Intelligent Techniques for Location Based Services Using Medical Information Retrieval in Cloud Database

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Abstract: In the recent years, information retrieval for providing location based medical services has become an important task and challenging in e-governance environments. For this purpose, many techniques were proposed by many researchers which focused on spatial query processing algorithms. However, most of the existing techniques could not provide the expected accuracy due to the use of only geographical information. Moreover, the data stored in the relational databases for developing geographical information systems are growing at a faster rate in the area of medical informatics. Therefore, it is necessary to develop more efficient techniques using computational intelligence in order to enhance the performance of location based service providing systems. This study proposes an intelligent location based service providing technique by effective storage and retrieval of medical data in cloud databases. Moreover, the proposed model uses rules to make decisions on selecting a suitable hospital in the location of the patient, recommendation of medical experts to be consulted and suggestion of alternative treatment plans. Experiments have been carried out in this work using Java programming with Amazon cloud for evaluating the proposed system. From these experiments, it is observed that the proposed system provides more accurate recommendations for selecting the hospitals and other medical services in Tamil Nadu through e-services.

Key words: Cloud database, medical data, information retrieval, location based services, location dependent queries, e-governance

INTRODUCTION

A healthcare application for providing health care services must take care of the diagnosis, treatment and prevention of disease effectively from anywhere at any time. In the past, the expert systems were developed for medical diagnosis which provided effective health decisions including the prediction of diseases using the symptoms and suggesting treatment plans. However, the existing knowledge based systems are constrained by memory due to the storage of knowledge in the main memory. On the other hand, the large volumes of patient data and medical records must be stored in a medical information system so that, it is possible to perform more accurate diagnosis. In Tamil Nadu, most of the population lives in villages. They have to go to nearest towns and cities to get any medical assistance/treatment. Majority of the rural population have financial restrictions leading to selection of cheaper hospitals. In such a scenario, the rural people must be provided with an intelligent decision support system which must recommend suitable and cheaper hospitals. Moreover, the distance from the house to the hospital should be minimized so as to reduce the

travel time which can save the life of many patients especially during emergency situations. Hence, an automated system which can provide location based services is necessary. Moreover, such a system must be able to perform location based query processing in order to find the nearest and cheapest hospitals.

In spite of the availability of relational database systems for health record maintenance, a web based solution is necessary for providing e-health services and to make cost effective treatment methods. Moreover, the cloud database systems provide facilities for large scale real time data storage and retrieval features (Muthurajkumar *et al.*, 2015). They also provide effective query processing facilities using map-reduce techniques. In addition, the existing database systems require the provision of mobile queries from the databases available in fixed networks. Hence, it is necessary to propose a data model and a recommendation system which can store the medical data efficiently and provide suitable recommendations for the patients.

In this study, we propose a new model for providing effective medical information retrieval from cloud database which can store the medical data, retrieve and suggest

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suitable hospitals and the availability of medical experts. This system has been tested using the data pertaining to hospitals available in all the towns and cities of Tamil Nadu in India. The proposed system provides location based services not only by using the geographical information but also the other constraints including the nearest hospital, transportation, cost of treatment and availability of experts.

Literature review: Many works are available in the literature on healthcare system. Among them, Zissis and Lekkas (2011) explored the use of cloud computing and its uses for e-governance services. They focused on electronic voting application with cryptographic security mechanism. Sharma and Vaisla (2012) analyzed the application of Information and Communication Technology (ICT) for providing effective healthcare services in Uttarakhand state of India. According them, effective use of Information Technology (IT) and ICT in Indian hospitals and medical colleges can be more useful to enhance the services of healthcare organizations. These systems focused on enhancing the performance of hospitals with respect to fast provision of healthcare services.

Shiraz *et al.* (2013) explained the features and use of the existing distributed application processing frameworks for Smart mobile devices in mobile cloud computing domain. The main objective of their work is to tackle the challenges present in the existing cloud based applications. Othman *et al.* (2014) developed a new application for supporting mobile queries in cloud platform. Sai-Qin Long *et al.* (2014) proposed an optimization technique for effective replication of distributed data and to perform analysis using mean and variance features. Lei *et al.* (2015) developed a new mobile cloud database service application for effectively storing and managing mobile data on cloud databases.

