided into mobile agent, agent information center and hospital system. The uppermost shows mobile agent, indicating mobile devices carried by users. At this juncture, mobile devices includes: a sensor control module that administers sensor, data management module that saves and transmits, and private information security module that protects user information, as well as an interface that provides convenience to users.

Agent information center is composed of module that manages information collected from mobile agent and is largely consisted of sensor information analysis, data storage, private information encryption, and descrambling. On this point, as mobile agent and agent information requires wireless transmission, it is critical in designing a network control module to ensure secured transmission. Furthermore, for the compatibility of each device and smooth transmission of data, XML protocol and SOAP based are necessary.

### 4.2 System Construction

Scenario to create the suggested system is described below. User A is using the mobile device that has sensors detecting temperature, blood pressure, and blood glucose level, and has recently been diagnosed with high blood pressure. When the sensors attached to the mobile device carried by the user detect abnormal increase in blood pressure, its purpose is to request for medical service and provide the hospital information most appropriate for the user.

Testing environment for this system is described in Figure 6. In the test environment, mobile device connected to the USB represents the mobile agent used by the user, which sends information on temperature, blood pressure, and blood glucose level to "middle-way" via separate application. Current location of the user also sends data to special area, while the hospital also inputs information of imaginary hospital based on the location of the user. For this example, let's say there are five hospitals, and one of the hospitals (M3) has previous history of providing

medical service to the user. Here, each hospitals are located M1 to M5 distance away from the location of the user.

Test result shows that depending on the intensity of the sensor information that represents emergency situation of the user, it indicates hospital M1 as the nearest, while as the sensor intensity decreases it indicates hospital M3 which has previous history of providing medical service to the user. In this system, XML type technology method is used in order to standardize information collected in various forms.

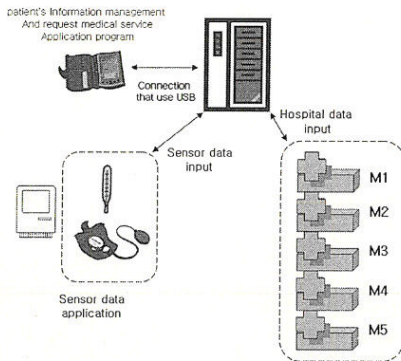


Fig. 6. Testing environment for this system

#### 4.3 System Evaluation and Comparison

As controlled system provides medical service that is based on the patient specific, it has fast response time on emergency and its system is less complicated, making it easier to adapt. The medical examination information process, using patient-focused mobile agent is as follows on Figure 7.

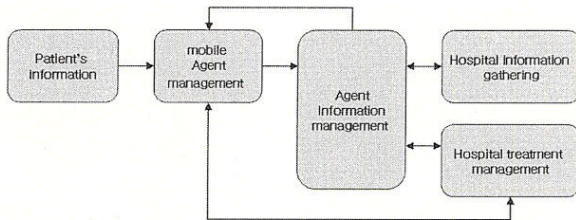


Fig. 7. The medical examination information process

In comparison to existing medical examination system, it proposes 5 items, as shown below in Table 2.

Table 2. In comparison to existing medical examination system.

Item	Information system	Patient-focused mobile agent
System scale	Large-scale system	Small system
Sensing scope	In hospital	Anywhere
User information management	In hospital	Real time
Patient medical information	In hospital	Real time
portability	Portability is good	Portability is good in

	in hospital Portability is bed outside	hospital Portability is bed outside

Existing examination system is tailored to large-scale hospital, and thus, its application is limited to such institutions. However, with the proposed patient-focused mobile agent, its services are created with the individual patient on mind, and hence, its application are now applicable for small to mid-size hospitals and furthermore, patients can receive various medical services that goes beyond traditional services.

#### 5. Conclusion

The proposed patient-focused agent medical examination service moves focus from existing automated hospital focus system to patient specific medical examination service and through provision of individualized service, it prevents redundancy and eliminates unnecessary procedures.

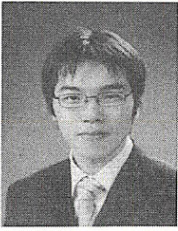
In addition, instead of adapting overly excessive system, it is possible to adapt only required service, such as medical information system that is specifically made for medical examination service. Thus, it is possible to select small to large scale sized system depending on the cost, size and its requirement of the institution.

The research on the materialization of sensor and mobile devices that concretely identifies the medical condition of patients is needed. Additionally, for privacy and security purposes, further study in the module development should be conducted to allow safe transmission of confidential medical information.

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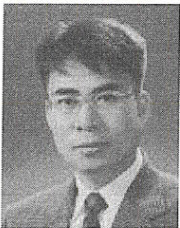
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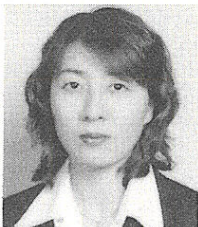
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