Secure Agent Based Optimized Medical Record Analysis

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Abstract: With the tremendous growth in human population and the need for better clinical treatments, the medical data or the medical record accumulation, storage and mining becomes the need for the advancement of human medical facilities thus demands a high focus of research. The medical record is been accumulated over the time for every single person during all the phases of clinical treatments starting from initial diagnostics to major medicated treatment or major surgical treatments to post treatment check-ups. The medical record accumulated by the hardware or software agents in the system. These records are been stored in the healthcare management systems owned by the hospital or sometimes by the agencies. However the data is heterogeneous in nature, hence the storage systems also demand to be heterogeneous in nature along with the processing systems. Hence defining any framework for predictive analysis of heterogeneous data is also demanding the high research aggregation. The accumulation of the data needs to be pre-processed to satisfy generic storage and processing for predictive analytic systems. The medical record storage is to be optimized for sharing with multiple hospitals or healthcare agencies to reduce the diagnostic cost and time. Moreover Data mining techniques are also to be analysed in order to recommend the most suitable mining techniques for medical records. Hence this work study and understand the available medical data accumulation agent architectures to identify the need for improvements and propose required up-gradation to the existing practices, study and analyse the existing medical record storage systems and propose up-gradation to the practices for better information exchange and finally propose a novel pre-processing technique for normalization of the data for better storage, mining and exchange.

Keywords: Medical Record, Agent based Architecture, Mobile Medical Agent, Storage Architecture, Record Mining.

I. INTRODUCTION

The use of agents for medical data accumulation is a standard method of conducting diagnostic study during the treatment. The agents are made to analyse different condition of the patient and henceforth generates results or medical records in different formats [1]. However the modern clinical treatment demands the interoperability in major scale. However such agent based architecture demands highly configured hardware, intelligent and easily usable software and good operating skills. These indicate the high improvisation of cost for the up-gradation. Moreover the timely and accurate operability is always the necessity of the systems. Henceforth it is understandable that the accurate and cost effective implementation of an agent based system for medical record accumulation is in high demand for the growth of medical treatments. In this work we understand the available standard architecture for agent based framework by analysing the components performance bottlenecks.

The accumulated medical records are to be stored in exchangeable format to be shared for various purposes.

Hence we understand the medical record storage architecture and the need for further studies. The tremendous growth in storage optimizations and high processing capabilities for the computational hardware is leading to automation in all fields including clinical medical processes. The growth forces to storage and further analyse the patient personal information, laboratory diagnosis reports, medication records including the financial and medical benefit records like billing and insurance details. To have an understanding of the benefits of adopting any Medical Record Management System, we analyse the report from World Health Organization demonstrating that a predicted 5 Crore people are going through high-end clinical treatments every year. The World Bank report demonstrates that an approximated 35% of that patient is having medical policies where a constant collection of medical records are to be prepared by the hospitals or by the individuals. This makes an approximated total of 1.8 Crore medical records to be generated every year for information exchange and further processing. Hence the need for optimized storage structure for the medical records cannot be ignored. A number of parallel researches are been executed in order to find the most cost effective and interoperable storage architecture. In this work we also analyse and understand the primary storage policies and identify the architectures.

The collected medical records are also to be analysed for medical and business requirements by intelligent systems [2].

The former approaches with intelligent systems are restricted to the use of data mining techniques as a sub component of data warehousing operations and software. The recent approaches have made data mining more meaningful and most important components for business and other process related decisions. Majority of the medical diagnosis systems deploy an intelligent component for predictive analysis where the data warehouse plays a role for data storage and data mining techniques are to be deployed on those data of medical records [3]. The most powerful feature of data mining is the wide range of algorithms for predictive analysis and mostly specific recommendations for domain specific datasets [6]. The mining of data is a generic approach where any small, medium and large datasets can be analysed. The data mining or knowledge mining techniques is spread over multiple phases. During the initial learning phase, the input training sets are feed to the algorithm to learn the classification pattern and in the classification process the actual datasets are analysed and classified for intelligent decision making. In this work we analyse the available data mining techniques for medical record processing for predictive analysis [4] [5].

Hence we identify the areas to be focused and further explore in this work as

- Propose a cost effective and timely agent architecture for medical record accumulation,
- Propose an efficient storage architecture for medical record storage to meet the requirements of information exchange and
- Propose a pre-processing technique for better predictive analysis.

The rest of the work is organized such as in Section II we analyse the available agent based medical record accumulation systems, in Section III we propose a novel medical record storage framework focusing on information exchange, in Section IV we propose a novel approach for medical record pre-processing techniques, in Section V we compare the results of this work and parallel research outcomes, in Section VI we conclude and understand the future scope of this work.

