Research and Design of Intelligent Signs Detection Terminal in Nursing Information System Based on Cloud Computing

Liu Bo[1], Xiaoyu Chen[1*], Xin Xia[1]

[1]*Department of Information*, Center, East Hospital, Tongji University, School of Medicine, Shanghai, China

***Abstract* — As an applied service model, cloud computing has greatly developed in the past several years in the field of medical IT. In this paper, we proposes a wireless solution for mobile medical nursery of automatic acquisition of patient vital signs and handheld mobile intelligent devices based on cloud computing in regional hospitals to make a solution for medical execution at bedside. It is based on intelligent detection equipment of signs and wireless local area network as the hardware platform, and combined with bar code identification and other related technologies to accomplish the automatic acquisition and wireless transmission of vital signs including body temperature, breathing, pulse, blood pressure, and heart rate. The proposed system also avoids the manual data entries and thus lightens corresponding workload of medical staffs, minimizes error rate in daily nursing work, improves management efficiency, and guarantees the medical quality in hospitals.**

Keywords - intelligent signs detection terminal; nursing information system; cloud computing

I. INTRODUCTION

With the rapid development of mobile communication and network technologies, PDAs (personal digital assistant) have been widely employed in the accessory systems of HIS (Hospital Information System), such as Medical Encyclopedia, Pharmacopoeia Reference, and Clinical Patients Tracking System, which provide better and more convenient treatments for clinical patients. MNIS (mobile nursing information system) has been widely applied in abroad [1-3],and it has also achieved the retrieval and identification of patients' information, management of nursing records, collection vital signs, and the integration of ICU monitoring equipment at bedsides in the coordination with PDA in Peking Union Medical College Hospital, PLA General Hospital, and Wuhan General Hospital of Guangzhou Military Region. Nursing information systems connect personal computers, monitors, and ventilator medical instruments together for sharing, processing, and recording of patient vital signs information automatically. It has already been shown that the use of PDAs can improve work efficiency in nursery work [4]. However, problems like interruption of wireless signals, maintenance, and power charging can still lead to failures in data acquisition and thus disrupt normal work. Thus, nurses often have to carry PDAs and manually input the collected sign data into HIS [5].

As an emerging service model, cloud computing has greatly developed in the past several years in the field of medical IT. This paper proposes a wireless solution for mobile medical nursery of automatic acquisition of patient vital signs and handheld mobile intelligent devices based on cloud computing in regional hospitals. The solution is designed as a mobile terminal execution system at bedside, which takes HIS as the support platform. It is based on intelligent detection equipment of signs and wireless local area network as the hardware platform, and combined with bar code identification and other related technologies to accomplish the automatic acquisition and wireless transmission of vital signs including body temperature, breathing, pulse, blood pressure, and heart rate. The proposed system also avoids the manual data entries and thus lightens corresponding workload of medical staffs, minimizes error rate in daily nursing work, improves management efficiency, and guarantees the medical quality in hospitals [6].

II. RESEARCH AND DESIGN FOR MNIS

We separate the proposed system MINSCC into two parts along its systemic structure: MNIS and CC (cloud computing).

A. MNIS

By integration of electronic medical devices for data collection with nursing information systems, data sharing and business collaboration can be achieved between various different electronic devices and nursing information systems.

MNIS sends the instructions through intelligent mobile devices to control the measurement of patients' sign data by monitors. The collected sign data will be sent back to the nursing information system, and saved to the database after confirmation [7,8]. The system architecture of MNIS is shown in Figure 1.

In this figure, we can see the system architecture includes two parts: the bed-side terminal equipment and the management platform of the back stage. The bed-side terminals mainly include clinical data acquisition and data transmission apparatus in nursery, such as blood pressure, glucose, ECG and so on, and the terminal sign collection apparatus send the collected data to the data transmission

equipment like computers, cell phones or other special apparatus; and the management platform part of MNIS mainly refers to the system hardware and software platforms of HIS; and the two parts are connected with each other through the transmission of health information and medical advice feedback from doctors.

MNIS consists of three basic elements: several intelligent client monitors, a mobile nursing server, and a database server (DBS), as shown in Figure 2. MINS employs the advanced technologies of data acquisition, wireless network and SOA for ensuring the data accuracy so that different clients can employ a unified user interface to execute different operations of access systems [9].

