Design and Implementation of a Mobile Healthcare Management Platform Based on Joomla and WeChat

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Abstract. For effective and convenient mobile healthcare management, we have designed and implemented a web-based healthcare management system to manage physiological data collected by Android app. The users can check their records and share them to their friends using a famous social network software called WeChat in China. A lot of different kind of wearable health monitoring devices and relevant app emerged in the market in recent years, but there isn’t a universal health data management platform which can manage different physiological data collected from different devices. This paper aims to build a mobile healthcare management platform (MHMP) based on Joomla and WeChat to manage different health data collected from different health monitoring devices. A MHMP prototype has been implemented based on Joomla, Apache, MySQL and WeChat. The laboratory tests show that the prototype MHMP has the advantage of managing different source health data very conveniently and effectively.

Introduction

Over the past few decades, it has had a major change in the doctor-patient relationship, people do not just take the time to see a doctor when they not feel well, but more concerned about the long-term physical health changes, which makes medical treatment more like a commercial activity [1]. Chronic diseases like hypertension, stroke and heart disease special need of long-term monitoring. It is easy to understand that personalized medicine is a highly targeted and effective treatment options because of each person’s special physical condition. On the other hand, hospitals also need long-term care for some patients to improve curative effect.

In the end of 2015, there have been more than 165,000 mobile health apps on the app market [2]. A number of handheld or wearable physiological data measuring devices and corresponding apps have been developed in our laboratory [3]. However, the large amount of physiological data lack of unified management, so users can’t make effective use of the data. To improve the health data management efficiency, a universal healthcare management platform is in great need. In order to solve these problems, we have designed and implemented a MHMP that can manage different physiological data using browser or WeChat. The MHMP will facilitate more efficient using of multi-source heterogeneous physiological data. Because app is mainly used by individual users, we have also developed a client side software for the scenario of managing multi-user in hospital and community.

The rest of this paper consists of the following sub-sections: Section two describes the overall schema of the MHMP and presents system architecture and technology roadmap of the platform. The design and implementation of the prototype MHMP were presented in section three and four respectively. The test results of the platform were shown in the last section.

Schema of the MHMP

The schema of the mobile healthcare management platform consists of physiological signal sensing devices and physiological data management system as shown in Figure 1. The physiological data
management system is comprised of modules such as data storage, data analysis, data visualization, user management, devices management, etc.

Figure 1. Schema of physiological signal sensing system and physiological data management system.

With the sensing devices, users can easily monitor their physiological data measured by sensors or recorded by smart phones and with the management system they can get some advice from the doctor. Doctors can view the real-time or history patient physiological data through this system. After users’ data is submitted by its app, they can not only use the browser to view and learn doctor’s advice, but also use WeChat app to view their records and recommendation from the doctor. According to news from official website of Tencent, there are more than half a billion WeChat users around the world [4]. Therefore, people can use our service conveniently through WeChat.

Figure 2. Architecture of the two scenario of the MHMP.

As shown in Figure 2, the overall architecture of the MHMP is comprised of data collectors, android app [5], the raspberry pi client side software, Ali Cloud server, smart terminals. Scenario A is for the individual user using app to submit, download and view his/her data. Scenario B is for the healthcare provider who has an administrator account to manage and check the patients’ vital monitoring data with the client side small application.

The data collectors include handheld and wearable wireless ones. Users equipped with these devices are able to measure electrocardiogram (ECG), impedance cardiogram (ICG), blood pressure (BP), heart rate (HR), acceleration (ACC), angular velocity (GYRO), etc. Data will be transmitted to our app by Bluetooth or measured by our raspberry pi monitor and then upload to the MHMP through Internet. Our platform uses Ali Cloud server which has Linux operating system and PHP runtime environment. Users can get convenient service by following our official WeChat account.
Design of the MHMP

We considered both compatibility and ease of use for the design and development of this platform. We not only design a module for the convenience of collecting health data from third party vendor, but also provide some basic APIs such as login verification and upload function etc. to developers. In consideration of the security of users' data, we designed encryption function for the app. Users normally don’t have enough knowledge to judge their physiological data, so we have provided channels of communication between doctors and patients, so that users can get professional advice from doctors timely and efficiently. For the design of the raspberry pi version of client side, we mainly consider the operation of the convenience and the view of simplicity.

Privacy and security module. The network has a lot of insecurity, such as leakage of private information and maliciously unlimited access to the MHMP. In each case, we have done effective protection. In order to prevent malicious access to the APIs, we designed an encryption key function with a parameter based on timestamp. A special string will be submitted to the system when our app gets or posts data. It’s like a private key that only our app could access the MHMP. And we also designed an authorization system for different roles to ensure that only authorized users could see the corresponding information. We use encryption function of Joomla for user’s password encryption.