II. AGENT BASED MEDICAL RECORD ACCUMULATION SYSTEMS

In order to achieve better understanding of health care system automation using diagnosis agents, we understand the basic components involved in the agent architecture. Any agent is adopted in the system in order to make the interaction to the environment automated and sometimes self-guided. The agents can be manually operated or sometimes decision based. In case of decision based agents, the agents interact with the environment in order to collect the necessary information for processing. The processed information helps the agent to take decision based on the intelligent processing. The intelligent processing is pre-programmed in the agents thus the agents become intelligent agents. The intelligent agents are pre-programmed and supported by intelligent software systems. The micro software systems embedded into the agents are required to perform analysis of data and make action determination based on the accumulated data. The software programs are micro as they are given the task to perform mini functions limited to one or maximum two tasks. The major throughput of the intelligent systems is to interact with each other's alongside with the environment for information exchange. This makes the system more capable of reducing the time duration for information accumulations. In order to achieve better understanding of the intelligent systems, we analyse the architecture proposed by Stefan Bohn at al [Figure - 1]. The complete study of this architecture will help us to identify the bottleneck of the system and propose up-gradation to the existing paradigm.
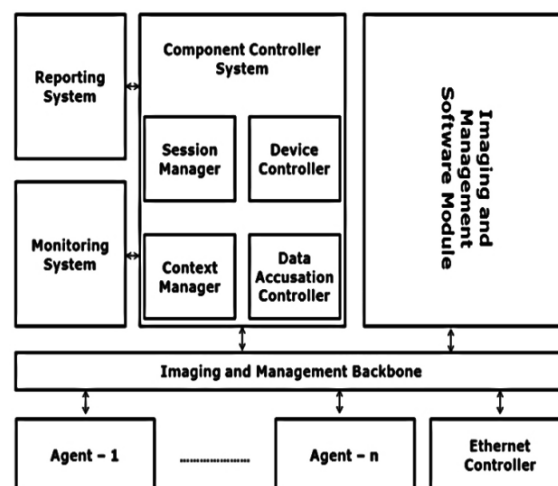

Figure 1: Intelligent Agent based Architecture

The generic components of the intelligent agent based architecture are understood here.

A. Protocol for Network Management

The medical information or medical record is transmitted through the configured network which runs on Simple Network Management Protocol. The simple network management protocol is based on TCP/IP thus can interoperate with any other standard network situations. The simple network management protocol allows operations for the information storage systems as GET and SET.

The bandwidth calculation for the half duplex medium using Simple Network Management Protocol is as follows:

$$\frac{(\Delta ifInOctets + \Delta ifOutOctets)\,x\,8\,x\,100}{(number\_of\_seconds\_in\,\Delta)\,x\,ifSpeed} \quad \text{.... Eq 1}$$

And the bandwidth calculation for the half duplex medium using Simple Network Management Protocol is as follows:

$$\frac{\max(\Delta ifInOctets, \Delta ifOutOctets)\,x\,8\,x\,100}{(number\_of\_seconds\_in\,\Delta)\,x\,ifSpeed} \quad \text{.... Eq 2}$$

Where

$\Delta ifInOctets$, the number of inbound octets in the traffic

$\Delta ifOutOctets$, the number of outbound octets in the traffic

$ifSpeed$, the speed of the interface

B. Hardware Control Monitor

The medical record information is accumulated using the hardware components connected to the network. The hardware components need constant monitoring for the performance in order to assure the timely and accurate out comes. Hence the hardware monitoring systems are becoming the essential component of the system. The monitoring components are generally embedded in the software package and installed in the master computer for the system. The performance parameters are defined for monitoring ranging from availability to packet loss measurements. The details of the parameters are discussed here [Table – 1].

TABLE I: HARDWARE PERFORMANCE EVALUATION MATRIX

Parameter	Best Value Performance		
	Time Aggregation	Space Aggregation	Space Concatenation
One Way Delay	Average	Maximum	Average
Delay Variation	Average	Maximum	Average
Packet Loss	Median	Minimum	Average
Bandwidth	Maximum	Average	Average
Utilization	Median	Average	Average
Capacity	N/A	Average	N/A
Bandwidth Achievable	Maximum	Average	Average
Availability	Maximum	Maximum	Maximum

It is easy to understand and apply the space operations using the one way delay for any network. To understand the formulation, we assume the network for agent based system is having two phase path as A to B and B to C, considering A is the source and C is the destination. The formulation is presented here:

$$< OWD_{AC} > = < OWD_{AB} > + < OWD_{BC} > \quad \text{...Eq 3}$$

C. Software Control Monitor

The software performances are to be measured in terms of Application Response Time. The standard architecture of in most cases use an open source library for ART implemented in C and Java. The parameters are predefined ranging from transaction duration to durability. Hence after the detail understanding of standard framework of agent based medical record analysis, we understand the demand for improvements. Hence in this work, we realize a novel framework for agent based medical record accumulation.

