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# Design and evaluation of a cloud-based Mobile Health Information Recommendation system on wireless sensor networks <sup>☆</sup>



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## ABSTRACT

Recent technological trends such as cloud computing, wireless communication, and wireless sensor networks provide a strong infrastructure and offer a true enabler for health information technology services over the Internet. This system is based on the cloud computing environment, integrating mobile communication technology, context-aware technology, and wireless sensor networks to build a mobile web for a personalized health information service, which includes two health information recommendation service functions: a collaborative recommender and a physiological indicator-based recommender. We further propose a hybrid predictive model, which combines the Grey Theory and Markov chain to predict the moving object's path. This will decrease the cost which arises from tracking errors and prolong the network's lifetime. From the experiment results of usability, it has been discovered that subjects have positive responses towards usability measurement dimensions of the system: satisfaction, expectation-confirmation, perceived trust, perceived usefulness, and perceived value.

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## 1. Introduction

Recent technological trends such as cloud computing, wireless communication, and wireless sensor networks provide a strong infrastructure and offer a true enabler for health information technology (HIT) services over the Internet. With the increasing popularity of mobile devices and development of wireless communication network technologies, more and more studies integrate mobile devices and context-aware technology for developing healthcare service platforms to support personalized health management to enhance the effectiveness of preventive medicine [1]. In addition, there have been more and more studies on applications of mobile communication technology, context-aware technology, and wireless sensor networks to Healthcare service [2]. Despite its great potential, more research is still needed as to how to effectively integrate these IT technologies and apply them to healthcare service.

In light of the advancement of HIT and communication technologies, many organizations have provided much on-line medical information available for general public. Specifically, more and more people use the information for personal health

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care management or patient-oriented decision making [1]. Through the on-line social media, people connect with others who have the same disease or condition, and track and share their own experiences. Many studies have shown that such effects influence the patient-physician relationship, as patients tend to become empowered as active participants in the health care decision-making process [3], especially those living with one or more chronic illness [4]. However, the information relevant to the patient's concern is usually scattered across many different web sites. It is, therefore, difficult for patients to find reliable healthcare information with the number of site and information source choices increasing and the overwhelmingly large volume of data to review. Furthermore, from the research on mobile health conducted by the Pew Research Center since 2010, it is found that integrating mobile devices in health information landscape nowadays is a trend, especially in groups of young people [5]. Through a wide variety of smart mobile devices (iPhone, Android, Blackberry, iPad, etc.) users can download or browse large quantities of health information anytime, anywhere, and thus the intention of people to use the Mobile web to assist self-health management has increased.

With this in mind, this study proposes a framework which integrates Cloud Computing, Wireless Communication, and Wireless Sensor Networks technology, and applies a Collaborative Filtering (CF) technique to develop a Mobile Health Information Recommendation service to help users to obtain their preferred health information more efficiently. Bobadilla et al. [6] argue that the recommendation system has proved to be a useful tool to process Internet information overload phenomenon, and can effectively reduce problems caused by an excessive amount of information. The study enhances the effectiveness of receiving health information by the user and develops two health information recommendation service functions: physiological indicators-based recommender and collaborative recommender.

After a brief introduction in Section 2 on the background to this paper, our system framework and functions for the development of Mobile Health Information Recommendation service is introduced in Section 3. In Section 4, the approach used by the proposed scheme of Grid Wireless Sensor Networks is described, then its performance efficiency is evaluated. The implementation of the collaborative recommender and the physiological indicators-based recommender are discussed in Section 5. The usability of the system is evaluated in Section 6. Discussion and conclusions follow in Sections 7 and 8.

## 2. Background and related work

In recent years, mobile health information systems have been integrated with ubiquitous wireless communication technology to capture physiological signals and symptom information. These data are collected by mobile sensors and transmitted to a remote server for analysis. Then the results of analysis are sent to the user as the feedback for treatment or a health care reminder. Deng et al. argues that mobile health service is to provide health care, prevention, diagnosis, treatment, and monitoring services through a mobile device [7].

Some researchers argue that the purpose of a mobile health service system is to provide medical and health care services to professionals so that their work can be better supported. As for the average consumers, mobile health information services allow them to obtain useful health information and guidance to achieve better health self-management [7]. Through the use of mobile health information services, healthcare administrators can enhance their management system, thereby reducing operating costs. The rising number of chronic diseases nowadays has become an increasingly heavy burden for health care organizations. The remote home health monitoring will help reduce health care costs [8] of constantly monitoring the health status of patients with chronic illness. In particular, via mobile health information services, it is possible to provide remote health monitoring with low cost and improved efficiency [8]. In addition, mobile health applications have become increasingly widespread, such as developing the health system to providing diabetes health education information, as well as encouraging users to talk to physicians through the mobile information system [9].

Nowadays, the health information landscape tends to integrate mobile device applications [5]. Through a variety of smart mobile devices, users can download or read a large quantity of health information to assist health self-management. Therefore, this study integrates mobile devices, context-aware technology, and collaborative recommendation algorithms to develop a health care system. The major application of this system is as a daily health care information recommendation service. The target subjects are young people. It is hoped to assist users of this system to pay more attention to preventive health care and health self-management.

## 3. System overview

### 3.1. Structure of the system

The present system is based on the cloud computing environment, integrating mobile communication technology, context-aware technology, and wireless sensor networks to build a cross-platform for the Mobile Web for Personalized Health Information service. The health information database of this study is from one online electronic health information resource in Taiwan and is used as testing data. Since the database must store a large amount of health information and perform real-time dynamic recommendation calculations, the system is set up in the cloud VMware Workstation in order to ensure computing performance of the system. By doing so, multiple users may share a virtual machine and the effectiveness of searching for online health information will be improved. The database adopted MySQL, and uses HTML5, CSS, JavaScript, PHP, and jQuery as the main programming languages.

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