

Cloud Computing Framework for Effective Patient Monitoring System

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ABSTRACT

This research work presents an application of cloud computing framework for effective patient monitoring system. In these days healthcare is becoming a big issue because the unavailability of expert doctors. Due to this issue there is a change in trend from demand base health monitoring to defensive health monitoring service. The healthcare field is growing and developing so fast because of the increasing ratio of senior citizens and decreasing ratio in birthrate. Due to this scenario we are going to propose a healthcare distributed system for saving patient data record in a centralized server with specific firmware and software for making a connection to network by using TCP/IP protocol which will be mixed with cloud computing technology.

That will make system able to track down patient remote and current location by using GPS navigation or cellular networks receiving signals from its nearby Base Transceiver Station and also able to generate EMR(Electronic Medical Report). The Electronic Medical Reports of patients will play an important role (diagnosing a patient and the improvement process) and are very helpful for a doctor to analyze a patient medical history. This system will help to keep a complete patient health record in a timely manner and also generate an alert message when the patient's health variable limit crosses the normal or boundary value, then the major data of patient's medical record immediately moved to the cloud storage, where only the authenticate registered expert doctors and patients (via Mobile App) have accessed on it.

KEY WORDS: Cloud Computing, Sensor Cloud Architecture, Cellular Network, Patient Monitoring.

1. INTRODUCTION

Health is a core supplement of the success or development of any nation all over the world. (Global Challenges for Humanity, 2014) World Health Organization (WHO) written in its own constitutions that everyone has a right to live with the achievable high level standard of health which is a basic and elementary right for every human being. A healthy person plays a vital role in the development of a society, in the terms of increase income, gross domestic product (GDP), tax revenues and decrease load on hospitals, clinics, medical consultant, charities, and government organizations. As people are moving from traditional to modern approaches by using technology, the cloud computing plays an important role for patient healthcare monitoring system. These types of systems are much able to facilitate people anywhere in the city or country. And, in traditional approach the doctors and medical experts must be able to visit patient on regular bases for routine checkups. (Amna Abdullah, May 2015)

The cloud computing generally depends on the sharing mechanism of resource computing rather than obtaining a connection between client-server and handheld personal devices to manage apps. This type of computing could be compared with grid computing. In grid computing, all the computers in a network with unutilized processing cycle that can be difficult to tackle problem in-depth for any isolated machine. (Bhatia, MARCH 2014)

The **Figure 1** shows cloud with a distribution layer of computing. The word cloud is used as a metaphor that has a meaning of "The Internet" so we can say that cloud computing is an "Internet Based Computing" where we have an access on divergent services like servers, storage and applications that must be distributed to a system of an organization and other devices like computers, cell phones, tablets, pda's etc by using the connectivity of internet. (Glenford Mapp and Mahdi Aiash, 2014)

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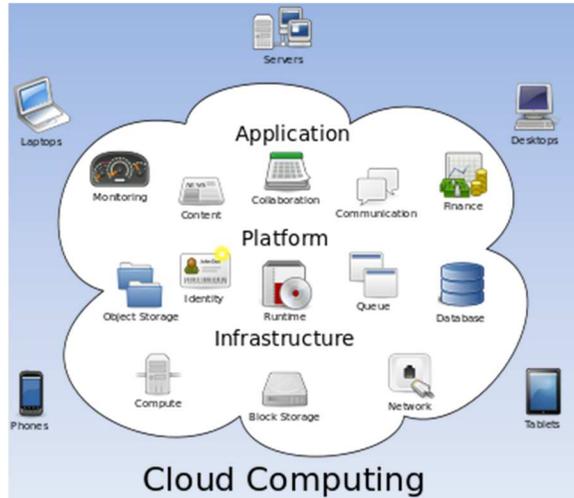


Figure 1: Cloud Computing Distribution Layer

According to the survey report almost 95,000 human healthcare apps are available on the internet and approximately 200 million people have been installed and used these apps on their mobile phones (smartphones). But, in 2015 the ratio crossed the line of 500 million people who have been using these apps. (Developer Economics Report, 2014) In the United States of America, smartphones and tablets are most commonly used devices for the doctors or medical experts to have access on medical records, past or present references, preparation element, qualified or skilled journals, patient mentoring and imaging etc. Patients may also used Smartphones for scheduling appointments, renewing prescriptions and accessing on their medical data. (Smartphone Revolutionize Healthcare, 2015)

