

Short Communication

## Internet of Things: Challenges in Web Based Remote Patient Monitoring (RPM)

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**Abstract:** Remote monitoring concept raises a lot of interesting possibilities, and helps to address different issues continually faced with effective patient administration. It is possible to record and transmit the vital signs of a patient using wireless and cellular technologies. This paper describes the definitions of remote patient monitoring. The content includes limitations of remote patient monitoring. Finally, the open challenges of RPM are debated to encourage more investigations into the domains.

**Keywords:** RPM, Remote, Health, Patient, Monitoring.

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### INTRODUCTION

Remote Patient Monitoring (RPM) solutions enable healthcare organizations to remotely monitor and manage patients with chronic diseases such as congestive heart failure, diabetes, chronic obstructive pulmonary disease and asthma. Through RPM health maintenance organizations provides significant benefits and outcomes to chronically ill patients. Remote Patient Monitoring (RPM) has garnered a lot of interest since the various emerging technologies made it possible to think of; and implement such a concept. Remote monitoring concept raises a lot of interesting possibilities, and helps to address different issues continually faced with effective patient administration. Some notable issues are managing patients in remote areas, monitoring (elderly) patients in their own homes and saving hospital bills [1]. With RPM solutions, healthcare organizations can:

- improve patient outcomes,
- reduce healthcare delivery costs, and
- increase access to care for patients living in rural/remote areas [2].

### Three tiers of RPM system

A typical RPM is a three tier system. Each tier is characterized by its location and functionality. First tier of a RPM system is an embedded system consists of group of sensors that perceive signal of interest from patient and then transfer the information to local

machine. Tier two is local machine (computer/mobile phone) which allows data storage or provides further processing before transmitting it to some remote location via GSM, internet or some wireless protocols. And the last tier is remote machine where physiological data is observed and analyzed by medical staff.

### First tier

Bio-medical sensors come in all forms, wired or wireless which form Body Area Network (BAN). „Heart rate“ is the number of heart beats per minute; it helps to understand the overall physical condition of the body. Heart rate variability is one of the most promising quantitative indications of autonomic activity [3]. Number of noninvasive methods exist for sensing the human heartbeat such as acoustic (stethoscope or Doppler), mechanical (sphygmomanometer), electrical (Electrocardiogram), or optical. The electrocardiogram (ECG) is the most common test used to assess the condition of the heart. Using bio-potentials status of the heart can be measured. Bio-potentials are electric voltages produced by individual cells and can be measured on the skin surface. The Electrocardiogram method is an accurate method which gives the correct heart rate count, but the setup is sophisticated and may require expert assistance to operate [4]. There is also another handy optical technique for measuring the heart rate, which gets its reading from the tiny subcutaneous blood vessels (capillaries) that expand or contract in

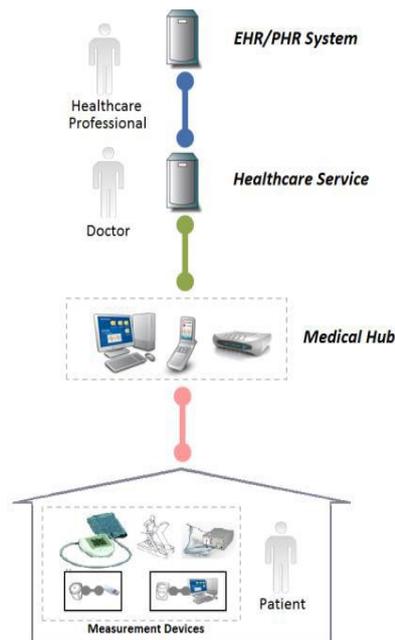
time with the heartbeat. Any patch of skin is suitable (fingertip, ear lobe, etc.) for this technique. Doctors measure heartbeats by feeling and counting the pulse of blood flow in body parts, such as a wrist, or a fingertip. The system for counting heart rate which is discussed here is designed by measuring alteration in blood volume with each heartbeat by analyzing change in reflected light after manually projecting infrared light on suitable body parts such as fingertip. Fingertip area provides more reflection and less absorption of light [5], so the heart rate is generally measured at fingertip. These sensors are further processed using microcontroller unit or directly transferred to next tier.

**Second tier**

Between First tier and second tier communication happens by either wired or wireless way. Two short range communication technologies, Bluetooth/IEEE 802.15.1 and ZigBee/ IEEE 802.15.4 are considered to network the bio-medical sensors. Serial communication using RS-232 protocol provides wired communication. The data transfer between tier two and three is provided using wireless protocols.

