THE NEW ERA OF MEDICAL IMAGING: CLOUD

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Abstract- In the past century developed technology has an essential role in healthcare industry. Cloud computing is a hot topic today, that is applied not only to many industries but research areas. There are too many advantages of cloud computing such as, easy access, configurable resource with low costs. Researchers are interested in cloud computing with these advantages. Especially, cloud is a good way for medical image databases which are growing day by day. Because management of medical image databases on cloud is easy to store, process, exchange and search with detailed queries. This study shows the advantages, disadvantages and risks about medical imaging on cloud. Consequently, although cloud computing technology has some risks or disadvantages, it is inevitable and inexcusable for healthcare industry.

Keywords- Cloud Computing, E-health, Medical Imaging, Medicine, Internet, Healthcare.

I. INTRODUCTION

In the literature, Cloud computing is defined in many ways, but NIST’s (National Institute of Standards and Technology) definition of cloud computing is the most commonly used and generally accepted. Basically, the phrase “cloud computing” mentions to retrieve of data storage, combining, and retrieval based on the Internet. It offers us to use flexible and mountable computing resources from remote places.[1] The main point of the cloud computing is the large-scale data processing applications. But as time passes, the importance and advantages of cloud computing began to be understood, in this way, the research area of cloud computing is expanded day by day. Today, cloud computing has a worldwide usage and among the sine qua non of our lives. Mail and online storage application (Gmail, google drive etc.) are all cloud computing successful applications. This developing area, of course, has also affected hospital applications and research.

In addition, there are different cloud models as services; Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) as shown in Figure 1.

![Cloud Service Models](image)

The usage of digital medical imaging systems has improved. Medical information, as medical imaging, is important documents recording patient information and health service. Generally, the hospitals have founded computerized medical record systems. These institutions are use PACS (Picture Archiving and Communication System) that has many advantages per traditional systems. With the interaction between cloud computing and medical imaging, a new approach has emerged.[3]

II. BACKGROUND

Cloud, as a hot topic, attracts the attention of researchers. Too much work, research and literature review is done in this area.

- The work in [4] is discussing about the owner of the medical image. This publication is questioning ethical values.
- The work in [5] suggests a platform for secure monitoring and sharing of generic health data in the Cloud. Danan Thilakanathan et al. developed a telecare application that provide doctors to shows to remotely via Cloud.
- The work in [6] presents a review of cloud computing in healthcare. Per Griebel et al. Researchers misunderstand cloud computing, in most cases the “cloud” term is used instead of “virtual machines” or “web-based”. Very few prototypes have been put forward in a real sense.
- The work in [7] is proposed a storing and sharing medical images between different locations or clinics. co-allocation HDFS in cloud is used as a technology in this article. A new application is implemented.
- The work in [8] is a review article that introduce the e-Health Cloud issues generally.
- The work in [9] proposes a new database approach for store and retrieve health data in cloud. Consequently, they have reached more effective database system per Microsoft SQL server.
- The work in [10] 12-lead ECG telemedicine service is developed based on cloud computing. This work presents a new approach per traditional
methods. This study removes the long-distance problem in this field.

- The work in [11] is related with PACS which is used most of the hospitals or clinics. This study applies this technology in cloud computing. They used PACS as a cloud service.
- The work in [12] is discussed about Security and privacy preserving approaches in cloud but using a disaster recovery plan. This work implement a disaster recovery plan and authentication approach in cloud.
- The work in [13] is applied a medical image retrieval in mobile cloud computing environment. This study is applied a medical image sharing and imaging to mobile environment.

As shown in this part of the study, cloud computing in healthcare is a hot topic and attracts the attention of researchers.

**III. CLOUD MEDICAL IMAGING**

If we examine the importance of Cloud computing in health, it is the beginning. It is not only in the sector but the market penetration value is low. However, it is expected that, this condition might alter rapidly soon. According to researches and general trend of industry, cloud computing will be an obligation in the healthcare industry.

Cloud computing is usually applied to medical imaging part of the health industry. This case routes the researches to data management, medical image processing and image sharing issues. [14]

**IV. CLOUD PACS**

This term simply means the standard PACS system that is located to cloud. Sample image stored on PACS can be shown in Figure 2. [15] Developed PACS uses new interfaces that is developed internet based. Cloud PACS provides to connect it location independent, with this approach it presents a new and respectful approach. Cloud PACS has more advantages, the most important one is the powerful workstation necessity.

Traditional PACS uses powerful computers, but the Cloud PACS uses cloud power instead of client power, this provides to reduce the power necessity. All the image rendering operations is done in the cloud. Users can use Cloud PACS with a thin client computers based on internet technologies or basically web technologies without any device dependence.

