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A Mobile Agent System for Diagnosis of Telerheumatology

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Abstract: *The ability to access consistent disease specific information from various hospital workstations and databases has been so far static through the use of services such as email, web application and syncing of information between multiple devices, these however employs the traditional (Client/Server) request and response strategy of retrieving information, and has so far favour telemedicine as a whole, however this comes with its own downside from giving limited information to uncertain authenticity of information. As a result, information access on the move via mobile agent is more than satisfactory. The primary aim of the research is to investigate the way in which Mobile Agent Technologies can be used in order to improve this situation in rheumatology through development of a mobile agent using the JavaScript mobile agent middleware, that is capable of migrating from its host into various hospital databases and workstation to retrieve information pertaining to the rheumatology disease. The mobile agent provides intuitive user interfaces suited with the capabilities to migrate to different end-points and retrieve information on the go. The result however provides a genuine and substantial data from which concrete decision about the disease, patients, a particular hospital and even physician relating to rheumatology can be made*.

Keywords: *mobile Agent, rheumatology, telemedicine, hospitals*

I. INTRODUCTION

Telemedicine is a broad term that covers the technologies that provide clinical and administrative support for patients and physicians. Telemedicine is the support provided for long distance clinical healthcare, patient and professional, including health-related education, public health and health administration by the use of electronic information and telecommunication technologies. Examples of telemedicine include live-interactive videoconferencing, remote monitoring, and store-and-forward imaging [1]. [2] also stated that telemedicine is a fundamental concept that focuses on any medical actions which concerns a factor of distance. In which the interaction between doctors and clinic involve telecommunication technique.

Telemedicine projects with its branches that includes telecardiology, teleradiology telerespiratory and telerheumatology etc., in developing countries has provide a chance for people living in rural areas to achieve better healthcare services [1]. Telerheumatology is the application of telemedicine which involves remote delivery of clinical care to patients with rheumatic conditions through information and communication technology [3]. [4] stated that telerheumatology is the use of telemedicine for diagnosis, treatment and management of inflammatory and autoimmune rheumatic disease.

However, this study shall seek to explore telerheumatology and the use of a communication technology framework known as Mobile Agent to provide and improve better health services.

Mobile Agent on the other hand is a piece of software that can move from one host to the other over the network to carry out the task that it was designed for. The Mobile Agent is a delegate of the user who endows it with a certain degree of autonomy required for the realization of the designated goal [5].

[6] maintained that mobile agents can significantly improve the design and the development of Internet applications thanks to their characteristics. This agency feature permits them to exhibit a high degree of autonomy with regard to the users they try to carry out their tasks in a proactive way, reacting to the changes of the environment they are hosted. The mobility feature takes several advantages in a wide and unreliable environment such as the Internet. First, mobile agents can significantly save bandwidth, by moving locally to

the resources they need and by carrying the code to manage them. Moreover, mobile agents can deal with non-continuous network connection and, as a consequence, they intrinsically suit mobile computing systems. All these features are particularly suitable in a situation such as medical emergencies. These characteristics exhibited by mobile agent are what make it a suitable technology framework in developing telerheumatology.

Shortage of rheumatologist and physicians in rural areas are acute and this has lead to delay in diagnosis and sometimes loss of life. Telerheumatology has become one of many approaches to overcome this problem [7].

The most common ailments that have been recorded in the rural areas are Malaria, Animal and Snake Bites, Bone Fracture, dislocation and Anemia. With such limited health care available, these complications often to lead to mortality. These areas also have a critical shortage of trained medical staff. A key obstacle to patients gaining treatment is often the distances required to travel to local clinics or regional hospitals this journey can often take several days by foot or by bicycle even for healthy people. This usually means a loss of income and with many health centers poorly staffed and under-equipped this effort may not guarantee any improvement for the patient. This means that often problems are not addressed until they become very serious. Early diagnosis and regular treatment would enhance the chances of recovery and reduce the number of referrals to hospital, helping to ease the burden on already over-stretched hospital services. With references to the aforementioned studies it is pertinent to develop a system that will bridge the gap between the patients and clinics regarding their health and general welfare, hence the development of a Mobile Agent system for diagnosis of Telerheumatology. The aim of this study is to develop a mobile agent system for diagnosis of telerheumatology that will act as a connection between the patients and their respective clinics. The study shall be tailored only to the development and the use of telemedicine in rheumatology.