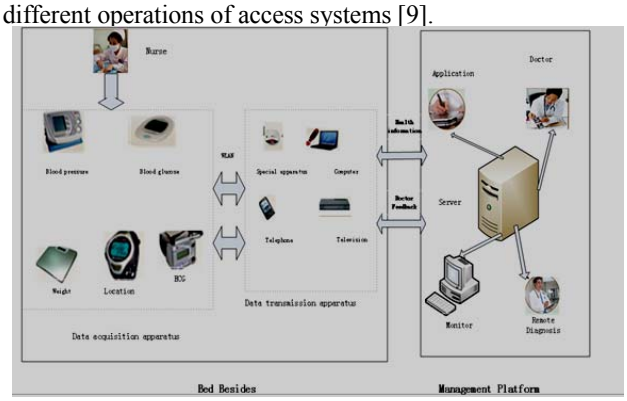

Fig.1 Systemic architecture of MNIS

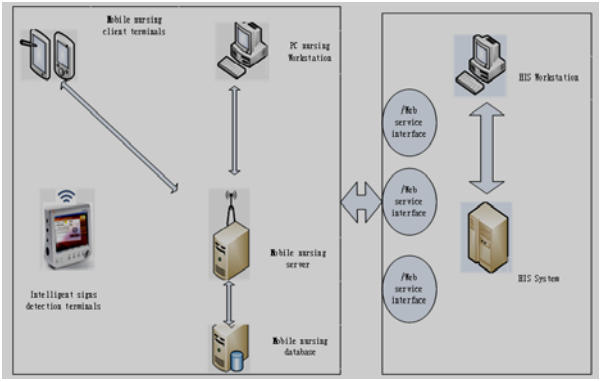

Fig.3 Network architecture of MNIS

B. Cloud Computing

Cloud Computing is a integration product of computer and network technologies consists of grid computing, distributed computing, parallel computing, utility computing, network storage, virtualization, and load balanced development [10].

In a narrow sense, cloud computing refers to the use of virtualization technologies, distributed computing for the foundation of a super computer or data center in providing on-demand computing, storage, data analysis and other services for free or to enterprises or individuals. In a general sense, cloud computing is deemed a cluster formed by network servers to supply various services, such as hardware rent, data storage, software applications, and data calculation and analysis according to customer demands [11]. In cloud computing, "cloud" is a shared resource access to remote servers through the network, including basic hardware, system software and application software, through the certification of the local computer and the network, the remote servers allocate the required resources and feedback to the local computers according to the requests from the remote terminals. At present, cloud computing has become a frontier research in domestics and abroad. As a progressing integration of gird computing and utility computing with a broad expansion of resources [12], the architecture of cloud computing is in Figure 3.

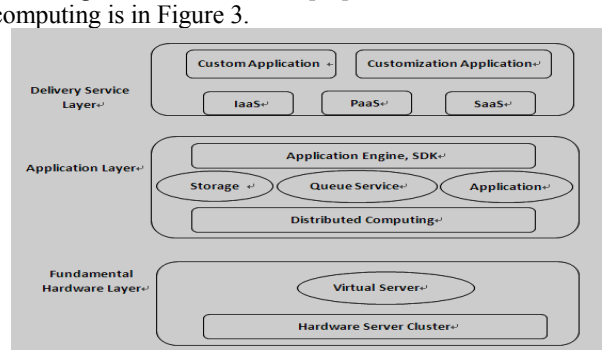

Fig.2 The architecture of cloud computing

In the architecture of the proposed system, we also employ cloud computing technologies to solve the problems of poor scalability, maintenance difficulties, high operating costs of HIS, while providing a nursery health information cloud service system; and mobile devices and cloud computing are combined together to fully utilize the powerful processing capability, unlimited available resources and rich variety of services of cloud computing, so as to effectively expand the capabilities of mobile devices. This requires the formation of a large scale medical information network system (Large - scale - Medical Information Network System Ultra, UMIS). In the architecture of UMIS, the distributed file system, computing system and storage system are implemented by using cloud computing technology. The distributed file system is located at the bottom, responsible for a large number of servers, machine data storage, to achieve the storage level of machine fault processing; the computing system sets parallel computing to achieve a large number of data nodes split, so that a task can be split on multiple machines, and the storage system can maximize the use of existing data storage capacity and computing power. UMIS divides the whole system into three types: the client, the main server, and the hospital data server. The client is the UMIS access interface, the main server is the UMIS management node, and the hospital data server node is responsible for the specific storage. Hospital information data is stored in a file format in the hospital data server, when the client accesses to UMIS, the main server node, accesses to the hospital data server information, and then directly accesses to the relevant hospital data server, and complete the access of data. UMIS is designed to control the flow of the data stream and the data stream is separated, the client and the main server only control the flow between the client and the hospital data server. Each hospital data server is parallel, making the system very easy to increase and

reduce the number of hospital data servers. and cloud servers provide a large amount of storage and a high speed calculation to enable wireless terminal users to access services for demand.

