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A Survey of Cloud Environment in Medical Images Processing

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Abstract— Cloud computing is one of the challenging technology to process the big data. In developing technologies, advanced software for processing medical images has gained a great interest in modern medicine field. It provides valuable scientific information, and hence, can significantly improve diagnosis and provide advance treatment like tumour detection in various unknown parts of the body like. The main contribution of this study is about the various challenges and need of cloud computing environment in the field of medical images datasets. Recently, various security measures and mechanisms have been suggested to overcome these challenges and accelerate the adoption of cloud computing services in the field of medical images. In this regard, numerous cryptographic techniques are used to safely process digital medical images, techniques that make use of homomorphic cryptosystems, Secret Sharing Schemes (SSS), Service-Oriented Architecture (SOA) and Secure Multi-party Computation (SMC). The main contribution of this study consists of need, important of cloud computing environment in the field of medical image processing.

Keywords— cloud computing, medical images, cloud computing environment.

I. INTRODUCTION

The rapid growth in the use of Electronic Health Records (EHR) across the global increasing level of diagnostic medical imaging means increasing amounts of data storage [8][9].In a such scenario, where a professional view and process medical images remotely for the purpose of constructing a diagnosis it may be necessary to move large data sets across the network for processing [10]. Moving such data sets has the potential to introduce undesirable latency and also causing service level agreement (SLA) violations and degrading network performance for other users of the same infrastructure. With the progressive imaging technologies such as synchrotron based X-Ray microscopy and micro-spectroscopy, and computed tomography, research scientists can directly acquire the images of sub-cellular structures and have a new dynamic view of life. Hence, reconstructing, pre-processing and measuring the large image datasets are in high demand. Medical image study often involves interleaving numerous tools from heterogeneous sources, which brings about the problems of data compatibility, file formats, and interface with multi-processing computing environments.

Cloud Computing has become a new model of computing service delivery as a utility over the Internet. Virtualization technology [11] lying at the heart of the Cloud environment allows leads to greater utilization of physical and virtual resources. Depending on the various resources available physical hosts or nodes on the Cloud can host numerous virtual machines, which in turn can host applications and data. Migrating medical imaging applications and data to the Cloud environment can allow healthcare organizations to realize significant cost savings relating to hardware, software, buildings, power and staff, in addition to greater scalability and higher performance [12][13].

This paper reviews medical image processing and its challenges in cloud computing environment and also states various benefits due to medical image processing in cloud. The rest of the paper is organized as follows: In section II, the related work and motivation of this paper are discussed. Section III describes the need of cloud computing in medical image compression algorithms. The cloud environment tools in medical image are given in the section IV. Finally, Section V draws conclusions and suggests guidelines for future research.

II. RELATED WORKS

Nowadays Medical imaging has become one of the most important methods and techniques for visualization and interpretation of diagnostic in medicine field [1], [3]. Due to the advent of high performance digital computer systems in the past decade, it has witnessed a tremendous development of various advanced modalities and instruments for detecting, storing, transmitting, analysing, and displaying medical images [10]. Nowadays a large volume of medical image data is being generated in hospitals and health care institutions through different modalities, namely, Magnetic Resonance Imaging (MRI), Ultrasound Imaging (US), Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET), Nuclear Medicine (Scintigraphy), Computed Tomography (CT) images, Digital Subtraction Angiography (DSA), Digital Fluorography (DF) and X-ray imaging (Radiography) [10]-[14]. Wearable Internet of Things (IoT) devices, Ubiquitous Sensor Networks (USN) and Body Sensor Networks (BSN) also generate a massive collection of bio signals such as heart-rate, oxygen level, respiration, blood pressure required at low cost [1]-[3].

Biomedical images and bio signals play a major role in modern e-health services and have become an integral part of medical data communication systems [2]. The medical communication system is a technology that allows any type of medical data to be transmitted from the point of healthcare to the desired specialist(s). The data is transmitted securely and rapidly for delivery to mobile devices or computers so that physicians can review the data and provide opinions [2]-[3]. With the increasing use of multimedia technologies and utility computing such as cloud computing, grid computing and cluster computing on the medical domain make the e-health services very successful, viable and inevitable for cost effective delivery to the common men [10]-[14]. E-health services have been trying to utilize these technologies such as teleradiology, teleconsultation, telemedicine, telediagonosis and telematics for better patient care and timely services [1],[2],[12]-[14].