II. RELATED WORKS

An agent is “a person whose job is to act for, or manage the affairs of other people”. In the context of computers, a software agent is a program that performs certain tasks on behalf of its owner. The software agent may be mobile or static. A mobile agent can move or be moved around the network, but a static agent works on one host computer on the network, including accessing resources which are on hosts other than the host on which the agent is executing. A new and emerging technology for computers to communicate in the distributed environment is via the mobile agent. The advantages of the mobile agent are too big that should not get from the static agents and conventional web technology. With its features, the mobile agent is one of the most prominent technologies for various intranet and internet applications. However, mobile agent technology has not been perfected because of deployment concerns such as reliability and security. The reliability deals with the persistency of the mobile agent when the malfunction or the agent itself is under a denial of service attack [8].

a. *Overview of Mobile Agent*

An Agent is a software element which is autonomous with intelligence, mobility, while having ability to collaborate well by other users, Intelligent Agents, and Systems. They hold responsibilities without constantly consulting the user with a dedication, on their behalf. They can effectively co-ordinate among agents, users and software hosts. A searching agent that is competent to retrieve preferred information on behalf of the users. The agent is sent away to carry out the look for off-line as well, after being told what to search for. Eventually, the agent can move back with needed output [9].

Telemedicine can be defined as the use of information and communication technology (ICT) to deliver medical services and information from one location to another. In other words, telemedicine can be seen as a way of distributing medical expertise and services to medically underserviced areas such as remote and rural areas using ICT as a communication platform. Though any communication system can be used in telemedicine, rapid development in computer technology and easiness to purchase has led to more amenability to computer-based telemedicine technologies which are IP-based. Services offered by telemedicine are designed to help improve healthcare access and information service while reducing the isolation of healthcare providers and residents in rural areas. Telemedicine can also reduce the time and allay the costs of rural patient transportation significantly. Telemedicine includes applications in areas such as pathology and radiology, as well as consultations in specialties such as neurology, dermatology, cardiology, and general medicine. Telemedicine is also used for Continued Medical Education (CME), administration, research and development. Telemedicine is a term generally used to describe a type of patient care which

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involves monitoring of a patient's condition by a healthcare worker located at a healthcare facility which is remote with respect to the location of the patient [10]. Telemedicine is an umbrella term referring to all systems, modalities and applications involved in personal delivery of health services to substitute for any exchange of information and communication in an electronic format [11]. Applications of Mobile Agents in Healthcare domain are presented in [12], [13], [14], [15], [16],]17], [18], [19].

III. DEVELOPMENT OF A MOBILE AGENT SYSTEM FOR DIAGNOSIS OF TELERHEUMATOLOGY

As presented in [20], mobile agent environment is a model which comprises of a server and a number of workstations where the server is connected directly to a number of workstations. The server is a typical computer which is composed of some hardware devices such as CPU, main and secondary memory, printer, scanner, switches, modems, network ports and so on, and in which a network operating system is running. Other categories of software can be running on the server. This include: frontend software, backend software and utility software. The workstation environment on the other hand comprised of basic hardware devices, an operating system and other software systems.

a. *Architecture of Mobile Agent System for Diagnosis of Telerheumatology*

Generally software architecture as a whole is more of abstract being above the level of algorithm and data structure, and this includes global control structures, protocol communication, synchronization and physical distribution. It is on this level that we see different architectures including distributed network architectures which mobile agents are based on. This distributed architectures help solve the problem over sending and receiving data over network, which give access to remote resources, remote object calls and how to send program code over the network. For this study the client-server paradigm was adopted, here the server is seen as the host that where the agent runs, it is launching area of the agent and also the base to which the agent returns, it consist of all codes and functions that make up the agent and encapsulate as much as possible features of mobile agent to its agent, the clients on the other side serves as workstation that will be connected to the server, these workstation are typical computers with loads of resources, databases etc, they serves as agent destination and provides permitted entry points to the agent to perform its function before returning to host base. The mobile agent architecture is presented in figure 1

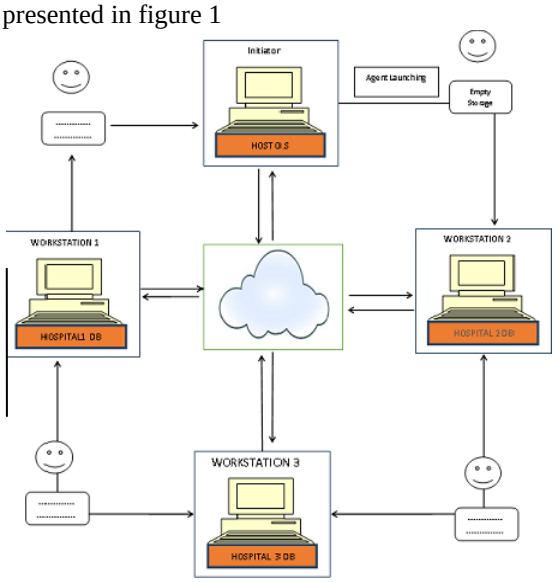

Fig 1 Mobile Agent Architecture

In carrying out our objectives, the server agent is developed using a node-js mobile agent middleware(source) for agent migration and express-js node modules for server configurations, the server agent is designed in such a way to carry out the below functions:

