Distribtud Medical Image Retrieval Techniques: Review

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Abstract **Medical image retrieval is the core process of illness diagnosis and treatment procedure in healthcare area today. The new medical image scanner produces a large number of images with high resolution in 2D and 3D. The main concern in this paper is to clear out that medical image retrieval is one of the hot areas even after long time of its existence, because of the implementation of new technologies such as cloud. The review is based on the platform that used in the medical image retrieval, cloud, distributed system, GRID and peer-to-peer. After covering a number of researches in this area, it is pointed out that cloud computing as a platform is the direction point of researchers in medical image retrieval. Additionally, enhancing the response time of the medical image retrieval is the main issue that has been motivating researchers to provide new techniques and algorithms.**

Keywords— Medical image retrieval, platform, cloud, distributed system, GRID, peer-to-pee, DICOM image

I. INTRODUCTION

Nowadays searching for images in the internet is one of the daily needs for any one especially the researchers. This made the need for retrieving these images is significant tasks to the users [1]. Additionally, the image could be from many sites in the internet and in many different formats and types like personal images, nature images, medical images and this is considered to be one of very important types. Medical image retrieval has got a lot of attention by physicians and researchers, because the image contains information for the diagnosis and treatment of the human diseases.

Image retrieval is the process of finding and retrieving the intended image from site, server, database or any other type of storage. Because of its importance the retrieving of image is considered to be one of fastest and largest growing area especially in the last few years. The researchers are concentrating on searching and retrieving of the digital image by finding the appropriate method for finding and retrieving the images. First they divided the process into two types text based retrieval and content based image retrieval (CBIR). In text based image retrieval, images are retrieving by specifying the keywords or phrase that describe these images or the information that is represented [2]. On the other hand, CBIR is retrieving of the images by specifying the visual description of the image like color or shape [3].

The development in the medical image retrieval systems connected several image databases distributed over multi location in a one system. This mechanism raise many issues, how to search all locations for the intended image and how to integrate these database together to constitute powerful and reliable systems, moreover retrieving medical from distributed location produce the need to enhance the response time because the retrieve of the image must be receive within short time, that is come from the nature of the medical image and the process of diagnosis the illness of the patient to immediately start the treatment. A lot of researches have been proposed many techniques to handle these issues. This paper discusses and reviews the technique implement in the distributed medical image retrievals.

This paper contains five section. Section two will discuss the related work, this followed by a critical review of the techniques in the literature which is classified based on platforms. The paper concluded with a comparative analysis for the proposed DMIR techniques, and highlighted the open issues and the research directions.

II. RELATED WORK

Medical image retrieval is very important branch of healthcare cycle. So the need for enhancing and developing new procedures and techniques for it are hot area for the researchers.

There are many researchers proposed review papers in medical image retrieval. In [4] the author concentrate on reviewing the will known system and techniques of content medical image retrieval that retrieve medical image from giant group or big dataset. Also in [5] the author focus mainly on the applications of content-based medical image retrieval in diagnosis of the right disease in medical image, educational and training , digital libraries and home entertainment. [6] in this review the author review the studies that used the well known mdulity in medical image fields, Infrared image, CT images, MRI images PET images, Ultrasound images X-Ray images and Pahtology. In [7] the author review seven online Content-based medical image retrieval system Figuresearch, BioText, GoldMiner, Yale Image Finder, Yottalook, Image Retrieval for Medical Applications (IRMA) and iMedline, by estimate gap and competence of these system to enhance to find the better way to retrieve bioinformatics. While in [8] the author produce a wide area covering review of content-based medical image retrieval, a comprising between the technique

used to measure the difference between the query image and the result from the search images, and technique for storage of medical images, another area using image retrieval are review beside medical image.

III. USE OF IMAGE RETRIEVAL IN MEDICAL APPLICATIONS :

It is obviously to any one close to the healthcare area that the medical image constitutes a very big and critical part of cycle of the patients illness diagnosis and treatment. And because of it is apparent important, more researchers point their research in this area. So as the number of the researcher increase the more new better way and enhanced techniques provided to the area of medical image retrieval. From the fact that the new technology provide complex and sophisticated enhanced scanner in the last few years[9], large number of medical image produced in hospital and clinic today push the researcher to dig for more superior response time method and technology for retrieving of the medical images.