**Third tier**

At the remote location, doctors or medical staff can monitor the current status of a patient in real-time. By means of an EHR, doctor or physician can monitor a patient in a better way. EHRs are secure and private lifetime records that helps to maintain person’s health history and care. They are formed by collecting information from various sources, including hospitals, clinics, doctors, pharmacies, and laboratories. This information is critical for treatment and is accessible only to health care professionals. It includes patient demographics such as medications, vital signs, clinical history, immunizations, laboratory results, and reports of diagnostic procedures. Now a days EHR system is widely adopted by physicians. Data from the National Ambulatory Medical Care Survey shows that about 57% of office-based physicians used EMR/EHR system [6]. EHR based diabetes clinical decision support significantly improved glucose control and some aspects of blood pressure control in adults with type 2 diabetes [7]. EHR based clinical decision support in RPM can help a physician to improve quality of health care and lower health care costs.



**Fig-1: Architecture of RPM**

**CHALLENGES OF REMOTE PATIENT MONITORING**

**Trust Management for Home Healthcare Services**

Home healthcare services have been proposed to decrease the cost of healthcare while making it more comfortable for the patient. These services aim to support people who are chronically ill (e.g., post-stroke, diabetes, Chronic Obstructive Pulmonary Disease (COPD)) or who are rehabilitating. They monitor the health and well-being of people, enabling tailored

assistance where and when needed. In particular, they gather sensitive personal information that is then interpreted by medical professionals in order to provide treatment. The adoption of such services, however, hardly relies on the trust that both patients and medical professionals have in the provided healthcare services. In particular, a number of questions should be addressed:

- How can compliance with a treatment be reliably measured?

- Can a physician trust data measured by a patient at home? It is very important that the measurements are accurate and that a physician can accept them as medical information.
- How can patients use home healthcare services while ensuring their privacy and controlling the use of information in a simple intuitive way? [8].

### **Reliability of Information in Remote patient monitoring**

To assess patient health status healthcare providers have to rely on measurements which may have been taken directly by the patients. Thus, trust and reliability of the measurements is a necessary condition for the acceptance of the service by healthcare providers. Next to ensuring proper patient/device authentication, data authenticity and integrity, it is important to capture the correctness of the authentication process too. An overall solution that can capture all these aspects is the application of reputation systems, where providers build a level of trust in the patient based on his ability to take measurement [9].

Additional problems appeared with the growing use of web portals rating healthcare services. Patients often subscribe to expert websites and search information regarding their illness on the Internet. Although this practice may have advantages, the major drawback concerns the trustworthiness of information. For instance, in Revolution Health3 and other similar online community reputation systems, the trustworthiness of information is assessed only by considering the information source. To assure information trustworthiness we also need to consider the information itself [10, 11].

An interesting research challenge is thus the design of solutions for measuring information trustworthiness for home healthcare addressing also the trust issues related to data coming from the Internet. Therefore, methods for assessing data reliability should be coupled with methods and tools that visualize indicators for data reliability in a way that is understandable by end-users.

### **User friendly advanced access control**

Healthcare services deal with very personal and sensitive information. The protection of sensitive information is usually enforced using access control. Several access control models have been proposed in the literature (see [12] for a survey). The challenge in designing an access control system for healthcare is that, while posing strict constraints on the access to sensitive information, the system has to cope with the dynamic environment of healthcare and the potential exceptions that are raised in case of emergency. Furthermore, medical data can also be formed as

arbitrary text, such as a patient report made by healthcare practitioners, leading to the need for policies based on content. In this trend, content-based access control [13, 14] and tag-based access control [15, 16] has been proposed. For instance, content-based approaches have been used for the protection of medical images [17]. Although these access control models are very expressive and allow the specification of a wide range of authorization policies, they are usually difficult to use by end-users.

The last years have seen an increasing interest in the development of user friendly privacy management and access control systems. For instance, various enterprises designed platforms which allow users to set their privacy and access control policies. One example is Google dashboard privacy tool, which through a web interface displays to users what information about them is stored and who can access it. Similarly, social networks such as Facebook let users restrict or grant access to other users or groups on their data (e.g., wall posts, photos). Although these proposals provide a simple and straightforward solution, they neither allow users to understand the effect of the specified policies nor ensure secure access control. Although these proposals increase usability and flexibility, they do not provide users with the overview of the effect of the specified policy.

### **Tracking and monitoring**

All patients shall be tracked and monitored with any wearable WSN devices at all-time regarding that sensor can effectively generate health signal in an enhancement with the communication capacity. It's always be a challenge that all the sensed devices or monitoring devices perform accurately in every situation.

### **Remote service**

Telemedicine and remote diagnosis are necessary to provide emergency detection and first aids for patients with congenital disease. All the remote services need to be accurate. In remote patient monitoring proper remote services are always required [8].

### **CONCLUSION**

RPM provide home healthcare services that improve people's health. In this paper, we discussed about three tire system of Remote Patient Monitoring (RPM) and challenges for developing trusted home healthcare services. Finally, we discussed the open challenges of RPM that encourage more investigations into the domains.

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