COLLABORATIVE COMPUTER AID DIAGNOSIS FRAMEWORK IN CLOUD ENVIRONMENT BASED ON MULTI AGENTS SYSTEMS

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ABSTRACT
The Aim of this paper is to provide and address a solutions for the problems of the low accurate decision, low availability especially in maintains procedures and the scalability in online Computer Aided Diagnosis (CAD). Most CADs became available online and provide a high importance medical services which develop the health of the human beings. CADs are to increase the detection of disease by reducing the false negative rate due to observational oversights. The online CADs faces three major problems: first, The CADs cannot diagnose some diseases because the symptoms of these diseases not available in the knowledge bases of this systems. The Second problem is the availability of CADs is depends on the web server which hosted them. Web server may possible to stop for maintenance that will implies to stop the CADs systems. Third problem is the scalability related with the cost if their admins want to expand them to cover more medical problems. In this paper we proposed a new framework to solve the above problems. Our framework is composed of Multi Agents System to work on the environment of the cloud computing. The framework consists from three Sections: SaaS Components, PaaS Components and IaaS Components. Each section has its own algorithms and procedures. To evaluate the framework we did survey included 150 persons from medical health sector, students, specialists, physicians and other. The results pointed to good ratio of acceptance from the users and the above problems is already solved.

KEYWORDS: *Collaborative Computer Aided Diagnosis, Cloud Computing, Multi-Agent Systems.*

I. INTRODUCTION

Nowadays, computer technology is the one thing that brings all humans together and makes of the world a numerical and international village, where information and services offered on the internet goes beyond the ability of the human being to analyze it and interpret it in an efficient way, in order to make use of it in a particular domain. For example, computer technology has had a tremendous impact on medical imaging. However, in this particular domain where information plays a critical role, the interpretation of medical images needs efficient technology, where doctors can use this technology in order to give efficient diagnosis about a particular patient's file and hence give appropriate treatment. This research area is called Computer-Aided Diagnosis (CAD)[1]. In fact, CAD is a procedure in medical science that supports doctors' interpretations and findings, where imaging techniques in X-ray diagnostics yield a great deal of information that the radiologist has to analyze and evaluate comprehensively and in a short time. The process of a diagnosis often needs more than a point of view of one doctor, especially with cases that needs special treatment, and hence joining different doctors by using technology in order to achieve a common and complete diagnosis becomes very important and definitely more accurate. In artificial intelligence research, agent-based systems technology has been hailed as a new paradigm for conceptualizing, designing, and implementing software systems. Agents