In this research paper we are going to propose a mobile application that wirelessly monitors patient health condition and it must be updated in time to time. The system need to be distributed for saving patient data record in a centralized server with specific firmware and software for connection to a network by using TCP/IP protocol. That will make system able to generate EMR (Electronic Medical Report). The patient remote and current location will be tracked down by using GPS navigation or cellular networks receiving signals from its nearby Base Transceiver Station. This system will help to keep a complete patient health record in a timely manner and also generate an alert message when the patient's health variable limit crosses normal or boundary value, then the major data of patient's medical record immediately moved to the cloud storage, where only the authorized expert doctors and patients (via mobile app) have access on it. (Amna Abdullah, May 2015)

2. RELATED WORKS

People have been showing a lot of contribution towards the development of healthcare monitoring system. There are various and rapid increasing growth of this research area in every year. We shown some literature work which had been done in past few years.

Cloud technology empowers the sooner identification of injurious situation and diseases. Some various numbers of research emphasis on sensors and these sensors are fixed or connected with the human body to monitors patients health condition. A semi conductor called "markov" is very helpful for predicting or suggesting eating habits and workout for patient. (Alexandros Pantelopoulos and Nikolaos G. Bourbakis, January 2010)

A healthcare system for senior citizens was introduced to monitor their indoor and outdoor active location. It has two major elements and these are Bio-signal sensor or mobile phone (smartphone). The working of this system is depends on a collected data which comes from bio-signal sensor and send it to smart server by using mobile phone through cellular network (GSM/UMTS). Through this phenomenon the system is responsible for monitor patient mobility location. (Bourouis, 2011)

The Harvard University started a project named as "Code Blue" and their research area was wireless sensor network in which they succeeded on developing WSN for medical apps. This application shows result when these sensors are connected to human patient body, it is responsible for conveying signals to healthcare providers by using ad-hoc network (Subasish Mohapatra, 2012).

MIT lab researchers were successfully built “MITHril”, in which they provide a platform to custom and off shelf sensors with no compatibility issue. (Subasish Mohapatra, 2012)

The system of ambulatory is responsible for providing a mentoring element to the rehab patients. The system is full depends on a multi-sensor device, a smartphone having an application and a service-oriented server. The system has been tested in a controlled environments consisting of some healthy volunteers and some congestive heart failure patients. (Strisland, 2013)

A cloud based intelligent healthcare monitoring system (CIHMS) has been presented for giving quick response to a patient about medical suggestions with the help of cloud computing. The system is able to contain sufficient amount of data associated to disease and hand it over to a real time location through cloud computing devices. (Parane, 2014)

Windows Mobiles (like nokia lumia) are often used for checking and supervising patient’s body parameters. The suggested system exists on a body network sensor, these sensors are used for counting and gathering physiological record. Bluetooth is used to provide communication between sensor networks to mobile device for transmitting data. This is a secure system so only the authorized user has an access on it. (Amna Abdullah, May 2015)

The system of an interactive cloud based healthcare was developed to provide better and cooperative interaction between patient and its doctor about all medical history data of that patient. This system helps to communicate in two ways live audio, video chat and text message chat through healthcare cloud. (R.K.Dixit, Sept 2016)

The proposed wearable 2.0: enabling human cloud integration in next generation healthcare system enhances the “Quality of Experience” and “Quality of Service” of upcoming healthcare system. The system is consists of washable smart cloth with sensors, electrodes and wires. We can get a physiological data and analysis results of patient health and emotive condition by using cloud base smart device. (Min Chen, 19 January 2017)

3. WORKING OF CLOUD COMPUTING AND TYPES

A large group of server networks are running in technology of Personal Computer at a decent amount of consumer with the association of spreading processed data to cover them. A large pool of systems are linked together in share IT infrastructure. The cloud computing power can be maximized by using the techniques of virtualization. (Hong Li, JULY 2014)

3.1. Types of clouds: There are various types of clouds and these clouds are known as:

- Private cloud
- Public cloud
- Hybrid cloud
- Community cloud
- Distributed cloud
- Volunteer cloud