1. Present a responsive registration interface for administrator
2. Presenting a Login and Authorization Page for the registered administrator
3. Display all server connection properties
4. Provides an avenue for the launching of the agent
5. Report the time-taken for agent to go and come back, this is known as “transfer time” or “Latency”
6. Give Report back to the administrator using a JSON object Format.

b. *Migration Process of the Model*

The agent in this model is launched from its host base, by specifying to the agent an entry point of the workstation or node to be visited using the node IP address and port together with parameters to be taken along by the agent, the agent in turn through the hardcoded instruction find the nodes with the specified IP-address and port and query its database with the parameters, immediately the agent return to its host base with results of his query, time-taken for its itinerary, and present its result using a JavaScript Object Notation, popularly known as JSON.

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IV. IMPLEMENTATION OF THE MODEL

a. Registration Screen

The Mobile Agent is protected from unauthorized access by implementing a two side authentication modules, which are the administrator registration and administrator's login page, figure 2 shows the administrator's page which include a registration form to be filled and submitted to the database, a login page is automatically loaded upon successful registration.

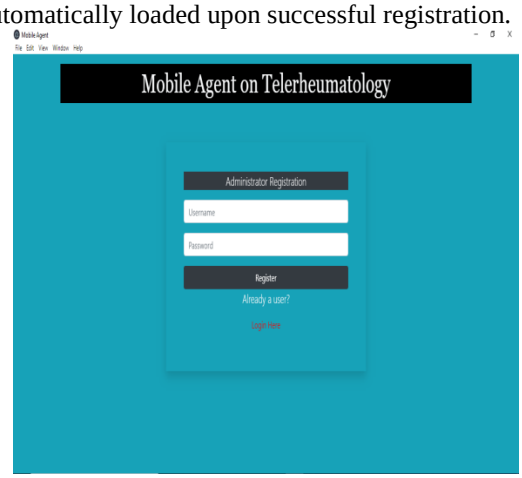

Fig 2 Administrator Registration Page.

b. Administrator Login Page

The administrator login page is the module that enables only authenticated administrator to access the agent dashboard, this page contains the administrator username field and password username field, agent dashboard is loaded upon successful authentication. Fig 3 shows the administrator login page.

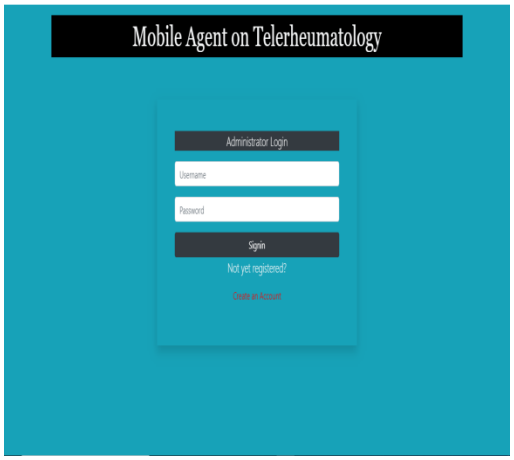

Fig 3 Administrator Login Page.

c. Administrator Update Page

This page presents a modal dialog only to the authenticated administrator to make changes to their login credentials. Figure 4 shows the administrator update page.