III.NEED OF CLOUD IN MEDICAL IMAGES

Healthcare systems are trying to evolve and benefit from cloud services. This is because information technologies and information-rich services such as medical imaging can be greatly enhanced by use of cloud technologies. Collaboration among medical institutions and hospitals is required for sharing medical data [7], [8] and images. Patient data can be easily stored in virtual archives that are accessible by different healthcare providers, thus facilitating data sharing and significantly reducing local storage requirements. Privacy issues arise from use of cloud systems for confidential personal data. Nevertheless, there are significant advantages in the interpretation of difficult clinical cases when employing cloud computing services. Experts from different medical fields can consult on the diagnosis from around the world. Continuing education and teaching efforts can also be facilitated by the cloud. Teaching files can be accessed by several institutions, and training courses can be co-organized to provide shared access to learning tools such as software, presentations, and medical images of clinical interest. While the number of medical imaging studies is increasing approximately 3%–5% annually, this rate is not a significant driver of growth.

However, the size of medical imaging studies, especially CT and MRI, is growing considerably faster, increasing storage requirements from 10% to 25% annually. Cloud storage prices have been dropping faster than enterprise storage prices, and this trend will likely lead to faster cloud adoption for medical image storage. An important driver of cloud storage is the observation that as CTs and MRI studies increase in size, longer times are required to transfer them to imaging workstations. Rendering imaging studies from the cloud to zero footprint viewing applications provides imaging studies anywhere they are needed. These factors are significant drivers of the move to cloud PACS, including storage.

IV. CLOUD COMPUTING ENVIRONMENT IN MEDICAL IMAGE PROCESSING

Medical image data, which are collected with medical imaging devices, such as X- ray devices, MRI devices, Ultrasound devices, Positron Emission Tomography (PET) devices or CT devices in the diagnostic imaging departments of medical institutions, are used for an image interpretation process called "reading" or "diagnostic reading." After an image interpretation report is generated from the medical image data, the image interpretation report, possibly accompanied by representative images or representations of the examination, are sent to the requesting physicians. Today, these image interpretation reports are usually digitized, stored, managed and distributed in plain text in a Radiology Information System (RIS) with accompanying representative images and the original examination stored in a Picture Archiving Communication System (PACS) which is often integrated with the RIS [2]. Typically, prior to the interpretation or reading, medical images may be processed or rendered using a variety of imaging processing or rendering techniques. Recent developments in multi-detector computed tomography (MDCT) scanners and other scanning modalities provide higher spatial and temporal resolutions than the previous-generation scanners.

Advanced image processing was first performed using computer workstations. However, there are several limitations to a workstation-based advanced image processing system. The hardware and software involved with these systems are expensive, and require complicated and time consuming installations. Because the workstation can only reside in one location, users must physically go to the workstation to use the advanced image processing software and tools. Also, only one person can use the workstation at a time [2].