are sophisticated computer programs that act autonomously on behalf of their users, across open and distributed environments, to solve a growing number of complex problems. Increasingly, however, applications require multiple agents that can work together. A multi-agent system (MAS) is a loosely coupled network of software agents that interact to solve problems that are beyond the individual capacities or knowledge of each problem solver. Advantages of a Multi-Agent Approach an MAS has the following advantages over a single agent or centralized approach: An MAS distributes computational resources and capabilities across a network of interconnected agents. Whereas a centralized system may be plagued by resource limitations, performance bottlenecks, or critical failures, an MAS is decentralized and thus does not suffer from the "single point of failure" problem associated with centralized systems [2]. An MAS allows for the interconnection and interoperation of multiple existing legacy systems. By building an agent wrapper around such systems, they can be incorporated into an agent society. An MAS models problems in terms of autonomous interacting component-agents, which is proving to be a more natural way of representing task allocation, team planning, user preferences, open environments, and so on. An MAS efficiently retrieves, filters, and globally coordinates information from sources that are spatially distributed. An MAS provides solutions in situations where expertise is spatially and temporally distributed. An MAS enhances overall system performance, specifically along the dimensions of computational efficiency, reliability, extensibility, robustness, maintainability, responsiveness, flexibility, and reuse [3]. Cloud computing is a set of virtual servers that work together through the Internet and can be dynamically managed, monitored, and maintained. Users are expected to develop their own virtual images or use existing ones as an executable environment on the cloud. Using virtual machines (VMs) that can be configured before deployment has the potential to reduce inefficient resource allocation and excess overhead. A VM can create an environment on a resource that is configured independently from that resource, allowing multiple such environments to be deployed on the same resource at the same time. In this manner of separation, each environment is kept secure from any others. Because sharing can be much more flexible, this also can also increase resource utilization[4].The cloud generally can be categorized into three different layers based on the service they provide: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS)[5]. Similar to the seven layers of the open systems interconnect(OSI) model in networking, each layer of the cloud computing model is conceptually related to the previous layers. IaaS, which is also referred to as hardware as a service(HaaS), provisions hardware, storage, virtual machines, servers, and networking components; it connects all of the resources to deliver software applications. Therefore, the IaaS service provider is responsible for hosting, configuring, and maintaining the equipment. IaaS customers can create or remove virtual machines and network them instead of purchasing servers or hosted services. Customers are charged according to the consumed resources. Amazon EC2 (Elastic Compute Cloud)[6] and Amazon S3 (Simple Storage Service)[7] are two examples of IaaS vendors. Platform as a service delivers a computing platform and solution stack as a service. PaaS ensures providers that different environments Get resources (hardware, operating systems, storage, and network capacity) properly. PaaS basically provisions a means to rent different resources over the internet. Customers who pay for platform services do not need to manage an operating system. They just create their own applications within a programming language that is hosted by the platform services. Google's App Engine[8] is an example of PaaS by which clients can build web applications and deploy them on Google servers. Software as a service provides on-demand applications over the Internet by employing multitenant architecture and complex caching mechanisms. These applications may include email, customer relationship management (CRM)[9], and other office productivity applications. Some types of services like email are provided to customers for free, while enterprise services have to pay monthly or by usage. For instance, Sales-force[10] is an industry leader that provides CRM services. In this paper, we propose a collaborative CAD domain, and that is based on Cloud Computing and Multi agents system while specifically tackling the problems of couldn't diagnosis some cases, availability and scalability of CAD systems by offering means to dynamically integrate new functionalities implemented as cloud services, in order to achieve a proper and collaborative diagnostic by the use of cloud and agents technology[11]. This paper has been divided into nine sections. Section **II** defines the cloud computing and MAS and describes how the cloud environment provide facilities to MAS. Section **III** addresses the related works. Section **IV** deals with the motivations and importance of this paper. Section V begins by laying out the design of the framework and shows the algorithms. Section **VI** explore the implementation of the research with

Message Control Diagram, Section **VII** describes the results synthesis, characterization and evaluation of the proposed framework. Our future works and development will show on section **VII**. The last section assesses the conclusion.

II. MAS IN CLOUD ENVIRONMENT

Cloud infrastructures can offer an ideal platform where run MAS-based systems simulations, applications and real-time running because of its large amount of processing and memory resources that can be dynamically configured for executing large agent-based software at unprecedented scale. Agents implemented in cloud systems can adapt to available virtual machines by using the basic properties of agents such as autonomy, pro-activity, negotiation and learning. Since "Clouds" are elastic, they can expand and shrink based on demand of users or applications. This property is very useful for the scalable execution of the MAS applications and simulation that are able to adapt to the available resources. In summary, agent can find in cloud computing infrastructures the appropriate platform where to run and access large data. However, a major problems with this kind of medical diagnosis application which deployed and hosted by cloud computing are the need of new knowledge and data in order to get more accuracy in diagnosis decision, Because these systems are specific with space storage in the case of increase should increase the cost of storage, so they be unable to be storing all new sources in their cloud storage. In addition these systems needs to search periodically from time to time on new data sources and that will cost them increase in the use of processors and does and increasing in the cost and not guarantee a totally get to know new source[12].