Weider *et al.* (2015) proposed a model which can predict the state of a person's health on providing the symptoms as input and to analyze pattern of disease growth. Their model applied the Naïve bayes classification algorithm for recommending hospitals so that it is possible to get treatment with less cost. Kim *et al.* (2016) proposed a new secured k-NN query processing algorithm that maintains the confidentiality of both the encrypted data and the user's query record. Their model focuses on the provision of security in query processing in cloud.

Liu *et al.* (2012) proposed an effective model for data gathering from social networks which is useful for effective home based medical treatment. Boonchieng *et al.* (2014) developed a new Global Positioning System (GPS) based location service system which helps to provide query from mobile devices to access the healthcare data

which are stored in the cloud for providing better services to the patients. In spite of the presence of all these existing works, most of the existing works used relational databases for data storage and hence periodic backup is necessary before adding new information. On the other hand, the number of patients requiring medical services is growing fast in Tamil Nadu. In order to satisfy the requirements of patients and other public who want to get information about hospital related services, a GIS based query processing and query answering system is necessary. Therefore, a new e-healthcare service system is proposed in this work that takes care of location constraints, temporal constraints and cost of travel as well as treatment.

MATERIALS AND METHODS

In this research, a new location dependent service model with a feature for handling location dependent queries is proposed. This model uses new types of intelligent agents namely Coordinator Agent (CA), Location Management Agent (LMA), Decision Making Agent (DMA) and Query Processing Agent (QPA). All these agents are responsible for analyzing the query as well as database consisting of services by applying the rules present in a knowledge base. If a query such as "find the nearest hospital to me", the proposed system uses a GPS to find the location of the user. From this location, it draws a circle with radius 'r' in order to find the area in which the query must be focused to find the hospitals. The value of 'r' is set by the database administrator depending upon the population of the area. This can be adjusted by the user if the user wants to find hospitals from more or less areas. Two new algorithms namely location dependent query processing algorithm and location based service algorithm have been proposed in this work to provide more effective medical services to the user.

Location dependent query processing algorithm:
- Input : Location dependent query
- Output: Set of all hospitals or Medical experts depending on the query
- Step 1: Read user query and give it to the CA
- Step 2: Use LMA to find the location of the user using GPS.
- Step 3: Using the location, find the range of towns and cities in which hospitals are available by calling the QPA.
- Step 4: Read the cloud database to take the details of all hospitals or experts.
- Step 5: For each hospital, compute the expected total cost using the formula

$$\text{Total cost} = [\ W1 \times \text{Distance (Hospitals)} + W2 \times \text{Travelling Time} + W3 \times \text{Severity of Disease} + W4 \times \text{Treatment Cost} + W5 \times \text{Specialty}] / [\ W1 + W2 + W3 + W4 + W5]$$

- Step 6: Call decision making agent to make a suitable hospital or medical expert
- Step 7: Provide the result to user

This query processing algorithm has been proposed in this research to provide location based services in an effective way by making use of intelligent agents. Once a suitable hospital or medical expert is identified using this algorithm, the set of all services provided by the hospital are obtained using the second algorithm namely location based services algorithm.

Location dependent service model: In this research, a new cluster based location based service model is proposed in this work for handling the requests provided by the users. In this model, the clusters are formed to find the set of hospitals which have pharmacy, testing centers and restaurants. The steps of the proposed location dependent service providing algorithm are as follows:

Location dependent service providing algorithm:
- Step 1: The coordinator agent starts the process by issuing begin analysis primitive, after starting a timer
- Step 2: The coordinator performs the clustering process by applying the K-Means clustering algorithm
- Step 3: For each cluster, perform the following using the QPA
- Find the hospital timings
- Find the type of clinical services
- Compute the cost of each service
- Check the consultation charges
- Check the availability of experts at current time
- Step 4: Call the decision agent to find the cheap and best service provider and services
- Step 5: Send result to the CA
- Step 6: Perform coordination between all agents to provide a suitable list of services
- Step 7: Close the timer and exit the algorithm

This algorithm is used by a patient who can register with the location based service providing software in order to obtain the details regarding the set of hospitals that provides services in their neighborhood.