3.1.1. Private cloud: The organization is fully responsible to manage the infrastructure of this cloud that must be functioned alone for a single organization. At sometimes, the organization handled it domestically or by involving a mediator (third person) to host it either privately or outwardly. (Luis C. Jersak, MAY 2013)

3.1.2. Public cloud: The services of this cloud always available in public places and it may be free of cost. (C. Neuhaus)

3.1.3. Hybrid cloud: The formations of two or more clouds are called hybrid cloud and these clouds may be private or public. These are remain different substances besides, they are bounded to compose for giving the advantage of various distributed models. (Lang, 2008)

3.1.4. Community cloud: The different infrastructure can be shared for a general concerns about security and complaining issues between various organizations. At sometimes, the organization handled it domestically or by involving a mediator (third person) and hosted either privately or outwardly. (C. Neuhaus)

3.1.5. Distributed cloud: In different locations, a distributed set of systems are connected through a single network or a hub service. That is collected by cloud computing platform. (Lang, 2008)

3.1.6. Volunteer cloud: There is a junction between public and cloud computing. Due to this junction the cloud computing infrastructure is develop on using volunteer resources. (Luis C. Jersak, MAY 2013)

4. FRAMEWORK STEPS FOR PATIENT MONITORING SYSTEM

The framework for patient monitoring system includes services and these are the following:

- Storage Service
- Database Service
- Information Service
- Process Service
- Application Service
- Platform Service
- Integration Service
- Security Service
- Management/Governance Service.
- Testing Service

5. FRAMEWORK OF PATIENT MONITORING SYSTEM

This architecture is consist on a filter system that is executing on smart phones, which is used to take the patient's current data about health from the application installed on smart phone and compared it with history data record store in a lookup table, it has an ordinary reading of the different health variables limit. (Dhanapal, 2012)

The **Figure 2** shows the graphical communication between doctors and patients via sensor cloud. If filters are find out an abnormal (not good) reading that is coming from health status. Then, the system will generate an alert message that is immediately sent to the patient's doctor. A single transcript copy of patient current health status will deliver to hospital management system for maintaining record in the cloud executing an EMR (Electronic Medical Reports). (Dhanapal, 2012)

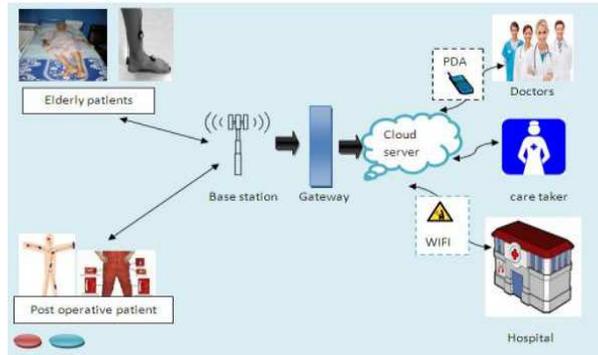


Figure 2: Sensor cloud communication b/w doctors patients

Sometimes, the patient may be in an alarming situation and patient doesn't know about his/her serious condition. The filters are used to identify the patient serious condition depend on the past and present input record values of the data which was send by the cloud. (Dhanapal, 2012)

If the filters find out the serious condition, a synthesized report should be send to the doctor via SMS, with attachment of the present active location (address) of the patient, sent through GPS executing on the smart phone. (Dhanapal, 2012)

6. USES

It is mostly used by military and also providing a research facility to perform specific tasks. (Mr.Khyamling A. Parane, 2014)

- Millions/Trillions of computations should be performed in a seconds
- Applications are Consumer oriented such as a financial portfolios
- Online computer gaming

7. MONITORING SYSTEM

7.1. Application in Remote Healthcare: This app acts as a mobile application software, that is used for providing an approach to access data and storage services. This doesn't require any kind of information about the end users location and the systems configured that it provides the computing resources. (Howard, 2010)

In Cloud Computing, the users have an access on web browser (this browser is an interface) and all data must be saved on the remote site servers because this server is a self sufficient device. (Dhanapal, 2012)

In recent years, the abundant human healthcare companies were start using this WSN (wireless sensor networks) technology to casually oversee patient health. As some human healthcare institutions and insurance companies are begin utilizing the Electronic Medical Record (EMR). (KorayErek, 2013) This system is used to contained medical record of patients these records are kept and maintained in the large centralize distributed database management system in which data are stored in the cloud by encryption and decryption of electronic records. (Dhanapal, 2012)

7.2. Patient Monitoring System: This is an approach where the health position of a patient is recover and convey health status messages in continuous fashion by using a wireless network. They can communicate with medical services because application installed on cloud to manage the EMR (Electronic Medical Records).