In this figure, the architecture can be generalized as three layers, the fundamental hardware layer, the application layer, and the delivery service layer. As the bottom layer in the structure, the fundamental hardware layer is a cluster of IT hardware, it is a platform for supporting the whole cloud computing, and includes various computers and servers to allocate the hardware resources services to clients on demand; the application layer is the layer of core technologies, supporting the cloud computing service platform, the layer makes a reasonable organization of hardware in the bottom layer to provide computing and storage services for clients.

The services model of cloud computing to clients can be divided into three layers: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS).These three layers can be used singly, or used as a mutual connection, interaction structure. The construction of service layers is a three-layer architecture in cloud computing, and it is shown in Figure 4 [13].

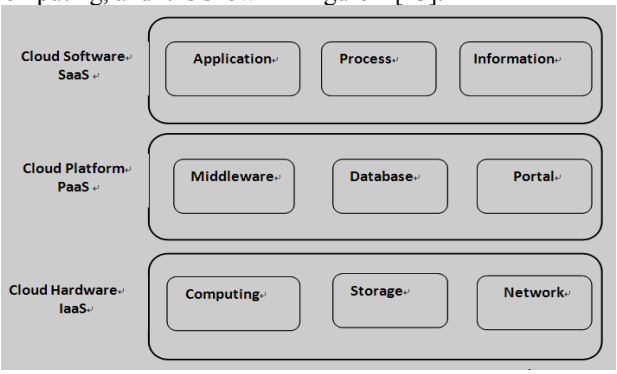

Fig.4 The construction of service layers in cloud computing

At present, the cloud computing technology is applied to the construction of regional health information or medical care, all levels of health authorities and medical institutions can greatly reduce operation costs, slowing down the use rate of medical resources, providing more convenience for patients via the Internet or private network interconnection [14-17]. Figure 5 lists the technical architecture diagram of cloud computing in regional medical nursery.

The regional medical nursery platform based on cloud computing has a total construction compile with multiple organizations and clients, it is competent with supporting the integration of medical institutions, regional health services, and it has a integrated, flexible, and secure running environment[10], the construction is shown in Figure 6 below. The network environment of the project is shown in Figure 7. Figure 6 describes the data transmission between the terminals and workstations in different hospitals of the platform of regional medical nursery based on cloud computing through the multiple servers groups; and Figure 7 shows the network construction in regional nursery platform; in this figure, we can see the data acquisition and transmission path in the network of the platform, including mobile terminals, monitors as the starters, WIFI network as the transmission path, and the switcher as the management node of the network, and the transmission structure makes the regional nursery and medical data share among different hospitals.

