A CRITICAL ANALYSIS ON USE OF CPS IN HEALTHCARE

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ABSTRACT

The term "cyber-physical system" refers to the fusion of physical processes with computing and communication. It has the potential to enhance social intelligence. Wireless sensor networks (WSNs) may play a critical role in CPS, since robust sensing capabilities is a key feature in CPS applications. CPS is still a fledgling technology, with several unresolved issues. There have been a few CPS applications in healthcare presented so far, and they lack the flexibility of technological integration, such as the integration of computer resources and sensor networks. This article provides an overview of the applications of CPS in healthcare that have been presented so far by academics and industry. Additionally, a detailed taxonomy is presented that defines and categorises the many components and methodologies necessary for the use of CPS in healthcare. The taxonomy not only shows the similarities and contrasts between the state-of-the-art technologies used in CPS for healthcare from a WSN and Cloud Computing viewpoint, but also indicates opportunities for additional study. This taxonomy and its mapping to relevant systems are predicted to be very beneficial in the future development of CPS for healthcare.

KEYWORDS: Healthcare, CPS, Industry.

INTRODUCTION

In recent years, cyber-physical systems (CPS) have garnered considerable interest and are being hailed as an emergent technology. It bridges the gap between computing and communication and the physical environment. CPS was selected as a critical study field by the US National Science Foundation (NSF) in 2008 and as the US President's Council of Advisors on Science and Technology's number one research priority in 2009. Sensing, processing, and networking are all necessary components of CPS. Recent advancements in wireless sensor networks (WSN), medical sensors, and cloud computing make CPS an attractive contender for healthcare applications such as in-hospital and at-home patient care. These advancements have the potential to enable CPS to monitor patient status remotely and take appropriate action regardless of the patient's location. Medical sensors are the subject of much study. These sensors are capable of collecting crucial patient data, including health information. The collected data is sent over the wireless communication means to a gateway. While wired sensors may be employed, wireless sensors provide more flexibility and comfort for both caregivers and patients. The sensors' data may be saved on a server and made available to physicians. Security is critical in this case, since patient data is considered secret under both legal and ethical standards. Thus, while developing a CPS architecture for healthcare

applications, extra consideration must be given to data security. Additionally, there are a number of critical concerns to address, such as the need to store and handle the massive amount of data generated by hundreds of medical sensors. As a result, database management solutions must be both efficient and dependable. Due to the fact that medical data may give valuable insight into the activities (treatments) required to preserve a patient's life, all data should be immediately available and accessible to authorised medical workers at all times and from any location. Additionally, healthcare apps demand a large amount of computational power to make intelligent decisions based on immense amounts of patient data. However, the networks of wireless sensors that gather patient data are severely limited in terms of energy consumption, processing capability, and storage capacity.

USE OF CPS IN HEALTHCARE

Cloud computing may be able to address some of these concerns. Current research in this field is aimed at using cutting-edge Cloud Computing technologies as the computational backbone of CPS in order to increase the system's scalability and allow real-time data processing. Cloud Computing is a term that refers to computing infrastructure that may be accessed from anywhere in the globe by any consumer organisation or person. It is a computer, storage, networking, and software-as-a-service model. According to Buyya et al., cloud computing is a parallel and distributed computing system comprised of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLAs) negotiated between the service provider and consumers.

Thus, based on the definitions, the cloud should include the following characteristics: (1) self-service, (2) per-use metering and invoicing, (3) elasticity, and (4) customization. Two elements of Cloud Computing appeal to end users: first, users may access personal data and apps from any computer connected to the Internet; and second, software programmes do not need to be installed on the user's computer since they are accessible through the cloud. Additionally, cloud computing companies supply developers with a variety of software services, application programming interfaces, and development tools. These services allow clients to migrate to the cloud their computer infrastructure. Cloud Computing evolved as a consequence of the progress of many technologies, including distributed computing, Internet technologies (service-oriented architecture, web services), system management (autonomic computing), and hardware (virtualization, multicore processors). CPS requires a combined sensor-cloud architecture, in which the cloud supports cyber (computing) activities and the sensors supports physical activities provides an in-depth examination of sensor clouds.

CPS APPLICATIONS

EMR is a term that refers to the development of a cyber-physical interface for automated vital sign readings. This method is an alternative to vital sign reading, which is often inaccurate and time consuming. This is a design for a cyber-physical interface that connects sensors across a wired network and enables the retrieval and storage of structured data in an EMR system. The following components comprise this prototype: an electronic medical record (EMR), a data handler (software adapter), a vital signs reading station (hardware

topology), and a customised vital signs form. This is a system design document (SDD) that discusses and decomposes the cyber-physical approach utilising a three-tier architecture. The components in this design are grouped into layers that are self-contained and depending exclusively on the components in the layer below. The primary benefit of this technique is that components may be updated independently of those in subsequent levels. The interface layer includes the components required for displaying the programme, the application logic layer includes the components that perform the business logic, and the data layer manages the database connections.

CONCLUSION

This article discussed cyber-physical systems in healthcare. To assist with this, a quick review of CPS in general is offered first. After that, a characterization (mapping) of cyber-physical systems for healthcare applications is presented based on a comprehensive taxonomy encompassing eight distinct perspectives (or elements): I application, (ii) architecture, (iii) sensing, (iv) data management, (v) computation, (vi) communication, (vii) security, and (viii) control/actuation. This classification aids in visualising the trends, methodologies, and possible CPS solutions associated with certain applications. The taxonomy was also applied to healthcare initiatives that use just wireless sensor networks (WSN) or cloud computing. Thus, the taxonomy and mapping described in this article may be utilised to denote the gaps between WSN or cloud-based healthcare solutions and CPS-based healthcare solutions. This will enable the use of current WSN and cloud-based healthcare technologies in order to construct more dependable and efficient cyber-physical healthcare systems. According to the data given in this article, security and privacy concerns are among the least researched aspects of CPS for healthcare applications. Additionally, the control/actuation component of CPS is still heavily reliant on the human involvement of a healthcare practitioner for decision-making and feedback. Although CPS has the potential to aid in event prediction in healthcare, little study has been conducted in this area.

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