III. RELATED WORKS

Collaborative Computer Aided Diagnosis systems has other names like telemedicine [13] which is a way to provide health care services at a distance that is being leveraged by the evolution of informatics and telecommunications. Because the rapid advance of Information and Communication Technology (ICT) and low of its cost, the telemedicine scenario is being widely addressed [14-16]by many health care service providers. So, many works have been done and we will show some of them in this section. Availability of data are very important in the telemedicine system to increase powerful and beneficial of the whole system[17]. In [18]authors analyzing benefit from using a new cloud computing model to improve medical care Systems. They carried on a cloud PACS, where he was promoted flexibility and ductility, and the provision of universal access to information anywhere, at any time, and increase data availability. The system uses the concept of "PACS as-a-service" and the authors say that it is possible to achieve interoperability with the device through DICOM PACS Cloud Gateway. Along with problems related to access to information, availability, interoperability, structure suggested also have some fears with security problems. All data is encrypted and stored on the cloud furthermore keys are stored which are used to cipher data provider mutual or at home, so the cloud providers are not able to decrypt the files. In[19], was created a system called MIFAS (medical images to access file system) focuses on solving the problem of medical information, stored and shared between different hospitals. It was used a cloud-based structure, where they are using Apache Hadoop and cooperation mechanism to implement the allocation of Distributed File System. System in [20]created synchronous collaboration mechanisms among the medical staff, improving telemedicine services and real time collaboration. If we go to the systems that used the cloud and agents in [21] the authors use the multi agent system technology to support the home-care monitoring and treatment of patients. [22] presents an architecture based on multi-agent systems technology that takes advantage of the adoption of established standards for the management of clinical documents. Its show how MAS features can improve Health Information Systems (HIS) in terms of interoperability, reliability, modularity and robustness; and how health professionals and thus citizens could benefit from this efficient distributed system.

IV. MOTIVATIONS

In this paper, the authors addresses one of the current healthcare problems that developing countries face, which is the lack of electronic collaboration between healthcare practices and institutions, and lack

of availability of expert physicians in particular areas. Some of the countries are geographically large and the villages are widely scattered in remote rural areas while the medical and healthcare facilities are largely provided in the cities and urban areas. This paper study and determine the feasibility and user experience of using web-based collaborative technology in healthcare and educational environments in developing countries. In addition to Investigate how a cloud computing collaborative medical tool could help achieve more efficient healthcare, accurate diagnoses and better decision making processes for developing countries and rural areas.

V. FRAMEWORK DESIGN

The design of our collaborative framework based on cloud computing. It consists from many parts are distributed on the three sections of cloud SaaS, PaaS and IaaS see figure (1).

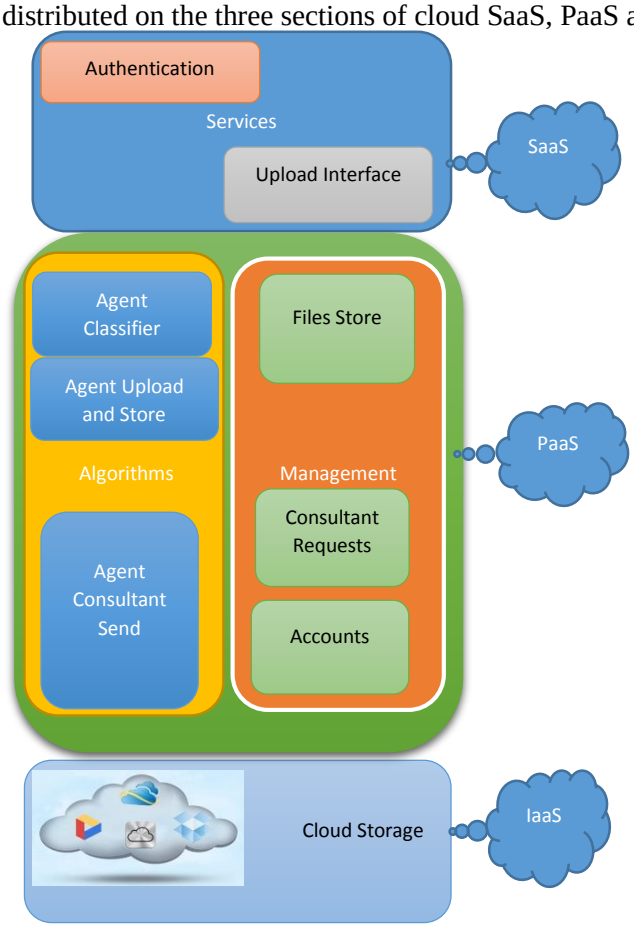

Figure 1 *Sections of the Collaborative Framework*

A-Problem Modeling

To start with explore the algorithms and structures of the agents we model and show the abbreviations will be used in the next section.

