Survey Paper on Health-CPS : Healthcare Cyber-Physical System Assisted by Cloud and Big Data

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ABSTRACT

Today the information technology has provided its great service to various fields including healthcare. Healthcare data is not only huge but also hard to handle and process. This healthcare data is created in a very small span of time at a rapid rate which can be regarded as a big data problem. The healthcare data can be flexibly handled using health CPS, assisted by cloud and big data. This system consists of data collection layer, data management layer and application service layer. Using cloud and big data the performance of the healthcare data can be enhanced. This paper provides a solution to big data problem via health CPS.

Keywords: Cyber Physical Systems, Cloud Computing, Big Data.

I. INTRODUCTION

In recent days, technology is a crucial ingredient of healthcare . Indeed, all healthcare consists of either human interactions, the application of technology or most commonly both. Since the healthcare data is explosive in nature there are challenges for managing, storing and processing the data. The various challenges are:

1) Rapid growth: The data from wearable device are frequently collected. The data need to be processed and can be used for emergency.

2) Heterogeneous data: The healthcare data can be from various source and it can be even of different varieties (eg: text, audio ,video).

3) Deep value: The hidden value from an isolated is limited, through data fusion of EMR and EHR (electronic medical record), we can increase the deep value from healthcare data.

4) Massiveness: With the improvement in medical informationization, the huge amount of data from the hospital as well as from various wearable devices drives a way for explosion of healthcare data .

II. TECHNOLOGIES USED

A. Cyber Physical Systems

In [1] Cyber physical systems are defined as the emerging collection of distributed cyber systems that controls based on a set of rules, the interconnected physical systems are networked by control loops. It integrates a network of sensors, collecting information that is analyzed and processed by a control processing unit, sending the commands via communication devices to control actuators.

According to researches, cyber-physical systems are the result of M2M (machine-to-machine) application and modernization. M2M refers to the communications between computers, smart sensors, embedded processors, and other devices minimizing human participation. M2M systems have many important characteristics for modern cyber-physical

systems [2]. Cyber-physical systems are used in multiple areas such as traffic management and security, automotive engineering, industrial and process control, energy saving, ecological monitoring a management, industrial robots equipment, biological systems technology and so on [2].

The role of cyber-physical systems in healthcare networks[1], proposes a general framework for the interconnected medical or medical related devices and service and discusses security problems. The motivation for choosing this topic resumes to the evolution of healthcare systems and lack of concern for security in the medical sector. A CPS design process is an iterative process, which consists of three phases: modelling, design and analysis[2] as shown in fig.1.

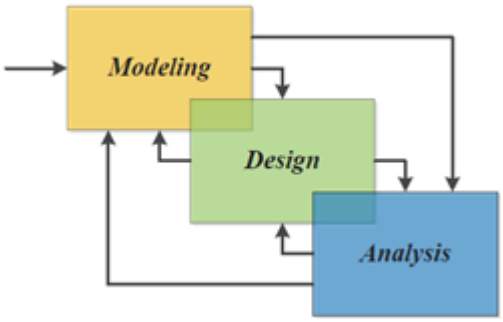

Fig.1.Cyber Physical System Design Process

CPS IN THE HEALTH NETWORK

The evolution of today's world introduced new health problems even at a much younger age and models of treatment delivery have to be adaptive and dynamic. Thus, people seek help from professionals within a vast range of private or public health care services. These services are more likely independent and the patient's data isolated from the rest of the system. There are several attempts to create an interchanged system that electronically connects health systems to share collaboratively information. This system is at an early stage where just a handful of services are interconnected but in the near future there will be an expansion and a wide integration of healthcare services that will exchange information globally in real time. The power of information in terms of health is indisputable. By analyzing it with the help of big data major improvements will change medicine and the process of health from predictions about patient's ailments risks, epidemics, problems in the general public's health before they even occur and also remedies or treatments in early stages, drug discovery, tailored healthcare packages and services[1]. The research center network (e.g. epidemiology/ medication/ treatments research centers) uses the processed data in their work and gives a feedback to the corporation if the strategy used reaches the target or had less results.