Data storage module. On this platform there are two kinds of data, one is small pieces of data, the other one are physiological waveform data. We use MySQL to store users’ information, WeChat information and the path of the physiological data. Large waveform data like ECG and ICG measured by our devices are stored in files. These data files were uploaded to the server through an API provided by the MHMP after the measurement.

Data visualization module. One’s physiological data is usually a time-series data. We also draw the waveform chart using these data for the user. That allows users to view data on any smart devices having a browser or supporting WeChat.

Devices management module. The system will record the device information if one user filled the devices registration form or its data is uploaded. The information could be also recorded by the administrator. There is also a field to record the health status of the equipment.

Feedback module. Users can get the corresponding useful advice from the chosen doctors. This is very convenient for the people who could not go to the hospital easily.

Client side module. The client side was developed for monitoring patients’ vital data in hospital or community which would be operated by administrators. The running environment of the software consists of server software and PHP run-time environment, which is installed in the Raspberry Pi Data Gateway. In this way, any computers could be used as management equipment which has network connection and installed browser. We also use Bootstrap and AngularJS to design the front-end layout and action of operations. WebSocket protocol is used in the communication between Raspberry Pi Data Gateway and computer or other smart terminal. Patients’ health data are stored in the local data collector or the Data Gateway, and can be uploaded to the MHMP automatically or manually.

Implement of the MHMP

The structure of prototype of the system is shown in Figure 3. Users can use our Raspberry Pi client-side or Android app for real-time measurements and local storage. Long history health data storage service and complex analysis service based on big physiological data are placed on the remote server.

As we talked in section two, we use Ali Cloud server (CPU: 1 core, Memory: 2 GB) that was installed Ubuntu operating system, Apache, MySQL and Hypertext Preprocessor (PHP). The data backup was implemented by using Ali Cloud disk for its high cost performance. With the increasing of users, we can easily set up a distributed cluster by using Ali Cloud.

Joomla! is an award-winning content management system (CMS), that is open source and free for developers. We have developed a component for Joomla3.5 to implement all of the services. We also
used another open source tool named ECharts for chart drawing which has user-friendly graphic interface and high plot speed. The size of the reduced version of ECharts 3.1 is only 208 KB.

As is shown in Figure 4, the relation of main data table is not very complex. The table named users stores the basic information about login authentication, role, and the selected doctors. The table named health_data stores the map of user and its data. The two tables with weixin as the prefix are about WeChat service. Table profiler is the extension of table users and the table device store the information of data collectors.

![Figure 3. Server-side structure of the MHMP.](image1)

![Figure 4. Main data table of the MHMP.](image2)

The simplified class diagram of the MHMP is shown in Figure 5. It is convenient to develop this platform by using Joomla which is a Model-View-Controller (MVC) framework. Figure 5 only shows the controllers, the classes about client operations was shown on the dashed box overhead and the classes about administrators was shown on the dashed box bellow. Such arrangement has the advantage of being easily expanded. For example, class called users keeps a list of users and class called user will play a role after clicking one link. The relationship between class called devices and class called device also has the similar relationships. As shown in dashed box overhead, normal users’ operation consists of classes called choose, upload, weixin and heartcare which all should be verified by class called user.
Experiment Result

The prototype of the MHMP that can draw a variety of physiological waves has very good compatibility and extensibility. As shown in Figure 6, the data visualization module can display physiological waves and motion data with a scroll bar. Zoom in and zoom out function is also provided with the scroll bar to adjust the viewing data set size. Users can view the waveform of the record by clicking the records in the list as shown in Figure 7.

Users can get the WeChat service such as getting portal address of the website, receiving message from the system and checking history data by following the WeChat Official Account as shown in Figure 8.

As shown in Figure 9, administrators can select the patients’ data collectors through the scan button and click button named back-to-measure to view the real-time physiological data through WebSocket technology at the raspberry pi client side. History data can be deleted or uploaded to the MHMP by clicking the corresponding buttons on the page.

<table>
<thead>
<tr>
<th>ID</th>
<th>measureTime</th>
<th>dataType</th>
<th>deviceID</th>
<th>dataRoute</th>
</tr>
</thead>
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<td>egmonitor</td>
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</tr>
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<td>A/D UA-767PBT-C 80830D</td>
<td>puckina_A&amp;D UA-767PBT-C 80830D_BP_2015_12_07_16_02_40.txt</td>
</tr>
</tbody>
</table>
Summary

In this paper, a novel prototype healthcare management platform has been designed and implemented for making effective use of the physiological data through web browser or WeChat. A series of open APIs are also provided for other developers to use the services provided by the platform. Complex data analysis service will be implemented in the future work.

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References