IV. THE REVIEW OF THE MEDICAL IMAGE RETRIEVAL TECHNIQUES

Medical images when used for the first time in disease diagnosis by doctors, it is process in the same pc's that the image resident on. This scenario is not fitting for large medicine institutions because there are many doctors need to use the same pc to diagnosis their patient's images. And after the revolution of the internet and the rapid development progress of the network technology, the medical image distribution start to be the dominate part for healthcare institutions. There are many techniques used to apply the medical image retrieval in the healthcare institutions today. The study will focus the review to include cloud, grid, peer-to-peer, distribution.

A. Image Retrieval Techniques Using Cloud :

A Cloud is a type of parallel and distributed system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resource(s) based on service level agreements established through negotiation between the service provider and consumers [10].

The author propose cloud base framework to allow the manipulation of huge and different data in healthcare. The image are scanned and send to cloud image storage for compression, and the record send to the metadata with compressed image move to the web image database (mysql) for storage. When the client query an image, the compressed image are send to cloud image storage for decompression then send to client viewer [11].

The author proposed a retrieval system of medical image based on hadoop File System to speed the response time of retrieve of medical image from single node system. First the features of the medical image are extracted and store them on Hadoop File System. Then Map/Reduce algorithm used to find the match image from the HDFS with the example image [12].

The author propose medical image retrieval system called Medical image file accessing system (MIFAS) using hadoop File system on cloud. The huge producing in high quality images create many problems low response time to retrieve because of its large size, it need more space to store, needs more security constraints to access. The Middleware component is used to maintain information about bandwidth and servers load status in the system. This information is used by MIFAS Co-allocation to choose the better way to execute the retrieve works. The Co-allocation is parallel downloading mechanism for the medical images. The Replication location Service will duplicate images to each cloud. However the process of reassemble the parts of the image using co-allocation needs more time, which it may cause delay [13].

The author proposes a cloud based solution for leak of scale in static infrastructures used in hospitals. He provides engine to compress 3D medical images and injecting security watermarks. The images are saved in mysql and CryptDB RDBM. However the process of decompressing the image and decoding the image from the encoding watermark take time to be done which leads to long time to retrieve the medical images. Also there is no duplication of the image in the other nodes. Beside that storing the medical image with large size in mysql [14].

The author proposed cloud based framework to reduce the response time to retrieval the medical image to mobile devices. The author proposes a learning-based adaptive data placement to maximize the query parallelism at the master node. Also content-aware and bandwidth-conscious multi-resolution-based image data replica selection scheme to adaptively perform the data transmission process in a reasonable time are proposed. And a priority-based image block data robust transmission method to progressively reduce the communication cost in the Mc, a devise a learning-based dynamic correlated data caching scheme to improve the efficiency of the query process. However in the content-aware and bandwidth-conscious multi-resolution-based image data replica selection scheme the process of diving the image into two parts: medical useful area (MUA) and the reminder area before sending the image to the mobile device. This consumes time which may lead to delay in the retrievals [15].

The author proposes Medical Image File Accessing System (MIFAS) to allow accessing medical images in store PASCs. The system consists of many layers, the first layer is Web-based System, then MIFAS Middleware and lastly Hadoop Distributed File System. The Middleware have three main components, Information services is used to collect information about load status of the nodes, Co-allocation is used to balance and speed the download using parallel download, finally Replication Location Services are used to duplicate the medical images from one node to anothers .However retrieving the image from Hadoop file system consume time [16].

The author proposes a cloud based PACS archive medical image retrievals. The system is provided to solve the problems of PACS that do not allow sharing or accessing for devices and cloud inside the hospitals. The system supply the hospital two function storages, query/retrivel of DIOCM images. The

proposed solution made of three components Master Index, Cloud Slaves and Gateway. The Master Index provides patients study important information. The Cloud Slave is a cloud provides two services, blobstore and database. The blobstore is used as storage for encrypted DICOM image and databases are used to store information extracted from DICOM images. The Cloud Gateway is used as interface between the hospitals DICOM image generators and the Cloud. The DICOM image is divided into parts and each part is encrypted with AES (Advanced Encryption Standard) algorithm before being sent to the slave repository blobstore. However dividing the DICOM images into parts and encryption of each parts of the image needs more time to decrypted and the process of assembling the parts of the image take time [17].