The use of wireless technology[3] makes it possible to install the system in all types of homes and facilities. A Wireless Health Monitoring system that can wirelessly monitor vital signs of users in real-time and notify medical personnel and family members immediately in case of emergencies.

Healthcare cyber-physical systems can be categorized by application (assisted, controlled), architecture (infrastructure, data requirement, composition system), sensing (sensor type, method, parameter), data management (data integration, data storage, data processing), computation (modelling, monitoring), communication (scheduling, protocol), security (privacy, encryption), control/actuation (decision-making, mechanism)[2].

B. Cloud Computing

Cloud computing are often outlined as a computing surroundings wherever computing wants by one party are often outsourced to a different party and once would like be arise to use the computing power or resources like information or emails, they will access them via web. Cloud Computing provides a surroundings for resource sharing in terms of ascendance frameworks, middleware's and

application development platforms, and business applications[6].

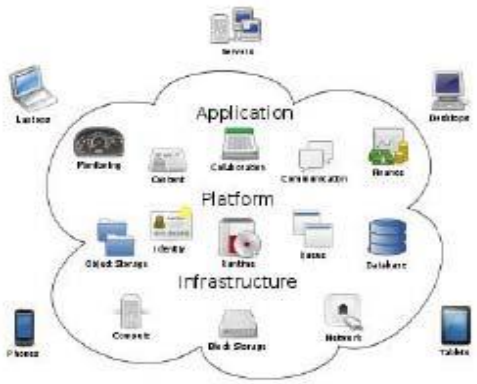

Fig.2. Cloud Computing [2]

CHARACTERSTICS OF CLOUD COMPUTING

In cloud computing, users access the information, applications or the other services with the assistance of a browser notwithstanding the device used and also the user's location. The infrastructure that is mostly provided by a third-party is accessed with the assistance of web. Price is reduced to a major level because the infrastructure is provided by a third-party. Less IT skills are needed for implementation[4].

- Reliable services are often obtained by the employment of multiple sites that is appropriate for business continuity and disaster recovery.
- Sharing of resources and prices amongst an outsized assortment of users permits economical utilization of the infrastructure.
- Maintenance is simpler just in case of cloud computing applications as they have not been put in on every user's pc.
- Pay per use facility permits activity the usage of application per shopper on regular bases.
- Performance is often monitored and so it's ascendible.
-Security is often pretty much as good as or higher than ancient systems as a result of suppliers are able to devote resources to resolution security problems that several customers cannot afford. However, security still remains a crucial concern once the information is sort of confidential[7].
- Cloud could be a massive resource pool that you just should buy in keeping with your need; cloud is simply like running water, electric, and gas which will be charged by the quantity that you just used.
= Cloud computing makes user get service anyplace, through any reasonably terminal. The resources it needed return from cloud rather than visible entity. Users will attain or share it safely through a simple method, anytime, anywhere. Users will complete a task that can't be completed in an exceedingly single personal computer.

CHALLENGES OF CLOUD COMPUTING

Based on a survey[4] conducted by IDC in 2008, the main challenges that forestall Cloud Computing from being adopted square measure recognized by organizations. Square measure as follows:

-Security:

Well-known security problems like information loss, phishing cause serious threats to organization's information and software system. Moreover, the multi-tenancy model and therefore the pooled computing resources in cloud computing has introduced new security challenges that need novel techniques to tackle with. For instance, hackers will use Cloud to arrange as Cloud typically provides a lot of reliable infrastructure services at a comparatively cheaper worth for them to begin an attack.

- Cost Accounting Model:

Cloud customers should think about the tradeoffs amongst computation, communication, and integration. Whereas migrating to the Cloud will considerably scale back the infrastructure value, it will raise the price of information communication, i.e. the value of transferring an organization's information to and from the general public and community Cloud and therefore the cost per unit of computing resource used is probably going to be higher[8].

C. Charging Model:

The elastic resource pool has created the value analysis lots additional difficult than regular information centers, which regularly calculates their price supported consumptions of static computing. These include: redesign and improvement of the package that was originally used for single-tenancy, price of providing new options that afford intensive customization, performance and security improvement for coinciding user access, and managing complexities induced higher than changes.