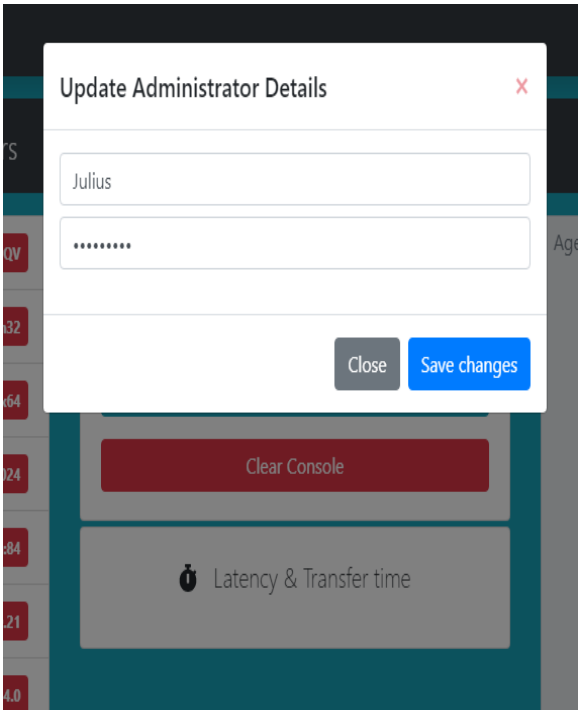

Fig 4. Administrator Update Page.

d. Agent Entry Point

Agent is known to travel through databases and fetch information, due to concerns of security of data and privacy intrusion, agent is mandated to be given a clear path to travel, and these paths are called "Entry Point" and are given by the destination database. These paths are usually gateway for agent to enter to perform its function and are normally encoded in network IP Addresses and communication Ports. Figure 5 shows the entry fields.

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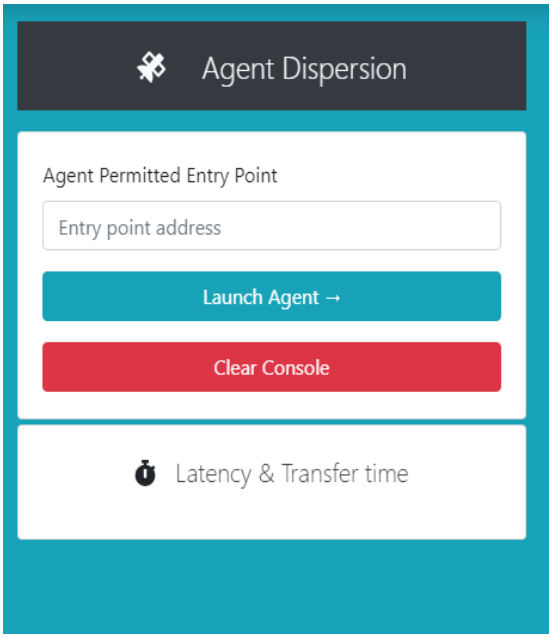

Fig 5 Mobile Agent Entry Point

e. Mobile Agent Dashboard

The mobile agent dashboard is the main interface where every functions related to the agent will be carried out, it has a 3 columns grid system, that does different function on their own, from this dashboard agent return information is seen, Client connection properties is shown and latency between agent travelling and returning is automatically calculated. Figure 6 shows the dashboard

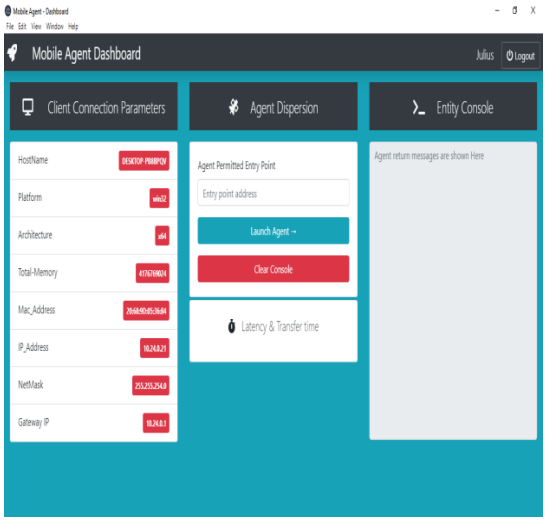

Fig 6 Mobile Agent Dashboard

f. Mobile Agent Entity Console

The mobile agent being a single entity must for every request bring back a response, these response are automatically logged in the entity console for proper usage, the agent retrieve data in the raw format, does automatic data conversion to a JSON (JavaScript Object Notation), this because data and messages in this format are easier to manipulate and converted even to other format as needs may arise. Figure 7 shows the entity console.