RESULTS AND DISCUSSION

This study provides the result and discussion of the proposed system. The proposed system has been implemented in Java programming language with MongoDB and Amazon Cloud.

Data set: In this research, the data collected from Tamil Nadu hospitals is used for carrying out the experiments. The hospitals are grouped into two categories namely government and private hospitals. Moreover, they are further grouped into small clusters which focus on specializations such as heart diseases, diabetics, accident cases, eye problems and other type of diseases.
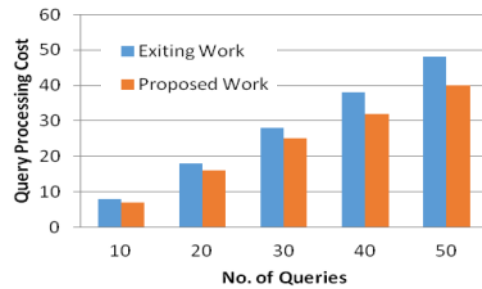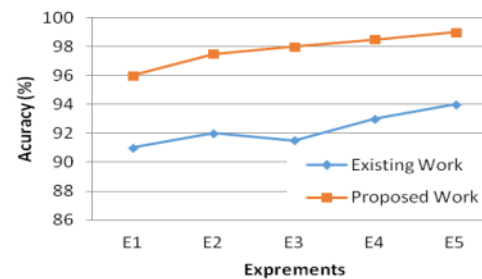

Fig. 1: Query processing performance analysis

Fig. 2: DecisionAccuracy Analysis

Experimental results: Figure 1 shows the location dependent query processing cost analysis for cloud database queries on Tamil Nadu hospitals data. This research has been compared with the existing research by Ganesh and Vijayalakshmi (2009) to analyze the cost of query processing.

From Fig. 1, it can be observed that the cost of query processing is reduced in the proposed research than the existing work. This is due to the fact that the proposed work considers the use of cloud and intelligent agents for making effective decisions. The query processing cost includes input/output cost, network cost and mobility cost. Figure 2 shows the decision accuracy analysis when compared with the existing work.

From Fig. 2, it is observed that the decision accuracy is very close to the actual accuracy and hence this system is more reliable. This is due to the use of weights in computing the overall cost which is used for effective decision making. Moreover, intelligent technique namely rule based decision making and agent based processing are used in this work to improve the decision accuracy. Fig. 3 shows the use of clustering for providing location based services based on service time.

From Fig. 3, it is observed that clustering helps to optimize the service time by reducing the travel time and communication time. The reduction in service time is based on many factors namely clustering of services, cloud storage and retrieval, virtualization and intelligent agents.
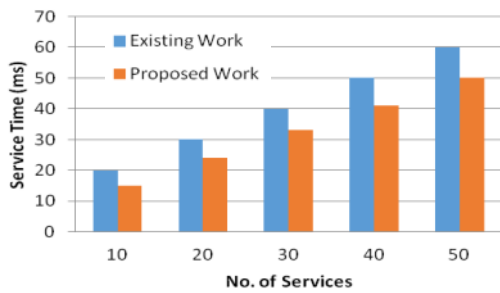
Fig. 3: Service time analysis

CONCLUSION

In this study, an intelligent medical service model has been proposed to provide location based services for helping the rural and urban population of Tamil Nadu . For this purpose, two new algorithms namely location dependent query processing algorithm and location based service algorithm have been proposed. In addition, the decision manager used in this research applies rules to perform effective inference. The main advantages of the proposed model are the provision of a new facility for sending location dependent queries, receiving accurate services as query responses and reduction in overall cost. Future research in this direction can be the use of fuzzy logic to make decisions under uncertainty.

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