ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 1, February 2014

International Conference on Engineering Technology and Science-(ICETS'14)
On 10th & 11th February Organized by

Department of CIVIL, CSE, ECE, EEE, MECHNICAL Engg. and S&H of Muthayammal College of Engineering, Rasipuram, Tamilnadu, India

Integrated Health Care System on Pervasive Computing

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Abstract-- With an increasingly mobile society and the worldwide deployment of mobile and wireless networks, the wireless infrastructure can support many current and emerging healthcare applications. This could fulfill the vision of "A Pervasive Health System Integrating Patient Monitoring" or healthcare to anyone, anytime, and anywhere by removing location, time and other restraints while increasing both the coverage and the quality. The pervasive healthcare applications include pervasive health monitoring, intelligent emergency management system, pervasive healthcare data access, and ubiquitous mobile telemedicine. The design and development of a pervasive health system enabling self-management of chronic patients during their everyday activities. The proposed system integrates patient health monitoring, status logging for capturing various problems or symptoms met, and social sharing of the recorded information within the patient's community, aiming to facilitate disease management. Especially, chronic patients may be benefited from self-management activities, in terms of understanding better their disease, enhancing their communication with their doctor, increasing their self-confidence, and so forth.

I. INTRODUCTION

Pervasive computing is an emerging field of research that brings in revolutionary paradigms. The goal of pervasive computing is to create ambient intelligence where network devices embedded in the environment provide unremarkable connectivity and services all the time. Thus improving human experience and quality of life without explicit awareness of the underlying communications and computing technologies.

Pervasive systems must offer an open, extensible, and evolving portfolio of services which integrate sensor data from a diverse range of sources. The core challenge is to provide appropriate and consistent adaptive behaviors for these services in the face of huge volumes of sensor data exhibiting varying degrees of precision, accuracy and dynamism.

Pervasive computing is more environment-centric than either Web-based or mobile computing. This means that applications will guide the middleware and networking issues to a large extent. Consider a heart patient wearing an implanted monitor that communicates wirelessly with computers trained to detect and report abnormalities. The monitor should know when to raise the alarm, based on its knowledge about the environment. So this is much more than simple wireless communication.

Sensors in pervasive computing are deployed anywhere and on any objects or human bodies. They collect data including a user's location, motion, biomedical information, environment temperature, humidity, or ambient noise level. Applications that provide customized services to users are based on this sensor data. However, sensor data exhibits high complexity (different modalities, huge volumes, and inter-dependency relationships between sources), dynamism (real-time update and critical ageing), accuracy, precision and timeliness. A pervasive computing system should therefore not concern itself with the individual pieces of sensor data (which room the user is in, what his heart rate or blood pressure is): rather, this information should be interpreted into a higher, domain-relevant concept, such as whether the user is suffering a heart attack or exercising.

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II. PROPOSED SYSTEM

The proposed system is particularly targeted at chronic patients who may wish to play a more active role in their disease management throughout their daily activities. It has been implemented using a mobile device and a wearable multi sensing device for unobtrusive health monitoring. Popular micro blogging services a form of micro journalism for posting small pieces of content are utilized, in order to demonstrate the social networking functionality. Many of the portable medical devices can be integrated in the handheld wireless device. These would allow the detection of pulse-rate, blood pressure, and level of alcohol.

III. SYSTEM ARCHITECTURE

The main purpose of the system is the chronic patients are rescued from the unexpected disaster. A pervasive health system enabling self-management of chronic patients during their everyday activities. The proposed system integrates patient health monitoring, status logging for capturing various problems or symptoms met, and social sharing of the recorded information within the patient's community, aiming to facilitate disease management.

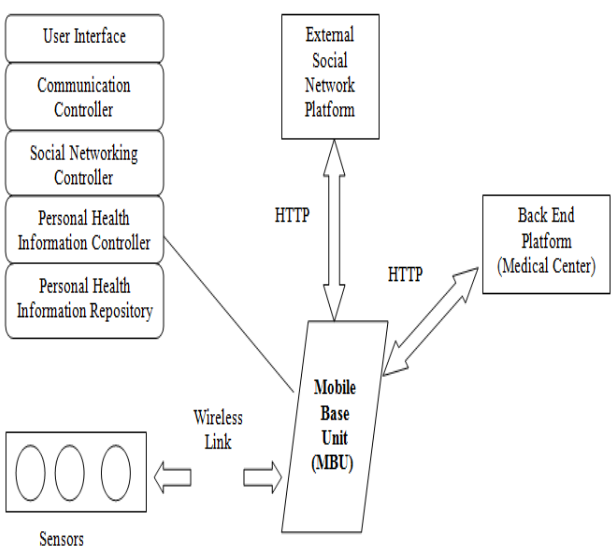

Figure 3.1 System Architecture

In Figure 3.1, the overall system architecture is depicted. The communication flow concerns four diverse nodes, namely, the mobile device referred as *Mobile Base Unit* (MBU), the *Sensors*, the *Back-end Platform*, and the *External Social Network Platform.*

The MBU is the system's core part consisting of five layers: 1) the *Personal Health Information Repository*, 2) the *Personal Health Information Controller*, 3) the *Social Networking Controller*, 4) the Communication *Controller*, and 5) the *User Interface*.