1. RC is request for consultant
2. U is user, physician or any person who request R.
3. DICOM is medical file type .uploaded by U to get RC.
4. MD is the Meta Data of DICOM file.
5. CS is a free cloud storage will use to store the DICOM files.
6. Ak is acknowledge send to the U to notify that his DICOM is correctly uploaded.

B-Framework Main Components

1-SaaS Components: This components are authentication interface and information uploading form. Authentication role is to register the new user or check its account information. The user use the

Information Uploading Form to input its symptoms and upload the medical images and reports to ask the consultation about them.

2-PaaS Components: This part of the framework consists from the algorithms and managements roles. The management roles organize the storing of uploaded files, accounts of specialists persons and their groups and consultant requests. The algorithms consists of Agent Uploader, Agent Classifier, Agent Consultant Send and Collaborative Cloud Algorithm. These three agents cooperate among in to finish the process starting from the consultant's request from user and finished with sending the decision of consultant from specialists group to the user. Agent Uploader get the information and files from the user and upload them to the cloud storage. Agent classify make a decision about what is the nearest specialist group should check the user information. Agent Cosultant_Send Send the consultant decisions about the information from the specialist group to the user. The cooperation among the agent be under the umbrella of Collaborative Cloud Algorithm.

3-IaaS Components: contain all the free cloud storage and computation powers.

C-Algorithms of the framework

The algorithms of the proposed system are explored below:

C1-Algorithm Collaborative Cloud

Input: Medical Symptoms /DICOM File(s)/
Output: Consultant Decisions
Begin:
1-User register for new account
2-Input your Authentication information
3-If the authentication not Pass Go to step 1 4-Input the Medical symptoms and DICOM file(s)
5-Deploy the information in step 4 to private cloud.
6-Send Request to Agent Classifier
7-send the Value returned from step 6 to the certain group of specialists
8-Send request to Agent Send
9-Return the consultations to the User
End.

C2-Algorithm Agent Classifier

Input: Request to classify
Output: Notification to Specialist Group
Begin:
1-As percept visit the private cloud storage
2-Extract the type T of the symptoms and resource file from the metadata of the upload files
3-Search in the List of specialist Group to find the nearest Group G to the value of T.
4-As Actuate send notification to all members in group G.
END.

C3-Algorithm Agent Consultation_Send

Input: User contact
Output: file of Consultant Decision
Begin:
1-As percept receive the consultant decision CD about the request R from any Specialist group
2-Recive the user U contact from the cloud storage how did the Request R
3-Send email to the user U.
End.

C4-Algorithm Agent Uploader

Input: Symptoms S, DICOM file from user U
Output: Acknowledge to User
Begin:

1-As percept receive the Symptoms S and DICOM file from the user
2- Looking for cloud storage CS.
3-Upload the S and DICOM to CS
4-Send acknowledge Ak to the User U
End.

VI. FRAMEWORK IMPLEMENTATION

In this section we will implement the framework step by step see the message sequence control in figure 5.

1. The User U want consultant decision from specialist physicians about symptoms and DICOM files.
2. The user input his authentication information to the authentication interface. First time the user must register.
3. The User U upload his Symptoms and DICOM files.
4. Agent Upload will upload the DICOM files to the Cloud Storage, return Acknowledge to the user and give notify to the Agent Classify.
5. Agent Classifier will check the uploaded files, check the MD, Make decision about what is the proper specialists group which be suitable to make consultant opinion and then send email notification to this group.
6. The Specialists group will check the files on the cloud storage, each specialist will give his consultant.
7. Agent Consultant Send finally will send the consultant opinions to the user U.