The **Figure 3** shows the graphical working of system between doctors, patients, hospital, filter app and cellular network. The standard area of our research work is just to present an architecture for combining the healthcare cloud with the enhanced technology of WSN (wireless sensor network) and GSM/UMTS network by using smart phones.

The healthcare application on smart phone wirelessly observe patient health, providing real time information about patient health condition to his/her doctor and other medical expert via cloud.



Figure 3: System Graphical Interface Architecture Diagram

7.3. Maintaining Record: This is a filter system executing on a smart phone, which is used to take the patient's current data about health from the application installed on a smart phone and also compared it with a history lookup data table, which has an ordinary reading of the different health variables limit. (Mr.Khyamling A. Parane, 2014) If filters are find out an abnormal/strange reading that is incoming health status reading then it will generate an alert message. The system is immediately sent to the patient's doctor and a single copy of patient report should be sent to the cloud who has running an EMR (Electronic Medical Report) which is preserved by the hospital management. (Dhanapal, 2012)

Sometimes, the patient may be in an alarming situation and patient doesn't know about his/her serious condition. This filter easily recognizes the patient alarming situation by statistical analysis established on the bases of old and new values obtain by sensor data. If the filter diagnoses the critical situation is too dangerous and risky, a synthesize report must be send to the authorized doctor via message including the current location (address) of the patient and become aware of GPS sensor functioning on the smart phone. (Dhanapal, 2012)

8. SERVERS

There are 3 types of servers used in this system. Such as:

- Storage server
- Medical server
- Communication server

8.1. Storage server: The massive amount of recorded data should be gathered and assembled in a process of patient monitoring. It is difficult to maintain and fetch out data for this purpose we are using cloud computing technology for storing and containing the collected data records in a well organized manner. (Youssef, June 2014)

8.2. Medical Server: The medical server is responsible for analyzing and predicting on the bases of on-line and off-line knowledge. A measurable analysis of composed large amount data will allow in a various states and arrangements. (Dhanapal, 2012)

8.3. Communication Server: The communication server is used to store data for analyzing, diagnosing and generating an alert signal when there is an alarming life threatening situation occurs. This framework architecture has a desire to create the cloud infrastructure in a very well useful manner which will be completely obvious and understandable to the doctor or caretakers. The threshold based algorithm used for detecting abnormal/strange condition of a patient and generating an alert message. (Bhatia, MARCH 2014)

There are three types of user who can have access to the patient information in real time.