In this paper the authors propose a distributed multi-agent system to enhance response time for retrieval of large image collections. The system contains three cloud agents: Cloud Computing Service Access Point Agents is providing methods to storing, processing and querying the images. The second one is Resource Index Agent, where used to store information about working agents like location, current load, estimation function for performance prediction and image processing status. The last one is the Working Agents that contain the implementation of the methods called from Computing Service Access Point Agents like extracting image low-level and semantic features, storing images and its information and retrieval of the images. However the parts resulted from dividing the image into parts are not duplicated in all agents. Beside that the retrieval of the parts of the intended image will take time and reassembly of the parts to compose the original image also consumes time [18].

The author provides a cloud based solution called Cloud Image Data Center (CIDC) to improve information sharing among Hospitals. The system allows synchronous and asynchronous consultation between these hospitals for quick and secure access. The system contains Hospital Information system part, Medical Order Transferring Server, Short-Term Image Database 1, Short-Term Image Database 2, Worklist Server these workflow servers represent storing image flowchart. And Long-Term Image Database 1, Long-Term Image Database 2, Image Routing Server, EMR Server, EMR Exchange Center Gateway these servers represent retrieval image flowchart [19].

The author develop A cloud based DICOM-compliant bridge for extending and sharing DICOM services across healthcare institutions to solve PACS communication and data exchange issues between separated healthcare institutions. The two main services implemented by this solution are Storage and Query/Retrieve. The solution contains two components, DICOM Bridge Router and DICOM Cloud Router. The DICOM Cloud Router is responsible of providing DICOM services and routing the messages to the specified destination depending on AETitle. On the other hand DICOM Bridge Router is used as switching point between DICOM Cloud Routers, DICOM Bridge Router store routing tables, AETitles, accounts information from routers and users from cloud that routers use to store information. Medical images and DICOM messages are transmitted through the cloud services in a ciphered way. However the creation of encryption channel between the institutions makes overhead of the data that had been transmitted by adding more overloaded data. Also the author did not provide any duplication of medical images in clouds. Beside the distribution of the routing table periodically make load over head in connection [20].

In this paper the author proposed a medical image archive solution in cloud using Windows Azure cloud and SQL Azure to enhance the delay of retrieving the DICOM medical images in single DICOM Server Architectures in hospitals using PACS Systems. The solution is used to save all hospital data include DICOM image in SQL azure. However the author do not provide any technique to distribute the retrieving of the DICOM images to many clouds [21].

B. Image Retrieval Techniques Using Grid :

A Grid is a type of parallel and distributed system that enables the sharing, selection, and aggregation of geographically distributed 'autonomous' resources dynamically at runtime depending on their availability, capability, performance, cost, and users' quality-of-service requirements [22].

The author proposed GRID platform. The data abstraction architecture is done using Open Grid Services Architecture Data Access and Integration. The platform offers service to retrieve and swap DICOM medical images. The platform is composed of two main components, one master node and the other nodes are considered as contribution nodes, the master node is responsible of offering supervision the database of the platform and maintain the security of the users. For accessing the platform, the users are offered certificate and justification to use the system. However, storing the security information for accessing the system and managing the databases from master node slows down the process of retrieving the image; because the information for the user rights to retrieve the images in are stored in one node. Beside using the certificate with certificate authority server slows the response time for retrieving the images [23].

The author proposed PACS System based on the co-allocation data grid environment to enhance the query response time for huge queries and file retrievals. The proposed system consists of three main components, Information services, a broker/co-allocator and local storage systems. First the user uses the application to specify the characteristics of the data and sends it to the broker. The broker searches for available resources then gets replica location from the information service and gets replica Management service from information service to retrieve lists of physical file locations. However the process of setup a User Certificate, Private Key, Certificate Authority (CA) file slows down the process of retrieving the medical images. Also the process of combining the segments of the image take time [24].