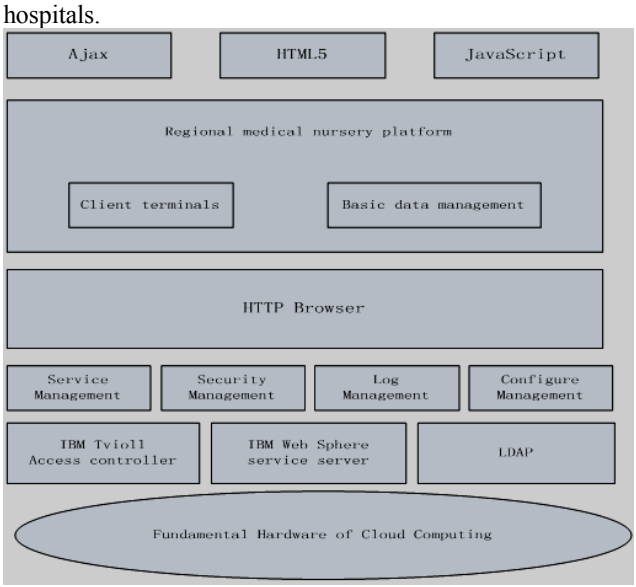

Fig.5 Architecture diagram of cloud computing in regional medical nursery

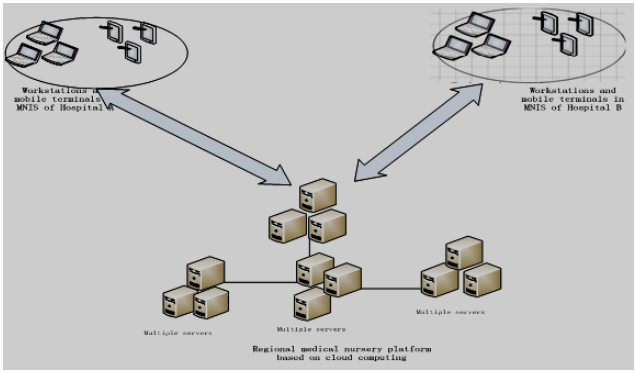

Fig.6 Overall construction of regional medical nursery platform

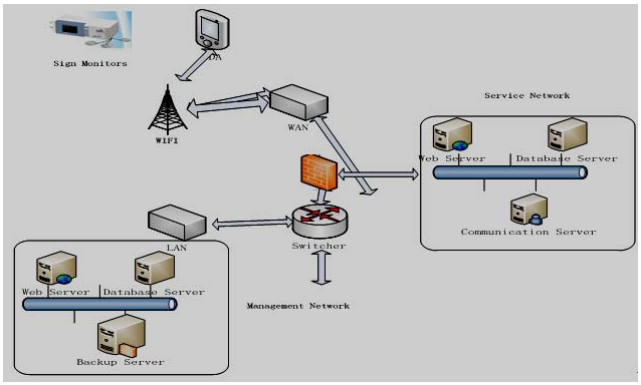

Fig.7 Network environment of regional nursery platform

III. DESIGN OF THE OPERATION FLOW IN MINS

The integration operation flow of intelligent sign monitoring terminals and nursing information system is shown in Figure 8. It can be summarized by using following steps:

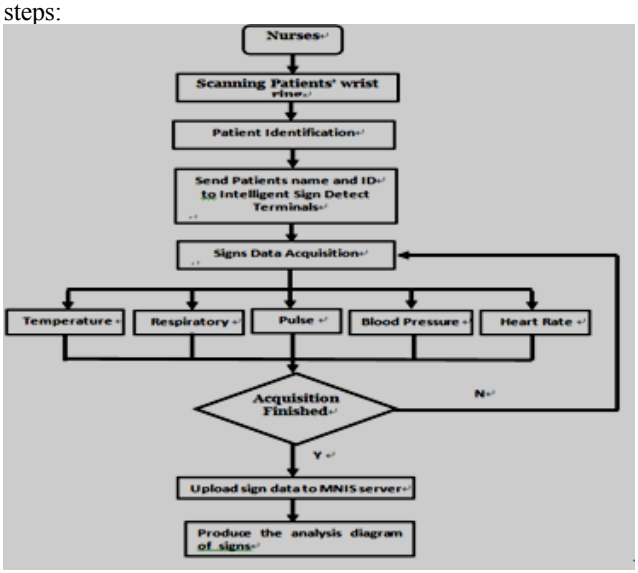

Fig.8 The work flow of MNIS

A. *Nursery Confirmation*

Nurses can confirm the identity recognition of patients by scanning in the wrist straps of patients with Bluetooth barcode scanners [18]; the information about patients' name and ID can be transmitted to the intelligent signs detection terminals through intelligent mobile devices and wireless network by nurses after confirmation [19].

B. *Data Acquisition*

The interface for guiding the patients to start data acquisition can be displayed in the terminal equipment. After the acquisition of body temperature, respiration, pulse and blood pressure by the terminals, the data will be measured for its accuracy; if detected as inaccurate, data will be retested.

C. *Data Collection*

After the acquisition is completed, the terminals will prompt patients to end acquisition, and the data will be uploaded to the server in hospital after the confirmation. Intelligent mobile devices will download the collected data to generate the records of body temperature, vital signs and nursing processes through wireless network, and the acquired information will be recorded in the database at the same pace.