The MBU is connected wirelessly with the sensors and its *Personal Health Information Controlle*r handles the information reflecting the patient's status. The *Personal Health Information Repository* is constructed based on the MBU's built in record management system, which is utilized in order to record the various conditions or problems met, along with the patient's activities and alerts.

All captured information is replicated to the back-end platform of the Medical Center offering the services and acts as the MBU surrogate host. Moreover, since the typical mobile device can be still considered as a limited platform to deploy advanced data/information processing, health information persisted in the back-end infrastructure can enable the employment of sophisticated data analysis methods for pattern and trend discovery. The *Communication Controller* module is responsible for utilizing and controlling the entire client communication with the back-end infrastructure, persisting also unsent information due to potential network unavailability for later transmission.

The MBU may safely connect to the *External Social Network Platform* via the design and implementation of appropriate client methods incorporated in the *Social Networking Controller* module.

IV. FUNCTIONALITIES OF THE SYSTEM

There are three main functions in the system

1. Patient monitoring
2. Status logging
3. Social sharing

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Patient monitoring

For vital signs monitoring, the Zephyr Bio Harness physiology monitoring system was used. Bio Harness is a wearable multi sensing device incorporating various sensors on a strap, which is placed on the patient's chest for continuous unobtrusive monitoring of the heart rate, activity, posture, respiration rate, and skin temperature. Bio Harness provides Bluetooth communication capabilities and an API for the reception of the sensor measurements by the MBU. The MBU can then process the received data according to threshold configuration and generate alerts related to the observed health status. The latter are persisted in the *Personal Health Information Repository* and visualized in a diary form along with other subjective elements perceived by the user through the *User Interface.*

Status logging

In the Android development tool kit, SQLite database can be used to log the status of the patient health information. Status logging is associated with the option given to the patients to log information concerning their disease as perceived by themselves through the proposed system. Thus, this information can be considered as subjective and corresponds to the following status descriptors.

1) *Problems/Symptoms:* Patients can record various health problems or symptoms, occurring during their daily life. Examples of such subjective type of information include dizziness, chest pain, nausea, stress, etc.

2) *Activity:* Activities such as shopping, driving, reading, working, exercising, resting, etc., characterized by their onset and end, may be recorded by the patient. These constitute an additional source of information which can play an important role in explaining the variation of the acquired signals through the patient monitoring, and identifying possible false alerts associated with the observed health status, also giving better insights into disease management during daily activities.

3) *Time and Location:* The time of the day and the location (if available) are important parts of information denoting the context of the patient that can be used in various ways. For example, the identification of a patient's location could be helpful for his/her safety in cases of emergency. Thus, by aggregating subjective (i.e., patient provided through status logging) and objective (i.e., alerts generated through sensing devices) elements of information, a detailed view of the health status may be provided for the patients. This approach is considered of particular significance for effective personalized health service delivery.

Social sharing

Patients are able to share the diverse recorded elements of their personal health information through structured messages with their networked community, consisting of friends and relatives, caregivers, health professionals, and other patients. This information sharing enables the patients to obtain feedback or help (subject to their condition), receive emotional support, etc.

The proposed system's social networking functionality is realized by utilizing external Web-based micro blogging services offered by Twitter. Moreover, Twitter offers some interesting features, e.g., the easy discovery of messages of interest and the construction of user lists, constituting additional factors for its adoption in our implementation as an enabling technology for the social sharing part of the system.

V. RELATED WORK

Chronic conditions closely related to lifestyles are the major cause of disability and death in the developed world. Behavior change is the key to managing well-being and preventing and managing chronic diseases. Wellness diary (WD) is a mobile application designed to support citizens in learning about their behavior, and both making and maintaining behavior changes. WD has been found acceptable, useful, and suitable for long-term use as a part of an intervention.

A health information system, Patients Like Me, designed specifically for patients to use themselves and in cooperation with other patients with the same disease. In this system, patients report their relevant health information, which is presented as coherent graphical displays on their profile. Member profiles are posted where other members can have access to them, providing a basis for passive information sharing and active dialogue among patients.

Patient self-management is often considered as an important prerequisite towards effective healthcare.

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This viewpoint has recently been demonstrated by the introduction and adoption of approaches and tools, such as the Personal Health Record (PHR). In the current work, the design of a mobile personal health system for logging information corresponding to the patient status and sharing it within social networks is presented. This "anytime-anywhere" information sharing may be valuable to senders (i.e. patients) and receivers (e.g. relatives, healthcare professionals, similar patients, etc.) in terms of emotional support, mutual understanding, sharing of experiences, seeking of advice and improved self-tracking. A prototype is implemented on a mobile device illustrating the feasibility and applicability of the presented work by adopting unobtrusive health monitoring with a wearable multi-sensing device, a Service Oriented Architecture (SOA) for handling communication issues, and popular micro-blogging services.

VI. CONCLUSION

The system constitutes a paradigm for accomplishing effective and user-accepted patient self-management through an integrative approach, elaborating on both objective and subjective information capturing and its sharing. The system is primarily targeting at patients willing to play a more active role in managing their disease. Now identified functional specifications and defined system architecture for realizing such a system. At the current stage, the prototype implementation constitutes a technical proof-of-concept concerning the feasibility and applicability of the proposed approach. It is important to remark that our development was based on existing, affordable/accessible solutions, i.e., a Smartphone, a commercially available multi sensing wearable device, and a widespread social networking platform, all selected as enabling technologies according to our design specifications.

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