The author proposed a distributed file system with hieratical metadata server to solve low fault tolerance when storing DICOM image file information in single server. The author separate DICOM image to metadata and image data into two servers, the metadata is stored on file information server called metadata server and image data is stored in data server. The

proposed system composed of Cooperation Server, institution metadata server and institution medical data server for each institution. The Cooperation Server store all the institutions metadata information, institution metadata server stores only the institution metadata information and medical data store only institution medical data information. However the author do not provide any duplication of the images [25].

The author proposed grid system using hadoop to solve time consuming to retrieve large number of images. The proposed system consists of one node act as Name node and data node. HDFS (Hadoop framework file system) is used to store image data. However there is no duplication of the images. The retrieval for large number of images will make load on the node leading to more time for processing each image for retrieve [26].

C. Image Retrieval Techniques Using Peer-to-peer :

Peer-to-peer computing takes advantage of existing desktop computing power and networking connectivity, allowing off-the-shelf machines to leverage their collective power beyond the sum of their parts. In a peer-to-peer system, peers (a blend of clients and servers) share computer resources and services by direct exchange [27].

The author proposed peer-to-peer PACS platform and indexing and retrieving framework solution to allow sharing metadata information between distributed DICOM resource; because PACS is not allow sharing or remote accessing of DICOM images by default. The proposed solution has two components, the first one is DICOM storage services (scp) is used to store DICOM image into PACS storage received from the modality. The second component is monitoring services depending on file system monitoring and document indexing services is used to monitor if file creation or deletion are occur. However the author did not provide any duplication of the DICOM image, also the searching in indexing metadata for large number of records consume more time where it lead to consume more time to retrieving the DICOM images [28].

In this paper, the author proposed distributed peer-to-peer content-based medical image retrieval system to reduce large data transfer when searching images in peer-to-peer systems. In the solution a distribution of low resolution feature vector of the image is distributed and use hash function to match feature of the searched image with the vectors stored in the databases. However the process of constructing the original image from the low resolution feature vector of the image consumes time, which will lead to long time for the overall process of retrieving the image. Using simulator will not give result as real network [29].

D. Image Retrieval Techniques Using Distributed system :

A working definition of a distributed data processing system adheres to the claim that "new" system designs will be required to achieve a major portion of the benefits cited in the table. Therefore what is presented might be considered the "research and development" definition of distributed data processing systems. This definition has five components [30]:

* A multiplicity of general-purpose resource components, including both physical and logical resources, that can be assigned to specific tasks on a dynamic basis. Homogeneity of physical resources is not essential.

* A physical distribution of these physical and logical components of the system interacting through a communication network. (A network uses a two-party cooperative protocol to control the transfers of information.)

* A high-level operating system that unifies and integrates the control of the distributed components. Individual processors each have their own local operating system, and these may be unique.

* System transparency, permitting services to be requested by name only. The server does not have to be identified.

* Cooperative autonomy, characterizing the operation and interaction of both' physical and logical resources.

The author proposed a distributed PACS called DIPACS to allow the access of patient medical image on the other health centers. The PACS servers of the center are connected to server called DIPACS gateway server, the DIPACS gateway server is connected to the internet to allow the DIPACS gateway server resident on the other centers to search for patient images. Nameserver are used to provide the DIPACS gateway servers with information of the other DIPACS gateway server in the systems. However the author do not provide duplication of the patient images in the other DIPACS. Besides Nameserver will represent point of failure because if the DIPACS gateway will not find the other DIPACS gateway [31].

The author proposed a distributed web-based system for retrieval of DICOM medical image, the system is provide to solve the problems that PACS which are the standard system in hospitals are that PACS are not allowing sharing DICOM and accessing image from devices out of the PACS systems. The system composed of components DICOM image indexing for retrieve and manage the DICOM images, interactive medical image transmission scheme to speed the retrieval of high definition image slice. However the process of decoding the tile parts from DICOM to PNG before send it to the browser take time which slow down the retrieve of the whole image, there is no load balance [32].

The author proposes a distributed architecture for sharing DICOM medical images. The system solving the problem of limiting sharing and accessing images only to the PACS system devices in the PACS system. The system composed of three components: INVOLVE2 viewer is used to display image in web using client-server solution. Secondly the preprocessor and are used for compressing and converting the DICOM image into TIFF and JPEG format. The last are Mobile access and it is used to allow the viewer to run on mobile devices. However the process of compressing and converting the DICOM image consumes time and decrease the quality of the medical image. Besides the author do not provide any security for the systems [33].