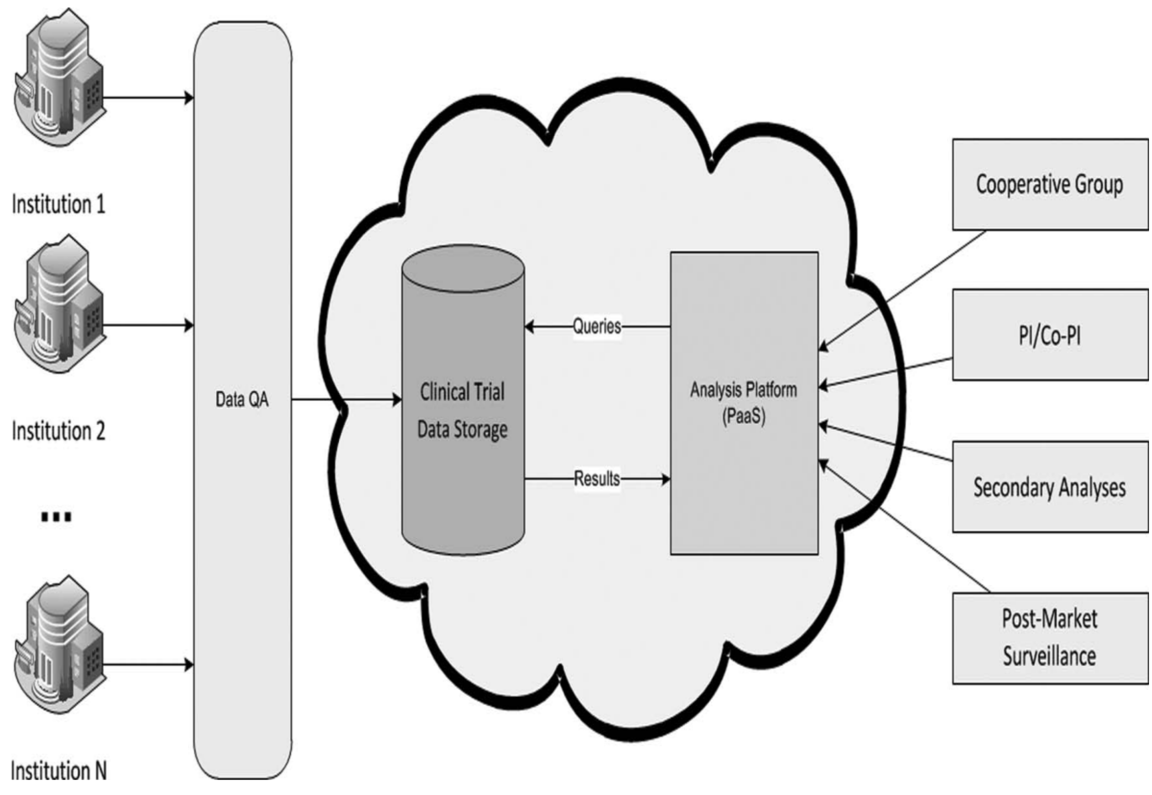

Figure 1: Cloud computing environment in medical imaging

Some have improved on this system by converting the workstation-based advanced image processing system to a client- server-based system. These systems offer some improvements over the workstation-based systems in that a user can use the client remotely, meaning the user does not have to be physically located near the server, but can use his/her laptop or computer elsewhere to use the software and tools for advanced image processing. Also, more than one client can be used with a given server at one time. This means that more than one user can simultaneously and remotely use the software that is installed on one server.

The computational power of the software in a client-server-based system is distributed between the server and the client. In a "thin client" system, the majority of the computational capabilities exist at the server. In a "thick client" system, more of the computational capabilities, and possibly data, exist on the client [2]. The hardware software installation and maintenance costs and complexity of a client-server based system are still drawbacks. Also, there can be limitations on the number of simultaneous users that can be accommodated. Hardware and software must still be installed and maintained. Generally the information technology (IT) department of the centre which purchased the system must be heavily involved, which can strain resources and complicate the installation and maintenance process [2].

V. MEDICAL IMAGE PROCESSING AND ITS CHALLENGES IN CLOUD COMPUTING ENVIRONMENT

One of the challenges facing medical image processing today is the development of benchmarks that allow image processing algorithms to be compared under common measures and standards. The cloud can contribute to such benchmarks by facilitating their creation as well as their widespread availability and use. Such databases combine different datasets necessary for the assessment of image processing algorithms (e.g., in segmentation, denoising, registration, fusion). An important component of these databases is realistic simulated medical image datasets, which usually are a first step in the evaluation of any image processing algorithm. These simulations could model the different components of an acquisition process to produce highly realistic datasets, with the advantage of a known ground truth. However, such simulation datasets are often associated with long execution times and, therefore, their production is largely confined to a few specialized centers. The same concept could be developed for the previously mentioned image reconstruction challenges, with the creation of databases hosting raw datasets of different medical image modalities that would facilitate benchmarking of future reconstruction algorithm.