- *Service Level Agreement (SLA):*

Although cloud customers don't have management over the underlying computing resources, they are doing it to make sure the quality, convenience, responsible, and performance of those resources once customers have migrate their core business functions onto their entrusted cloud. In alternative words, it's important for customers to get guarantees from suppliers on service delivery.

- *Cloud Interoperability Issue:*

Cloud has its own approach on however cloud clients move with the cloud, resulting in the "Hazy Cloud" development. This severely hinders the event of cloud ecosystems by forcing marketer protection that prohibits the flexibility of users to decide on from various vendors at the same time so as to optimize resources at completely different levels inside a company[9].

C. Big Data

According to McKinsey[10], Big Data refers to datasets whose size are beyond the ability of classic database software tools to capture, store, manage and analyze. There is no precise definition of how big a dataset should be in order to be considered Big Data. New technology has to be in place to supervise this Big Data phenomenon. IDC defines Big Data technologies as a new generation of technologies and architectures designed to extract value economically from very large volumes of a wide variety of data by enabling high velocity capture, discovery and analysis .According to O'Reilly,[11] Big data is data that exceeds the processing capacity of conventional database systems. The data is too big in size, moves too fast in speed, or does not fit the structures of existing database architectures. To gain value from these data, there must be an alternative way to process it. Investigation of the Big data allows conceivably boundless potential outcomes for learning [5]. Big data provides variety and flexibility of data management technologies such as NoSQL, NewSQL, Hadoop, graph databases, etc.

CATEGORIES OF BIG DATA

The data generated is usually categorized as structured, semi-structured and un-structured.

1) Structured data: This type of data information is generally present in organization databases, data warehouses and enterprise solutions.

2) Un-structured data: These data are generally those raw data that has been extracted from applications on the Internet but has not been processed into productive and more meaningful formats.

3).Semi-structured data: This type of data is generally found, where structured and unstructured data meet such as social media data, location type data, and user-generated data.

CHARACTERISTICS OF BIG DATA

Big Data is not just about the size of data but also includes dimensions such as data variety, data velocity, and data volume and data varacity .Together; these four attributes form the four Vs of Big Data. It requires human knowledge and perspectives to explore big data.

1) Volume: It refers to the amount of all types of data generated from different sources and continues to expand. The benefit of gathering large amounts of

data includes the creation of hidden information and patterns through data analysis.

2) Velocity: It deals with speed of data transfer. For time sensitive processes such as catching fraud, big data must be used as it streams into your enterprise in order to maximize its value.

3)Variety: Big data is any type of data structured and unstructured data such as text, sensor data, audio, video, click streams, log files etc.

4) Veracity: 1 in 3 business leaders don't trust the information they use to make decisions. How can you act upon information if you don't trust it? Establishing trust in Big data presents a huge challenge as the variety and number of sources grows.

BENEFITS OF BIG DATA IN CLOUD

The benefits of Big Data solutions is enabling companies to discover and analyze data at an unmatched speed, which leads to better and timelier decision making process. Following are the key factors of cloud computing which benefits the big data analysis.

1) Reduced Cost: Cost is a clear benefit of cloud computing, both in terms of investment and Operations. The reduction in investment is obvious because an organization can spend in increments of required capacity and does not need to build infrastructure for maximum (or burst) capacity. For most enterprises, Operations constitutes the majority of spending; therefore, by utilizing a cloud provider or adopting cloud paradigms internally, organizations can save operational and maintenance budgets.

2) Flexibility: Flexibility benefits rapid provisioning of new capacity and rapid moving or migration of workloads. In public sector scenarios, cloud computing provides quickness in terms of procurement and acquisition process and timelines.

3) Improved Automation: Cloud computing is based on the principle that services can not only be provisioned, but also deprovisioned in a highly automatic fashion. This specific attribute offers significant efficiencies to enterprises.

4) Focus on Core Competency: Government enterprises can gather the benefits of cloud computing in order to focus on its core operation and core objectives and leverage IT resources as a means to provide services to citizens.