The author provided a de-identification web-based distributed system called RadTransceiver of DICOM images for inside

and outside distribution. The system is proposed to solve the transfer of the DICOM image that contains critical information about the patients and the institutions for test or research. The system provides three pipeline services for transferring DICOM image, first transfer without de-identifying for inside institution, second transfer with de-identifying to outside and transfer with de-identifying for export. However the processing of de-identifying the image take time [34].

In this study the author present analysis study and comparison between RDMS and HDF5 distributed file system for replication and retrieval of DICOM image. The author proposed a cluster of four machines, one of the machines will be the master node to reserve the medical images and large medical files and metadata and only the metadata in the other nodes. However storing all large DICOM medical images and files in single server will slowdown the retrieval time. Besides there is no load balance in the master node [35].

The author proposed a data model called Medical Image Annotation Model (MIAM) to describe and annotate a collaborative Medical DICOM images between hospitals, and proposed a method for distribution of medical image from a web server to web browser. The system contains three servers Medical Image Rendering Server, Medical Image Annotation Server and Instant Messenger Server. The Medical Image Rendering Server is used to rendering image from DICOM format to be displayed to web browser image format (JPEG, BMP), Medical Image Annotation Server is used to store and retrieve annotation to medical image into repository, Instant Messenger Server is used to provide audio and video chat services to clients. However the process of rendering the DICOM image to format appropriate to display in web browser consume time [36].

The authors develop a Java-based distributed medical informatics (DMI) framework to be used for multimedia data exchange. The developed system contain three tiers, at first tier there is client applications and in the second tier there is java ORB used as middle agent that provides access to the third tier medical imaging data query server and database to first tier. The first tier client application is java application used to display medical image in DICOM formats. The second tier java ORB is used to transfer medical images. And the third tier the server is containing algorithms used for executing query and send response back to the clients. However, the author do not provide any duplication of the images, beside that there is no duplication or load balance provided [37].

The authors proposed a web pages system for HRIs (high resolution images) lossless sharing and e-whiteboard to solve rapid access lossless medical high resolution images (HRIs) between different networks. The system composed of four components: first HRIs access layer, in this layer the image is split into multi-resolution hierarchical layers by 4x ratio and each resolution are segmented into tiles, format conversion layer: this layer used to convert the tiles from DICOM to web compatible displayed format, business logic layer: this layer is used for browsing and annotation of the medical images. Finally web-user-interface layer is to providing the user with interface that interact with to modifying or displaying the medical images. However the system required more bandwidth for sending xml file for storing the metadata. The author did not provide any replication of the image and he did not provide load balance for the image to speed up the retrieval process [38].

The author in this paper proposed (BIMM) Biomedical Image Metadata Manager to manage biomedical image metadata, retrieve similar image from PACS using semantic feature metadata. The image semantic metadata is annotated by radiologist and is sent to controller. The controller sends the metadata to the models for storing in sql server. The web browser is used to query metadata and retrieve the image from the PACS. However, the author do not provide any duplication of the DICOM images, Storing DICOM medical image in mysql database may slow down the retrieval process because DICOM image could be very large size [39].

V. Discussion

The paper reviews medical image retrieval techniques in distributed systems. A review is done for platform, modulity of the image, dataset of the image, the problem, medical image file type, retrieval techniques, the existence of duplication of the medical image, the storage area is used to maintain the medical image, if the load balance is used in the system and if extracting of metadata of the medical image is done.