VII. RESULTS AND EVALUATION

To know the analysis and evaluation of the framework, a survey on consultants, postgraduate, physicians, lecturers and health worker staff in different hospitals has been taken using online survey[23].We define the results as:
1-Diagnostic accuracy: Investigate whether collaborative CAD has contributed to correct diagnoses. Web based collaborative application users found the application assisted some cases with accurate diagnostics by having precise opinions by specialists. See figure 2

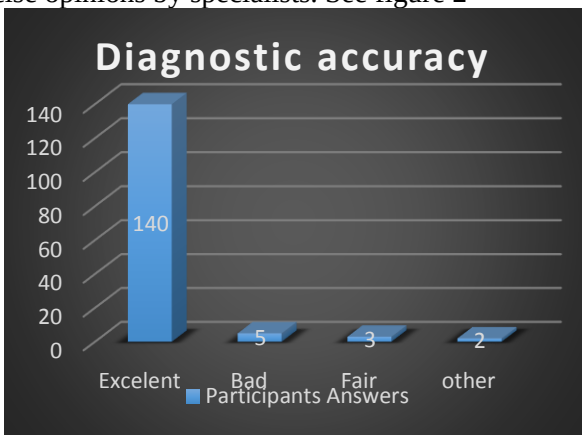

Figure 2 Results Diagnosis Accuracy

2-The Availability of application: Because the application deployed on the trusted cloud so it was available for the entire period of testing.
3-Benefits of Collaboration: Participants found the application useful after using it for a period of time and also found it a new way to collaborate with their colleagues and exchange information and opinions on different medical aspects and events. Most of all the doctors who used the application agreed that sharing and discussing cases were very useful and should be widely used and carried out in the future. See figure (3)

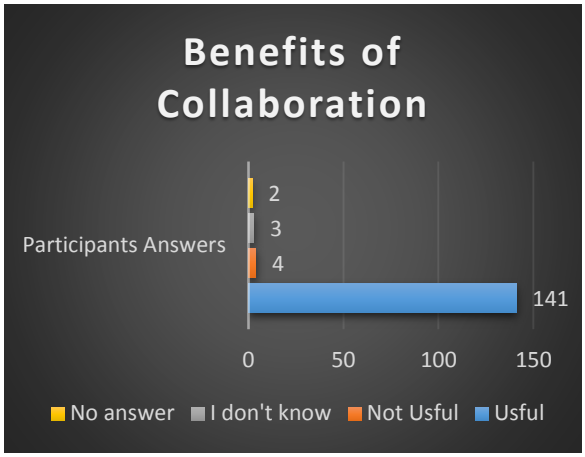

Figure 3 Survey Results of Benefits of Collaboration

4- The Ability of Use: Participants faced some difficulties in the beginning due to the lack of previous experience of using web based applications after that the users were more familiar and they became more usable and most of the difficulties has been dismissed.
5- Availability of application: Because the application deployed on the trusted cloud so it was available for the entire period of testing.
6- Consultant response: There were few consultants available while launching the application, but in later stages many consultants joined the system and were available for consultation. See figure (4)
7-Scalability: The system is deployed on the cloud that mean if the there is a load on the system so the admin easily take more processing capacity .as reverse the admin can reduce the any resource when there is no need for it.

Figure 4 Survey Results of Consultants Response

8-Speed of Upload: System performance did not meet users' expectation regarding speed due to the connection problems and the large size of medical images that need to be uploaded or retrieved while reviewing the cases.
9-Application Cost: Using the free cloud storage, prices suitable cloud provider and the system has used open source Therefor all that reduce the cost to minimum.

VIII. FUTURE WORK

In the near future, we will improve the framework by using some more efficient algorithms. More development should be performed to establish the common cooperative distributed medical software tools. New collaborative component with extended features like video conferencing, web 2.0 and web 3.0 applications. Also, confidentiality aspects will be improved by implementing advanced data encryption before send it to cloud provider. In addition to focus on make the framework as learning framework for medicine students as well as to other biological students by add more facilities for it. Another future implementation is to develop a version of the framework for mobile devices with many types of operating systems like android, IOS and Blackberry.