VI. CLOUD COMPUTING TOOLS FOR MEDICAL IMAGE PROCESSING

Bednarz et al. [16] proposed Cloud Based Image Analysis and Processing Toolbox being carried out by CSIRO, is to run on the Australian National research Collaboration Tools and Resources (NeCTAR) cloud infrastructure and is designed to give access to biomedical image processing and analysis services to Australian researchers via remotely accessible user interfaces. The toolbox is based on software packages and libraries developed over the last 10-15 years by CSIRO scientists and software engineers: (a) HCA-Vision: developed for automating the process of quantifying cell features in microscopy images; (b) MILXView: a 3D medical imaging analysis and visualization platform increasingly popular with researchers and medical specialists working with MRI, PET and other types of medical images and (c) X- TRACT: developed for advanced X-ray image analysis and Computed Tomography. By providing user-friendly access to cloud computing resources and new workflow-based interfaces, our solution will enable the researchers to carry out various challenging image analysis and reconstruction tasks that are currently impossible or impractical due to the limitations of the existing interfaces and the local computer hardware. Several case studies will be presented at the conference.

The NeCTAR [17] research cloud delivers basic compute and storage capabilities as standard services over the network. Servers, storage systems and network resources are pooled and made available to handle workloads ranging from application components to high performance computing applications. The NeCTAR cloud uses the Open Stack cloud operating system which is architected to provide flexibility with no proprietary hardware or software requirements. The Open Stack cloud operating system provides three shared services, Compute, Networking and Storage. The Open Stack Compute provisions and manages large networks of virtual machines; the Open Stack Networking provides pluggable, scalable, API driven network and IP management services; and the Open Stack Storage provides services of object and block storage for use with servers and applications. The Open Stack dashboard provides administrators and users a graphical interface to access, provision and automate cloud based resources [3].

The Java Image Science Toolkit (JIST) addresses key challenges by ensuring module interoperability, providing graphical user interfaces, and batch processing tools. Work is underway to integrate JIST with the SOLAR-Eclipse imaging-genetics package. Medical image processing involving large multi-modal datasets and imaging genetics data require management of huge amount of data and necessitates high-performance computing facilities. JIST allows external algorithms with a CLI to be wrapped as JIST modules and JIST automatically presents a CLI for all native modules [4].

VII.BENEFITS OF MEDICAL IMAGE PROCESSING IN THE CLOUD

Cloud computing provides computation, software, data access, and storage services that do not require end-user knowledge of the physical location and configuration of the system that delivers the services. Cloud computing providers deliver applications via the Internet, which are accessed from Web browsers, desktop and mobile apps, while the business software and data are stored on servers at a remote location. Cloud application services deliver software as a service over the Internet, eliminating the need to install and run the application on the customer's own computers and simplifying maintenance and support [15]. A cloud system also allows for dynamic provisioning. This allows lower costs and removes the need for the individual sites to have to manage the asset. The cloud servers can handle backups and redundancies and security so the users do not have to worry about these issues. The users can have access to all and the newest clinical software without having to install the same.

Tools and software are upgraded (automatically or otherwise) at the servers to the latest versions [16]. A cloud server, also referred to as an image processing server, has the capability of processing one or more medical images to allow multiple participants to view and process the images either independently or in a collaborated manner or conferencing environment. Different participants may participate in different stages of a discussion session or a workflow process of the images. Dependent upon the privileges associated with their roles (e.g., doctors, insurance agents, patients, or third party data analysts or researchers), different participants may be limited to access only a portion of information relating to the images or a subset of the processing tools without compromising the privacy of the patients associated with the images [15]. The browser/client/mobile application standards allow easier integration with an electronic health record. The integration can be done as seamless as possible, so one does not have to open separate applications or repeatedly enter login information. Integration may be based on patient ID, or other common parameter which automatically links different types of records [15].

VIII. CONCLUSION

In this paper, we study about the various related work in the area of image processing in cloud environment also discuss about the need of "cloud computing" environment in the field of image processing and also discuss about the various challenges in medical field using cloud computing tools. The future direction of the work will be to study on various algorithms and methods using to compressed medical images in cloud such as Genetic Algorithms (GAs) and Fuzzy Logics.

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