Table 1 describes a summary for 26 papers in the medical image retrieval. The authors are focusing on the platform, year, dataset, modulity, problem, image file type, the retrieval technique used. Also check if the technique implement duplication of the medical image retrieval or not and where the medical image file store. Beside that a check for if the technique implement load balance of the retrieval of the image and metadata are used in the technique. A percentage estimations where calculated to highlight the direction of the research in medical image retrieval filed for the coming few years. From Table1, 42% of papers used cloud computing while distributed computing used in 34% of the papers, GRID computing and peer-to-peer used in 15% & 7% consequently. MRI and CT modality are the predominant medical image file types used in hospitals and clinics. 53% of the studies use small dataset for testing the performance of the retrieval techniques. Also response time is the major problem that has been handled by decreasing the retrieval time, accessing and security are also considered as problems for medical image retrieval. Because of the revolution in the scanner technology used in producing medical image, most of the produced image is DICOM image. The retrieval techniques are considered to be the most important part of retrieving the medical images, duplication is not implement in most papers because it represent overhead for the technique. Load balance and metadata where used in techniques but in few of them because 42% of papers propose a technique that retrieve the medical image from the cloud in the internet where they have no control of the speed of the internet, for the metadata and because 53% of the paper use small dataset the issue that arise from retrieving and query from a large metadata form big dataset of DICOM medical image does not appear clearly.

Table 1:Review of medical image retrieval techniques :

No	Platform	Year	Modulity	Dataset	Problem	Image file	Retrieval Technique	Duplication of the Image	Storage File System	Using Load Balance	Using Metadata
[11]	cloud	2014	-N/A	-N/A	Response time	DICOM	Compressing the image.	NO	mysql	NO	NO
[12]	cloud	2014	CT , MRI X-ray	large	Response time	-N/A	HDFS, Map/Reduce.	Yes	HDFS	Yes	NO
[13]	cloud	2015	CR, CT	small	Response time	DICOM	MIFAS	yes	HDFS	yes	Yes
[14]	cloud	2015	MR,CT	small	scalability	DICOM	Compressing the image.	no	mysql and CryptDB	No	No
[31]	Distributed	2011	-N/A	small	Accessing	DICOM	DIPACS	-N/A	PACS	-N/A	-N/A
[15]	cloud	2014	X-Ray, CT,MRI	small	Response time	DICOM	MIRC	-N/A	-N/A	-N/A	-N/A
[24]	GRID	2010	X-Ray, CT	small	Response time	DICOM	MIFAS	Yes	GRID	Yes	Yes
[16]	Cloud	2010	CR,CT	small	Accessing	DICOM	MIFAS	Yes	HDFS	Yes	-N/A
[32]	Distributed	2014	DR,CT	large	Accessing system.	DICOM	MIAPS	Yes	HDFS	-N/A	Yes
[33]	Distributed	2013	PET,CT	-N/A	Accessing.	DICOM	INVOLVE2	-N/A	PACS	-N/A	Yes
[34]	Distributed	2015	MR,CT	large	Privacy	DICOM	RadTransceiver	-N/A	SQL Server	-N/A	-N/A
[17]	Cloud	2011	XA,MRI, CT,NM	small	Accessing	DICOM	Store, query/ retrieve	Yes	Cloud	-N/A	Yes
[35]	Distributed	2011	EKG, MRI,CT	small	Response time	DICOM	RCTM	-N/A	RDMS,HDFS	-N/A	Yes
[18]	Cloud	2011	-N/A	small	Response time	DICOM	Distributed Multi-agents	-N/A	Cloud	Yes	-N/A
[19]	Cloud	2016	MG,MRI,CT	-N/A	Computing power	DICOM	CIDC	Yes	Cloud	-N/A	-N/A
[36]	Distributed	2012	CT	-N/A	accessing	DICOM,JPEG, BMP,PNG	MIAM	-N/A	-N/A	-N/A	-N/A
[20]	Cloud	2013	NM, MR, CT/PET, XA	Small	accessing	DICOM	Storage and Query/Retrieve.	-N/A	PACS	-N/A	-N/A
[37]	Distributed	2009	-N/A	-N/A	Integration PACs	DICOM	distributed medical informatics	-N/A	IBM DB2	-N/A	-N/A
[25]	GRID	2012	MRI	Small	Response time	DICOM	distributed file system with hieratical metadata	-N/A	Grid	-N/A	Yes
[38]	Distributed	2015	-N/A	-N/A	Response time	DICOM file, PNG, JPEG	URPS, FCE, XML behavior relationship storage structure	-N/A	Windows Server 2008 file system	-N/A	-N/A
[26]	GRID	2014	-N/A	Small	Response time	DICOM	Storage and Query/Retrieve.	-N/A	HDFS	-N/A	-N/A
[21]	Cloud	2012	-N/A	-N/A	Response time	DICOM	Storage and Query/Retrieve.	Yes	SQL Azure	-N/A	-N/A
[28]	Peer-to-Peer	2009	XA, US , CT.	Large	accessing	DICOM	Index, retrieve.	-N/A	OS file system.	-N/A	-N/A
[29]	Peer-to-Peer	2010	fMRI	Small	Large data transfer.	DICOM	Search, retrieve.	-N/A	OS file system.	Yes	-N/A
[39]	Distributed	2011	CT	Small	Managing	DICOM	BIMM	-N/A	MySQL	-N/A	-N/A
[23]	GRID	2011	X-ray, , CT , MRI	Large	Accessing and integration	DICOM	mantisGRID	NO	OS file system.	-N/A	Yes

