A Data Driven Multi-Layer Framework of Pervasive Information Computing System for eHealthcare

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ABSTRACT

In the last decade, significant advancements in telecommunications and informatics have seen which incredibly boost mobile communications, wireless networks, and pervasive computing. It enables healthcare applications to increase human livelihood. Furthermore, it seems feasible to continuous observation of patients and elderly individuals for their wellbeing. Such pervasive arrangements enable medical experts to analyse current patient status, minimise reaction time, increase livelihood, scalability, and availability. There is found plenty of remote patient monitoring model in literature, and most of them are designed with limited scope. Most of them are lacking to give an overall unified, complete model which talk about all state-of-the-art functionalities. In this regard, remote patient monitoring systems (RPMS’s) play important roles through wearable devices to monitor the patient’s physiological condition. RPMS also enables the capture of related videos, images, and frames. RPMS do not mean to enable only capturing various sorts of patient-related information, but it also must facilitate analytics, transformation, security, alerts, accessibility, etc. In this view, RPMS must ensure some broad issues like, wearability, adaptability, interoperability, integration, security, and network efficiency. This article proposes a data-driven multi-layer architecture for pervasively remote patient monitoring that incorporates these issues. The system has been classified into five fundamental layers: the data acquisition layer, the data pre-processing layer, the network and data transfer layer, the data management layer and the data accessing layer. It enables patient care at real-time using the network infrastructure efficiently. A detailed discussion on various security issues have been carried out. Moreover, standard deviation-based data reduction and a machine-learning-based data access policy is also proposed.

KEYWORDS


DOI: 10.4018/IJEHMC.2019100106

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1. INTRODUCTION

In the last one decade, the significant advancements in broadcast communications have been experienced. Additionally, high end utilization and development of cell phones (3G, 4G and Internet of Things (IoT)) make the things more automotive (Mukherjee et al., 2014; Ogunduylie et al., 2013; Yuan & Herbert, 2011). The population of aging people with illnesses such as diabetes, heart disease and much more is increasing. In addition, youngsters are also experiencing diseases like asthma and obesity due to a lavish lifestyle (Jensen et al., 2014). With all such issues, there is a hike in healthcare costs. Hence, there is a demand for cost-effective, reliable and pervasive patient healthcare systems. If a patient’s health could be continuously observed over an extended amount of time, then the doctor could diagnose serious health problems at an early stage and may also provide more accurate treatment. The Republic of India; a youthful nation with the world’s most populous community, has battled for making emergency medical care safe (Sriniyisan, 2012). Nowadays, Government is thinking about its socioeconomic expansion through Digital India and Skilled India, but it also plagues many challenges (Sriniyisan, 2012; Fernald et al., 2011). The private medical sector of India is holding more or less 81% medical services and 88% medical professionals (Sriniyisan, 2012). India started its health reforms journey in the most recent decade. Although, healthcare workforce in India remains inadequate and underutilized. This journey now needs to pick up momentum. Home-based self-monitoring devices are required to become self-reliant for chronic diseases (through self-monitoring) (Gudwani et al., 2012).

Pervasive healthcare frameworks utilize (for spatiotemporal measurements) pervasive computing technologies such as wearable biomedical sensors with the remote system.

The medicinal service administrations can be benefited with such pervasive computing for enhancing the patient wellbeing. The most accurate information about the patient at the right time is essential to obtain the best possible service for the patient (Jensen et al., 2012). The goal of pervasive healthcare (PH) is to utilize pervasive computing technologies to provide continuous health care services from anywhere. It means medical services can be provided at outside the scope of traditional medical places, such as hospitals and medical clinics (Kuhn & Prettner, 2016). Pervasive healthcare is aiming to change this conventional way (Visiting a physician /specialist) into pervasive patient monitoring. It exploits the sensing and communication technologies to monitor patient round the clock. Pervasive healthcare encourages patient-doctor collaboration, and can give exact, precise, and upright care to all (Mukherjee et al., 2014; Wu et al., n.d.; Yang et al., 2013). This is especially helpful nowadays, since the population is expanding quickly and medical institutions are confronting deficiencies of medical staff (Fernald et al., 2011; Muhammad et al., 2013). The electronic healthcare framework has been the primary application of pervasive computing to enhance healthcare quality and preserve human lives. A number of frameworks consisting of many devices have been invented for remote observation to obtain the patient wellbeing (Yuan & Herbert, 2011; Andreu-Perez et al., 2015).

Nowadays, it is easy to modernize the way of healthcare services due to technological advancements in different fields like wireless network, microchip, integration, and thinness of devices, sensors, and the internet (Chondrogiannis et al., 2017). These systems are structured in such a way that it can react to crisis and manage illness (Banaee et al., 2013). In this view, Body Sensor Network (BSN) is probable solution, because it is an appropriate blend of modest wearable gadgets connected to the patient’s body for observing the patient’s physiological information. Sensors continuously screen and gather the patient’s information and send it to a remote server through a network that is referred as Database Server (DBS) (Tiwari & Kumar, 2012).

2. PROBLEM FORMULATION AND ISSUES

As of now, development of a remote patient monitoring system in all aspects is an evolving state, and many issues need to be investigated professionally. A significant issue is to give continuous and persevering medical services via wearable human services gadgets. Furthermore, many patients are
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