According to the workflow in Figure 8, we can see that the function modules of MNIS can be summarized with the following points, and listed in Figure 9, including:

1) Management of patients' basic information

Patients' basic information includes inpatient number, hospital bed number, names, gender, age, inpatient date, clinical section, diagnosis, doctor, disease status, diet, medical care level, body weight, height, operation time, allergy history, and resulting medical costs.

2) Vital signs collection

The vital signs of patients, such as heart rate, blood pressure, body temperature, and blood oxygen can be in real-time acquisition through the integrated intelligent signs detection terminals and information systems.

3) Management of medical orders

The system split the medical orders along clinical nursing path, and the mobile client devices display only the current medical orders required to execute, and remind nurses of remaining time of the medical orders.

4) Management of nursing process

The time of special treatment and nursing care can be set up with special tones, and the exact time measurement results, operation results, observed conditions, treatment and nursery are recorded by the terminals in the ward at any time by clicking on the way to the patient.

5) Quality of nursing management

It mainly refers to the medical quality inspection of each section and the related records of quality inspection.

6) Management of bar code scan

Bluetooth barcode scanner are employed for the identification of wrist straps firstly by nurses at bedside, and the extraction of laboratory orders can be finished, then follow the feedback information to select the desired test tube, blood collection can be carried out after scanning the test tubes.

7) Management of supplies

The supplies used in the nursing process can be recoded and achieved charging after medical orders executed by clicking the dialog box of supplies and selecting the related names and specifications.

8) Management of dictionary base and nursing tools

Nursing calculation formulas and evaluation forms are set up with the loading of dictionary base of nursing diagnosis for the convenience in nursery at any time.

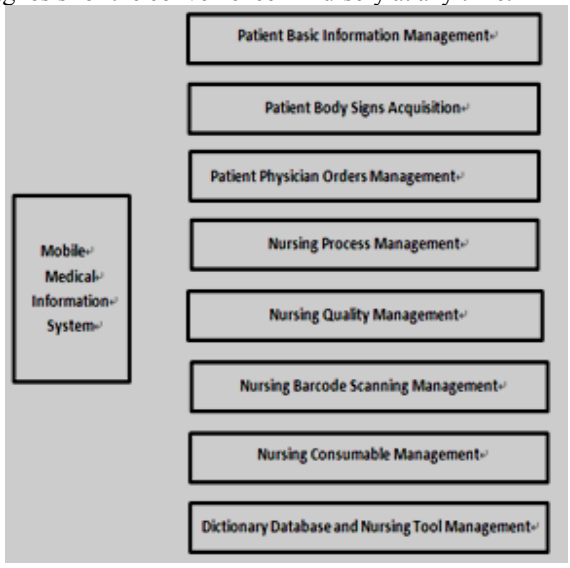

Fig.9 Function modules of MNIS

IV. DISCUSSION AND CONCLUSION

According to the actual operation flow, the functional modules of MNIS are constructed as patients' basic information Management, Vital signs collection, Management of medical orders, Management nursing process, Quality of nursing management, Management of Bar code scan, Management of supplies, and Management of dictionary base and nursing tools. And the highlights of MNIS are described as follows: the implementation of integrated intelligent terminals and NIS can complete collection and transmission of body temperature, blood pressure, heart rate, respiration, pulse, and other vital signs through automatic acquisition and wireless transmission. Thus, MINIS offers an application of intelligent cell phone for solving the problems of PDAs in carrying, calling, wireless signal interrupts, data failure caused by maintenance and charging, as argued in the first section. MNIS is capable of avoiding repeated manual data inputs of nursery system, reduce the work intensity of medical staffs, and decrease the operation mistakes in medical care. Moreover, it makes a progressive enhancement regarding nursing quality control and performance evaluation.

This paper proposes a scientific and effective nursing system on mobile intelligent terminals to avoid the information mistakes caused by communication and transmission in clinical nursery, and the proposed project also makes a full realization of the medical quality control for reducing medical errors and accidents. Nurses can promptly and effectively provide a variety of information of treatment and nursing care to patients by MNIS, establishing a connective communication with patients and improving the satisfaction level of patients to medical care.

The successful development and construction of MNIS will totally realize the implementation of intelligent, mobile and paperless healthcare delivery processes in nursery medical care and provide a proper solution to play a major role in promoting the applications of smart detection terminals and mobile communication technologies in Shanghai, or even in domestics.

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