VI. Conclusion

It was conclude that even after long time and a large number of researches medical image retrieval are still hot research area and attracted more researchers. Also the review pointed out that the direction of the distributed medical image retrieval are cloud computing.

References

1. Khan, S.M.H., A. Hussain, and I.F.T. Alshaikhli. *Comparative study on content-based image retrieval (CBIR)*. in *Advanced Computer Science Applications and Technologies (ACSAT), 2012 International Conference on*. 2012. IEEE.
2. Murthy, V., et al., *Content based image retrieval using Hierarchical and K-means clustering techniques.* International Journal of Engineering Science and Technology, 2010. **2**(3): p. 209-212.
3. Lehmann, T.M., et al., *Content-based image retrieval in medical applications.* Methods of information in medicine, 2004. **43**(4): p. 354-361.
4. Malviya, M.N., N. Choudhary, and M.K. Jain, *Review on Content Based Medical Image Retrieval System and Techniques.*
5. Solio, M.A.A. and S.A. Ladhake, *A Review of Query Image in Content Based Image Retrieval.* International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), 2013. **2**(4): p. pp: 1619-1622.
6. Sanghavi, J., K. Bhoyar, and U. Gawande, *Review of content based image retrieval systems of medical domain.* Advances in Medical Informatics, 2012. **2**(1): p. 22-24.
7. Ghosh, P., et al. *Review of medical image retrieval systems and future directions*. in *Computer-Based Medical Systems (CBMS), 2011 24th International Symposium on*. 2011. IEEE.
8. Müller, H., et al., *A review of content-based image retrieval systems in medical applications—clinical benefits and future directions.* International journal of medical informatics, 2004. **73**(1): p. 1-23.
9. Boni, E., et al., *ULA-OP 256: A 256-channel open scanner for development and real-time implementation of new ultrasound methods.* IEEE transactions on ultrasonics, ferroelectrics, and frequency control, 2016. **63**(10): p. 1488-1495.
10. Buyya, R., et al., *Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility.* Future Generation computer systems, 2009. **25**(6): p. 599-616.
11. Arka, I.H. and K. Chellappan, *Collaborative compressed I-cloud medical image storage with decompress viewer.* Procedia Computer Science, 2014. **42**: p. 114-121.
12. Yao, Q.-A., et al., *Massive medical images retrieval system based on Hadoop.* Journal of Multimedia, 2014. **9**(2): p. 216-222.
13. Yang, C.-T., et al., *Accessing medical image file with co-allocation HDFS in cloud.* Future Generation Computer Systems, 2015. **43**: p. 61-73.
14. Castiglione, A., et al., *Cloud-based adaptive compression and secure management services for 3D healthcare data.* Future Generation Computer Systems, 2015. **43**: p. 120-134.
15. Zhuang, Y., et al., *Efficient and robust large medical image retrieval in mobile cloud computing environment.* Information Sciences, 2014. **263**: p. 60-86.
16. Yang, C.-T., et al. *Implementation of a medical image file accessing system on cloud computing*. in *Computational Science and Engineering (CSE), 2010 IEEE 13th International Conference on*. 2010. IEEE.
17. Silva, L.A.B., C. Costa, and J.L. Oliveira, *A PACS archive architecture supported on cloud services.* International journal of computer assisted radiology and surgery, 2012. **7**(3): p. 349-358.
18. Alonso-Calvo, R., et al., *Cloud computing service for managing large medical image data-sets using balanced collaborative agents.* Advances on Practical Applications of Agents and Multiagent Systems, 2011: p. 265-270.
19. Weng, S.-J., et al., *Cloud image data center for healthcare network in Taiwan.* Journal of medical systems, 2016. **40**(4): p. 89.
20. Silva, L.A.B., C. Costa, and J.L. Oliveira, *DICOM relay over the cloud.* International journal of computer assisted radiology and surgery, 2013. **8**(3): p. 323-333.
21. Umamakeswari, A., N. Vijayalakshmi, and T. Renugadevi, *Storage and retrieval of medical Images using Cloud Computing.* Journal of Artificial Intelligence, 2012. **5**(4): p. 207-213.
22. Buyya, R., *High Performance Cluster Computing: Architectures and Systems, Volume I.* Prentice Hall, Upper SaddleRiver, NJ, USA, 1999. **1**: p. 999.
23. Ruiz, M.G., et al., *mantisGRID: A grid platform for DICOM medical images management in Colombia and Latin America.* Journal of digital imaging, 2011. **24**(2): p. 271-283.
24. Yang, C.-T., C.-H. Chen, and M.-F. Yang, *Implementation of a medical image file accessing system in co-allocation data grids.* Future Generation Computer Systems, 2010. **26**(8): p. 1127-1140.
25. Hiroyasu, T., et al. *Distributed PACS using distributed file system with hierarchical meta data servers*. in *Engineering in Medicine and Biology Society (EMBC), 2012 Annual International Conference of the IEEE*. 2012. IEEE.
26. Grace, R.K., R. Manimegalai, and S.S. Kumar. *Medical image retrieval system in grid using Hadoop framework*. in *Computational Science and*