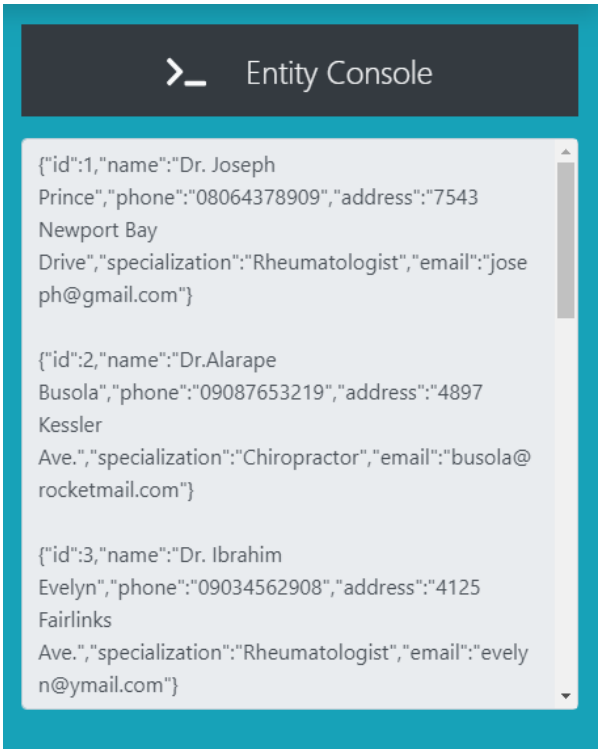

Fig 7 Mobile Agent Entity Console

g. Latency and Transfer Time

For efficiency and to determine the speed of agent, it is necessary to find the time-taken for an agent to move from its source to its destination and back t its source, although this is mostly dependent on the strength of the destination connectivity. Figure 8 shows in milliseconds (ms) the time taken for an agent to fetch only doctors that are rheumatologist from a particular hospital and back to its source.

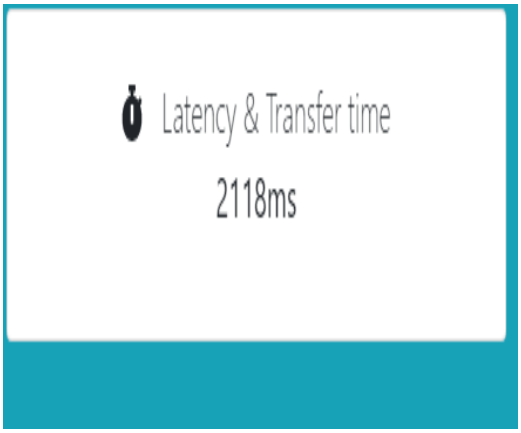

Fig 8 Mobile Agent Latency and Transfer Time

h. Client Connection Parameters

This shows the network connection properties and system resources of the agent's platform. Figure 9 shows the network connection properties.

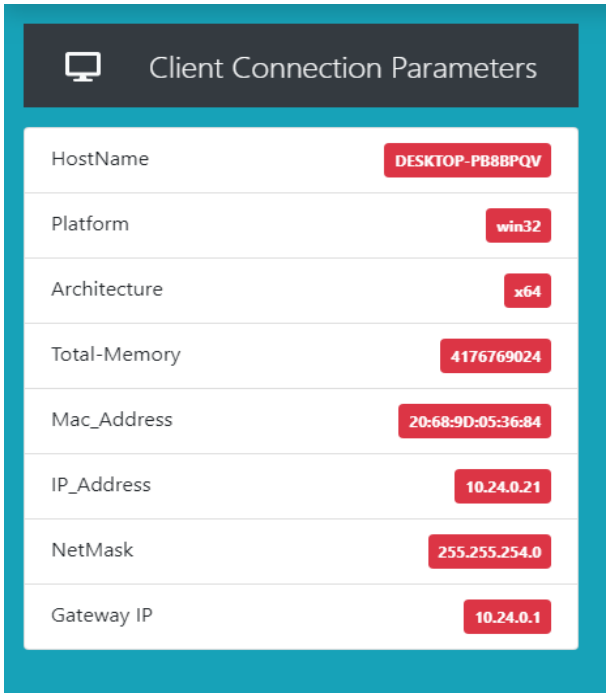

Fig 9 Client Connection Parameters

V. CONCLUSION

Telerheumatology deals with the use of telecommunication technology in rheumatology, this study however employs the use of mobile agent in searching and retrieving information related to patients, doctors, and medicine in rheumatology from different hospital database. Mobile agent enhanced these functions has it has the ability to move from its base to a particular destination with a return message back to its host base. This however eliminates the stress of moving from one hospital to another seeking for information. The study provides instant information retrieval and conversion which can further be used for decision making in enhancing the fields of rheumatology has a whole. Furthermore the study also solves the one of the security challenges faced in mobile agent development. It's highly recommended that the study be put to use in its entirety and if possible be ported to other areas in telemedicine, as this is one of the applications of distributed computing which enhanced information sharing and support decision making.

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