Consequently, Cloud PACS has three main features; first, location independent visualization, second, more powerful processing resource, the last is browser based application instead of desktop applications. [14]
The last component of PACS is image archive. Moving this component of PACS provides significant benefit. One of the most important benefit is the sharing option. All the records can be sharing anywhere without any location dependency.

V. CLOUD COMPUTING IN EVERY ASPECTS

Cloud computing is more efficient when working with more data sets. The productivity means not only for easy operation with parallel processes but cost-effective manner.

Another main advantage of cloud computing in health industry is accessibility of raw data and power of analysis. On the further side of storage and easy access, the vital component of the cloud is the analysis part. This part of the cloud should support a large query of data.

In this section, some of different aspects of the cloud computing will be defined, these issues are also examined in the literature. [17]

1.1. Data Security and Privacy
All the healthcare information such as medical images contain personal or private information about patients. Therefore, some of the legislations are published related to data security and privacy. One of them and the common one belongs to Health Information Portability and Accountability Act (HIPAA).

[18] HIPAA, a U.S. federal law, enforces a strict rule to every healthcare facilities to comply with this rule. HIPAA simply defines how the information about a patient is protected, collected or accessed. HIPAA contains two main rules package; security rule and privacy rule. All the information is controlled under these rules. Thus, the storing of such a special and important information in cloud is a matter of great concern.

1.2. Service Validity and Reliability
As a crucial mission in healthcare information technology (HIT) must have a high performance, reliability and availability criteria. There is no doubt about importance of system continuity for medical application and cloud must provide continuity also. This can be possible with distributed systems and disaster recovery systems that must be located to geographically distributed data centers.

With the distributed systems, other systems continue to work even if there is an interruption in one system. [19] And disaster recovery systems, steps can be shown in Figure 4, guarantee to information protection. [20] There are some statistics about uptime of systems. It’s monitored that 99.948% of cloud based systems are up or they are down only 273 minutes per year. [21]

1.3. Integration
This concepts basically defines the exchange information between medical facilities, stakeholders. Integration is an indispensable process for medical applications. To help and generate a format, the HCOs have many Standards Development Organizations (SDOs) improved standards. One of the developed standard is Digital Imaging and Communications in Medicine (DICOM).[22] Many manufacturers accepted this standard.

1.4. Data Transfer
Another important issue that influence healthcare facilities necessity is change data between another cloud vendor. To avoid such a situation, it is important to write an agreement which defines termination rights.

VI. ETHICS

Although cloud computing brings a lot of advantages, cloud computing also reveals many ethical problems. These problems are;

- Authorization: Cloud computing is a target because of the important data it holds. So only authorized people can access the data even the authorization process can be managed file dependent.

- Encryption: All the transfer and processes must be done with encryption. In this way, think that an encrypted file is captured by an unauthorized person, it is garbage and useless.

- Agreement: It must be guaranteed by the service or cloud computing provided, that any information cannot be accessible by service provider. And the ownership of data must be defined clearly.

- Data Migration: This problem may come up when the institution wants to change service provider. This issues must be defined in the contract.

- Transfer Data: When a data exchange required over the internet, the new network encryption methods must be used, such as, Secure
Sockets Layer (SSL) or Transport Layer Security (TLS). [23][24] In addition, virtual private networks (VPNs) technology can be used between facilities and the cloud computing. [25]

- Data Protection : Cloud computing uses new storage technologies like Redundant Array of Inexpensive Disks (RAID) [26]

- Logging : There may be system failures or vulnerabilities may occur in cloud computing. This is a natural process in computer systems. But, it is important to record all the information about these kinds of processes. Because it is a crucial operation in computer systems. These logs help to manage systems for system administrators. [27]

CONCLUSIONS
Cloud computing is a new and developing field. In this manner, the advantages or risk must be understood clearly. All the facilities want to use cloud computing should do a strategy study. In addition, using cloud computing in healthcare is inevitable. It’s impossible to ignore advantages of cloud computing in healthcare industry.

Cloud computing services can access to end-users over the internet. These services have effective ways to share, store and process large medical image databases. Likewise, cloud computing provides to reduce the infrastructure and end-user computer expenses.

PACS are also started to run on cloud computing. This operation enables to improve the accessibility and manageability. But there are some risks, such as, security, ethics and privacy. But such risks are decreasing day by day. When cloud computing is evaluated from all aspects, it is a good choice to use cloud based infrastructure and cloud based services for healthcare facilities.

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