Computational Intelligence (CSCI), 2014 International Conference on. 2014. IEEE.
27. Albrecht, K., R. Arnold, and R. Wattenhofer, *Clippee: A large-scale client/peer system.* 2003.
28. Costa, C., et al., *Indexing and retrieving DICOM data in disperse and unstructured archives.* International journal of computer assisted radiology and surgery, 2009. **4**(1): p. 71-77.
29. Charisi, A. and V. Megalooikonomou. *Content-based medical image retrieval in peer-to-peer systems*. in *Proceedings of the 1st ACM International Health Informatics Symposium*. 2010. ACM.
30. Enslow, P.H., *What is a" distributed" data processing system?* Computer, 1978. **11**(1): p. 13-21.
31. Onbay, T.U. and A. Kantarcı, *Design and implementation of a distributed teleradiaography system: DIPACS.* Computer methods and programs in biomedicine, 2011. **104**(2): p. 235-242.
32. Shen, H., et al., *MIAPS: A web-based system for remotely accessing and presenting medical images.* Computer methods and programs in biomedicine, 2014. **113**(1): p. 266-283.
33. Constantinescu, L., et al., *A patient-centric distribution architecture for medical image sharing.* Health information science and systems, 2013. **1**(1): p. 3.
34. Aryanto, K., et al., *A web-based institutional DICOM distribution system with the integration of the Clinical Trial Processor (CTP).* Journal of medical systems, 2015. **39**(5): p. 45.
35. Santos, E.A., et al. *An analysis of replication and retrieval of medical image data using a database management system and a distributed file system*. in *Computers and Communications (ISCC), 2013 IEEE Symposium on*. 2013. IEEE.
36. Shen, H., et al. *Collaborative annotation of medical images via web browser for teleradiology*. in *Computerized Healthcare (ICCH), 2012 International Conference on*. 2012. IEEE.
37. Noor, A.M. and M. Saman, *Distributed java based medical imaging informatics model.* environments, 2009. **1**: p. 2.
38. Qiao, L., et al., *Medical high-resolution image sharing and electronic whiteboard system: A pure-web-based system for accessing and discussing lossless original images in telemedicine.* Computer methods and programs in biomedicine, 2015. **121**(2): p. 77-91.
39. Korenblum, D., et al., *Managing biomedical image metadata for search and retrieval of similar images.* Journal of digital imaging, 2011. **24**(4): p. 739-748.