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Smart Health Monitoring System-an Overview

V.SHRUTI | III BE (ECE) COIMBATORE INSTITUTE OF TECHONOLOGY COIMBATORE - 641 014.

ABSTRACT

In recent years, researchers have developed a variety of health monitoring technologies to assist elderly citizens. In this work, different categories of detection systems are first identified and then a classification of detection methods is build according to their use and principles for better understanding of the existing approaches. Health monitoring systems have rapidly evolved during the past two decades and have the potential to change the way health care is currently delivered. Although smart health monitoring systems automate patient monitoring tasks and, thereby improve the patient workflow management, their efficiency in clinical settings is still debatable.

KEYWORDS Smart Health Monitoring, Remote Health Monitoring, Mobile health monitoring

INTRODUCTION

A proliferating interest has been observed over the past years in the development of an precise system for monitoring continuous human activities in the health care sectors, especially for the elderly. Health monitoring systems have rapidly evolved during the past two decades and have the potential to change the way health care is currently delivered. Although smart health monitoring systems automate patient monitoring tasks and thereby improve the patient workflow management, their efficiency in clinical settings is still debatable. This paper presents a review of smart health monitoring systems and an overview of their design and modeling. Furthermore, a critical analysis of the efficiency, clinical acceptability, strategies and recommendations on improving current health monitoring systems will be presented. The main aim is to review current state of the art monitoring systems and to perform extensive and in depth analysis of the findings in the area of smart health monitoring systems. In order to achieve this, over fifty different monitoring systems have been selected, categorized, classified and compare. Finally, major advances in the system design level have been discussed, current issues facing health care providers, as well as the potential challenges to health monitoring field will be identified as compared to other similar systems.

With the rapid increase of the older population coupled with that of its life span, the number of patients who require monitoring also increases. Therefore, it is predicated that the cost of hospitalization and patient care will rise world wide. In the us, the mortality rate is over 7,70,000 per year. This includes patients who suffer sentinel events associated with incorrect medication, dosage inaccuracies, contraindications or critical delays in interventions resulting in hospitalization.

The aggregated costs of these events across the US is between 1.5 billion US Dollars and 5 Billion US dollars annually.

Therefore, health monitoring systems(HMS) can play a significant role in reducing hospitalization, burden of medical staff, consultation time, waiting list and overall health care costs. Health monitoring systems can be classified into three categories which are identified below.

Remote health monitoring systems(RHMS):
It refers to those with remote access or systems which can send data to or from a remote location. The function of this particular type of system ranges from a single to multiple parameters which cover a variety of symptoms and can be utilized in individual homes as well as hospitals.

Mobile health monitoring systems(MHMS):
It refers to mobile phones, personal digital assistants (PDAs), Pocket personal computer(PC) based systems which are used as a the main processing station or in some cases at the main working module.

RHMS and MHMS are considered to be more convenient and cost effective than traditional, institutional care, since they enable patients to remain in their usual environment whilst receiving professional health care.

Wearable health monitoring system(WHMS)
It refers to wearable devices or biosensors that can be worn by patients consisting of WHMS, RHMS and MHMS.

Smart Health Monitoring System(SHMS)
It refers to as advanced technology or a new approach to health monitoring.

Digital health care
It is also known as digital health is an upcoming discipline that involves the use of information and communication technologies to help address the health problems and challenges faced by patients. These technologies include both hardware and software solutions and services. Generally, digital healthcare is concerned about the development of interconnected health systems so as to improve the use of computational technologies, smart devices, computational analysis techniques and communication media to aid healthcare professionals and patients manage illnesses and health risks, as well as promote health and wellbeing.

Digital healthcare is a multi-disciplinary domain which involves many stakeholders, including clinicians, researchers and scientists with a wide range of expertise in healthcare, engineering, social sciences, public health, health economics and management.

Innovation cycle
The innovation process for digital healthcare is an iterative cycle for technological solutions that is classified into five main activity processes beginning from the identification of the healthcare problem to implementation and evaluation in working clinical practices.

These five processes are:
***Identifying the healthcare problem*:** This stage involves defining the healthcare problem, identifying and understanding users and their needs, and the clinical care pathway. User requirements and the context of use of digital technologies will

then be formalized through relevant scientific, engineering and psychological theories and principles.

***Doing the research*:** The research that informs the digital innovation is produced by scanning published literature to identify existing technologies that are appropriate and relevant to clinical practices, as well as potential technologies that can be developed.

***Designing the digital solution*:** The prototype solution is designed and developed with the aid of various stakeholders according to principles of human-computer interaction, including user-centered, experience-centered and/or activity-centered designs.

***Evaluating the digital solution and generating evidence*:** The technological solution is pilot-tested in patient and user groups to ensure its effectiveness, safety and affordability. Impact evaluations are then carried out in large-scale clinical studies and/or trials, and the evidence is synthesized through published literature. This may also include clinical studies that evaluate the economic impact.

***Supporting the digital innovation*:** The knowledge generated from the synthesized evidence is then shared among various stakeholders (e.g. patients, clinicians, industry) to promote and spread the digital innovation.

Health Monitoring System (HMS) for the home environment:

There are several approaches towards assisting the elderly who live independently. A smart home for the elderly has been developed, using pulse rate(PR), BP and sensors to measure weight, light, temperature, the presence of gas or smoke, fall risk and moisture throughout the home. A digital IP camera transmits data via an IP based Rabbit microcontroller with a built-in small web server, and information is accessed via a secure web. Although, this method has achieved a higher accuracy, it incurs higher costs as more sensors need to be deployed around the home setting. Patients exhibiting symptoms of cardiac infarction, sleepapnoea or hypopnea were successfully monitored by body and excretion weight and during sleep. Similar work was also carried out by an ECG monitor on patients in the bath or bed without direct skin contact. Respiration rates and pulse rates were monitored by an air mattress sensor and body temperature and movement by a thermistor. A toilet-seat-installed BP monitor and a respiration and cardiac beat monitor fitted under a pillow, using vinyl tubes, filled with silicon-oil, has also been explored.

Conclusion

The wide range of smart health monitoring systems, their applications and efficiency have been identified and discussed. A number of studies supported the effectiveness of such systems both in a hospital setting as well as the home environment. Standardization of demand for such systems and the applications of telemedicine are a fast growing area for research. For instance, a vital signs transmission system, based on VITAL and DICOM standards for telemedicine applications have already been developed. It was identified that online monitoring and real time transmission of bio-signals, and related systems require high quality signals without artifact to be capable of operating without delay. To address such challenges, an online monitoring system was developed using wavelet decomposition and reconstruction techniques for filtering ECG data. The development of a trend detection algorithm for EEG monitoring is another example. Such online or web based monitoring systems are playing a major role in remote patient monitoring producing high quality data and accuracy.

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