- Caretaker
- Doctor
- Patient

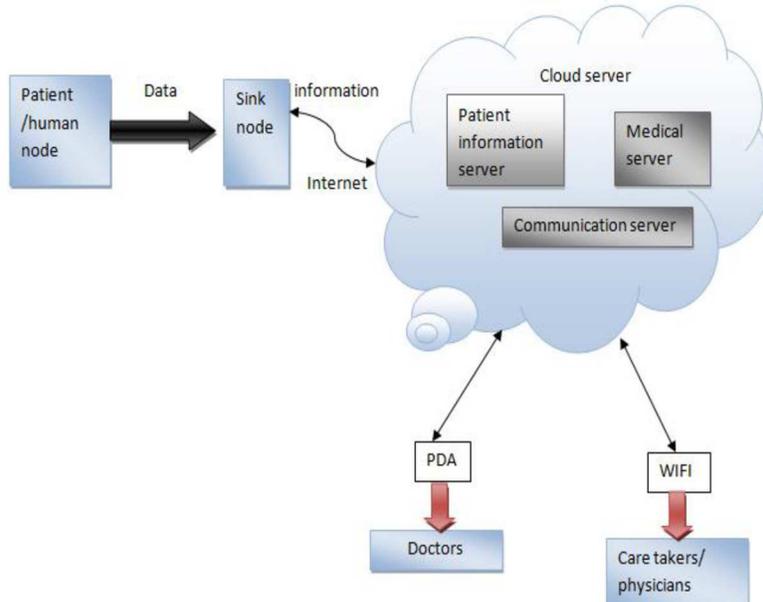


Figure 4: Cloud computing Servers platform for patient monitoring

9. Security Concerns:

The health data records should be super private and protected. The Health Assurance Flexibility and Liability is a regular standard principle of behavior that has full approach on the patient’s health data records. (C. Neuhaus) The **Figure 5** is a flowchart diagram of all the rules and regulations that will be regularly checked and must be updated patient’s data record with the passage of time if it finds any violation than it will generate an emergency alert. So, this alert message immediately sent to the authorized medical specialist who will have a complete access on patient’s health data records. This condition will execute whenever it find out any single strange (not good) input variable from the filter system. (T. Umedo, 2010)

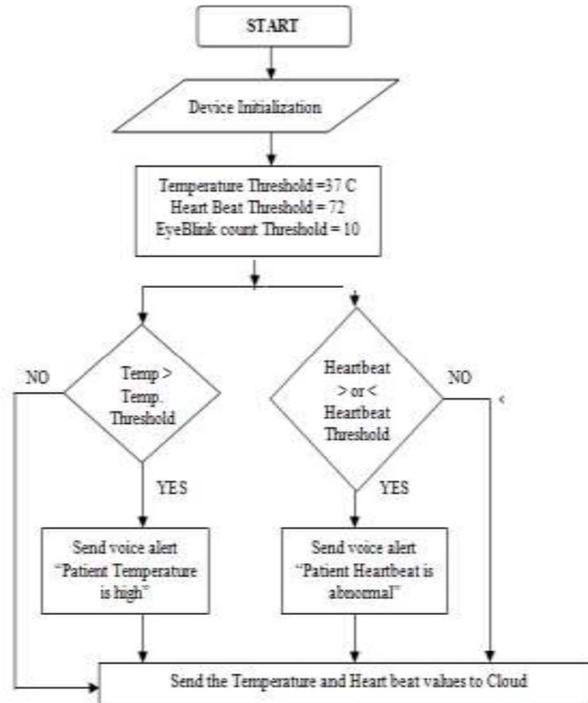


Figure 5: The Program Flowchart

10. FUTURE SCOPE:

The future scope can be defined in terms of:

- System Outcomes
- Expected Impact
- Security Outcome

10.1. System Outcome: There are the following system outcomes:

- Environmental parameters are being measured
- User friendly interface (Calif, 2007)
- Energy should be used for websites (remote sites), cell phone and data courier unit deployed on a vehicle. (Bhatia, MARCH 2014)
- Servers and remote site should be able to operate for longer period of time without maintenance (Youssef, June 2014)
- System receiving feedback
- Security implementation on WSBS and Android or any other Operating system (Waxer)

10.2. Expected Impact: It has a vision to provide a better human healthcare system for those patients who are living in the backward areas. There will be a definite impact on the quality of human HealthCare which may these patients can receive. (Youssef, June 2014)

10.3. Security Outcome: This work is dedicated to the systematic analysis and evaluation of a secure communications network for the purposes of not over scoping. We will follow traditional step by step method of evaluating a secure network. (Youssef, June 2014)

E-health will be the revolutionary step in the growth of HealthCare services.

11. CONCLUSION:

This research work is offering a secure framework for HealthCare monitoring system. In mobile cloud computing environment all the analytics are based on big data analysis. The framework is used to supply concatenation of an upper bound, high rank of interoperability, and sharing this with healthcare contributors, patients and expert/professional doctors. The cloud allows a quick and speedy internet approach for sharing by/with authorized users. The big data analysis helps to recognize the righteous appropriate patient at the righteous perfect time to providing a patient righteous well healthy intervention.

The patient healthcare monitoring system framework is responsible for guaranteed about security constraints and the access control is fully secure to providing a total guaranteed of morality, confidentiality and a complete privacy of a patient medical history. The best and ideal objective of this framework is just to present different age groups about Human HealthCare system that is smart enough to give services of healthcare at a very great and better quality with reasonable amount of money to the patients. By using, the combination of two most supreme technologies cloud computing and mobile computing.

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