5)Sustainability: The poor energy efficiency of most existing data centers, due to poor design or poor asset utilization, is now understood to be environmentally and economically unsustainable. Through leveraging economies of scale and the capacity to manage assets more efficiently, cloud computing consumes far less energy and other resources than a traditional IT data center.

III. PROPOSED SYSTEM

Healthcare cyber physical system utilization best feature of above technologies and tries to overcome the challenges of handling huge amount of healthcare data. Health CPS mainly consists of three layers: Data collection layer, Data management layer, Application service layer.

Data Collection Layer: In this layer data is collected from various data nodes, such as temperature sensor, heartbeat sensor etc. Collected data is then passed to the adapter where the noise in the data is removed and it is even converted to understandable format.

Data Management Layer: Encrypted data is then sent to the cloud. This layer consists of Distributed File Storage (DFS) which provide data storage and Distributed Parallel Computing (DPC) which provides the corresponding process and analysis method. Analysis can be either real time or offline.

Application Service Layer: In this layer decrypted data can be accessed by the patients and the doctors by successful authentication process. Doctors can even prescribe medication to the patients in this layer.

IV. CONCLUSION

This paper has presented a smart health system assisted by cloud and big data, which includes 1) a unified data collection layer for the integration of public medical resources and personal health devices, 2) a cloud-enabled and data-driven platform for multisource heterogeneous healthcare data storage and analysis, and 3) a unified API for developers and a unified interface for users. Supported by Health-CPS, various personalized applications and services are developed to address the challenges in the Traditional healthcare, including centralized resources, information island, and patient passive participation.

V. REFERENCES

[1]. PhD. Student Delia Ioana DOGARU1, Emeritus Professor Ioan DUMITRACHE– "Cyber-Physical Systems in Healthcare Networks", The 5th IEEE International Conference on E-Health and Bioengineering - EHB 2015 Grigore T. Popa University of Medicine and Pharmacy, Iasi, Romania, November 19-21, 2015.

[2]. Edgars Sultanovs, Alyona Skorobogatjko, Andrejs Romanovs-"Centralized Healthcare Cyber-Physical System's Architecture Development, 2016 57th International Scientific Conference on Power and Electrical Engineering of Riga Technical University (RTUCON).

[3]. Himadri Nath Saha, Supratim Auddy, Subrata Pal, Shubham Kumar,Shivesh Pandey, Rocky Singh, Amrendra Kumar Singh, Priyanshu Sharan, Debmalya Ghosh, Sanhita Saha – "Health Monitoring using Internet of Things (IoT)".

[4]. Er. Anurag Jain, Palvinder Singh – "Survey Paper on Cloud Computing", International Journal of Innovations in Engineering and Technology (IJIET).

[5]. Vinay Kumar Jain, Shishir Kumar – "Big Data Analytic Using Cloud Computing", 2015 Second International Conference on Advances in Computing and Communication Engineering.

[6]. Mr.Khyamling A. Parane, Mr.Naveenkumar C.Patil, Mr.Shivananda R. Poojara, Mr.Tejaskumar S. Kamble – "Cloud based Intelligent Healthcare Monitoring System".

[7]. Yashpalsinh Jadeja; Kirit Modi, "Cloud Computing - Concepts, Architecture and Challenges" in Proceeding of International Conference on Computing, Electronics and Electrical Technologies [ICCEET], 2012.International Journal of Innovations in Engineering and Technology (IJIET).

[8]. Adem TEPE, Güray YILMAZ, "A Survey on Cloud Computing Technology and Its Application to Satellite Ground Systems".

[9]. Kuyoro S. O.; Ibikunle F; & Awodele O., "Cloud Computing Security Issues and challenges" in Proceeding of International Journal of Computer Networks (IJCN), Volume (3), Issue (5), 2011. International Journal of Innovations in Engineering and Technology (IJIET)Vol.

[10]. James Manyika, et al. Big data: The next frontier for innovation, competition, and productivity. [Online] Available from:http://www.mckinsey.com/insights/mgi/research/technology.

[11]. Edd Dumbill. What is big data? [Online] Available from: http://radar.oreilly.com/2012/01/what-is-big-data.html [Accessed 9th July 2012].