IX. CONCLUSION

In this paper we presented a new approach for the Collaborative CAD based on cloud computing and multi-agent systems, this approach handle the issues that the CAD is facing today. The Collaborative solve the problem of diagnosis accuracy because many specialists will share their opinions and give the user the final consultant. Deploying CAD systems over the cloud bring to this systems a new advantage which is the availability and scalability. By using the multi-agent platform and the use of the temporary cloud storage implies to reduce the cost of this systems. From the results of the survey, discussion with doctors and analysing participants feedback and their experience, we can conclude that the use of web-based medical application like Web 2.0 in general and collaborative CAD specially can be successfully applied for medical use in rural areas.

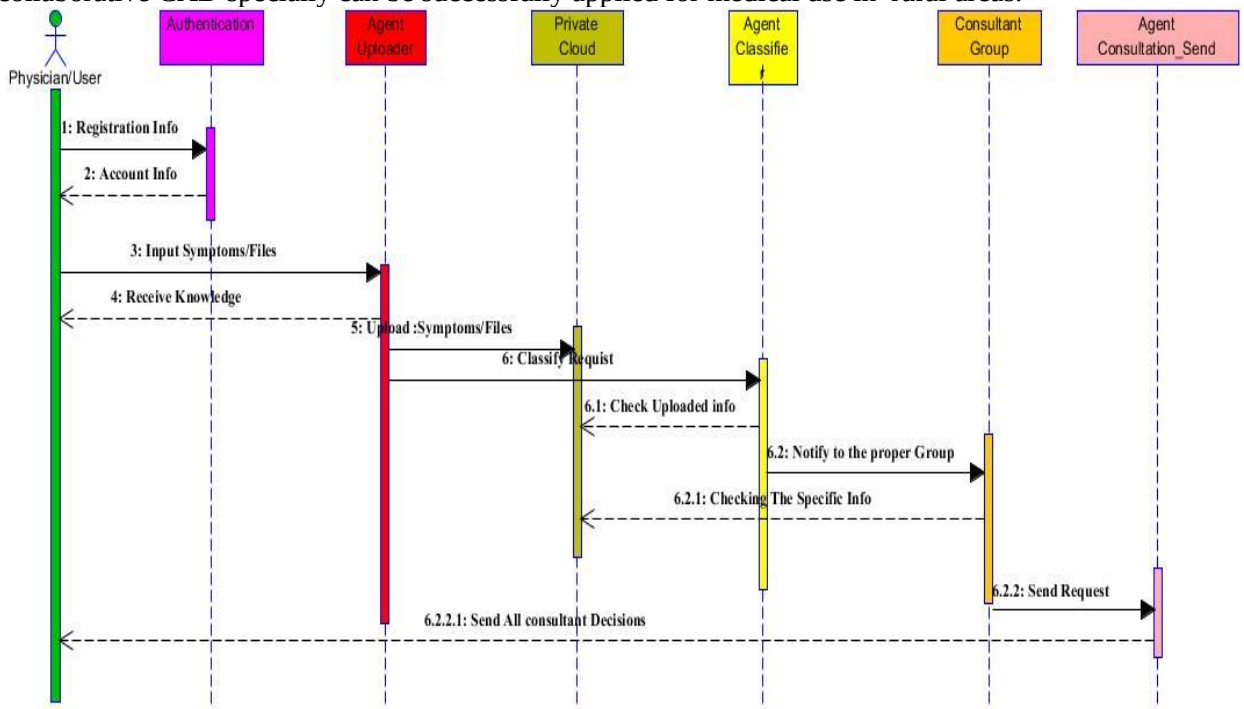

Figure 5 Message Sequence Control For Framework Implementation

However, due to the limitations of technology and the Digital Divide, it is also important to consider the need for new technology awareness among users. The results illustrate that the use of web-based applications have a positive outcome on the healthcare in many areas. We believe that introducing the use collaborative CAD would gradually be accepted as a necessary component of healthcare systems in developing countries and will solve the problem of healthcare delivery in a cost-effective way; this is particularly true for rural populations which were disadvantaged as result of an underdeveloped healthcare system. The use of a collaborative application for consultation purposes tries to minimize the number of patients transferred to the city for diagnoses and consultation where it could be done by a local doctor with the help of remote expert doctors.

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