III. PROPOSED NOVEL MEDICAL RECORD STORAGE ARCHITECTURE

After the detail understanding of the medical record storage architecture and outcomes from the parallel studies we realize the novel method for storing the medical records.

Before we project the novel storage architecture, we present the best practices for medical record storage architecture considerations understood from the parallel researches.

The following are best practices:

- **Appropriate Business Case**: An appropriate business case is the primary requirement for modeling the storage architecture. The business case must consider the major outcomes and stakeholders uses the storage. The business case will help to develop the most cost effective architecture with less need for further up-gradation.
- **Technology Understanding**: The recent researches have demonstrated that the lack of knowledge for managing and maintaining the medical record systems. This may lead to less cost effectiveness of the clinical business. Hence the up-gradation of parallel systems and the technicians are foremost important in order to extend the full benefit of medical record storage systems.
- **Promotions**: Promoting the use of medical record system is equally very important so that the necessary stakeholders' technology also become usable.
- **Consideration of Effects**: During the planning phase, it is important to consider the effects on the existing technology, process and hardware in the medical facility. Ignorance of the effects may lead to further problems like recursive up-gradation of the existing hardware and other resources.

The existing storage framework demonstrates the use of any primary identification to uniquely storage, update and retrieve the medical record pertaining to each patient.
This process leads to sub-pressing the possibilities of information exchange. Hence in this study we propose a framework where the primary identification is a patient's biometric information which will allow the sharing of information seamlessly over multiple agencies [Figure – 3].
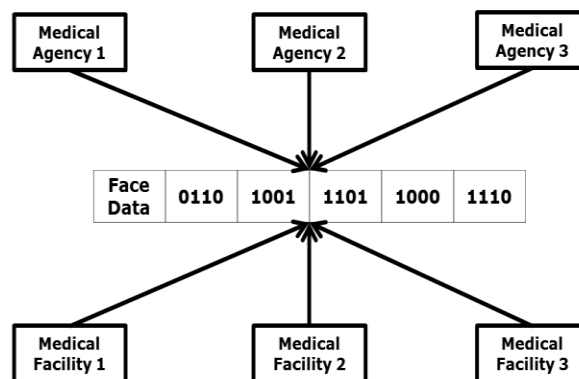

Figure 3: Face Date based Storage Architecture

We consider the facial recognition system as a primary identification of the patient medical records.
The system deploys a mechanism for face detection using the Legendre Moments for accurate near neighbour pixel information storage and accurate comparison.
The applied Legendre moment in the work is formulated here:

$$P_o(x) = 1$$

$$P_1(x) = x$$

$$P_2(x) = \frac{1}{2}(3x^2 - 1)$$

$$P_3(x) = \frac{1}{2}(5x^3 - 3x)$$

$$......$$

$$P_6(x) = \frac{1}{16}(231x^6 - 315x^4 + 105x^2 - 5)$$

IV. PROPOSED MEDICAL RECORD PRE-PROCESSING TECHNIQUES

The in details study of pre-processing techniques and outcomes from the parallel researches [13] have demonstrated the new direction of research and as an outcome we have the following mentioned proposed novel data aggregation pre-

processing techniques for medical records. The attributes collected from the test dataset are listed with the implication and importance in the predictive model [Table – 2].

TABLE III: DATASET ATTRIBUTES FOR PREDICTIVE ANALYSIS FOR BLOOD SUGAR

Attributes Importance	Attribute Description		
	Name	**Initial Type**	**Description**
Medium	Sex	Binomial	Patient Sex
Medium	Age	Numeric	Patient Age
High	Heredity	Boolean	Parent dieses history
Medium	Weight	Numeric	Patient Weight
High	Blood Pressure	Numeric	Patient BP
High	Blood Sugar	Numeric	Patient BS Level

After we apply the normalization and aggregation process on the data set, we derive the pre-processed and minimized dataset [Table – 3].

TABLE IIIII: DATASET ATTRIBUTES FOR PREDICTIVE ANALYSIS FOR BLOOD SUGAR

Attributes Importance	Attribute Description		
	Name	**Value**	**Replaceable Missing Value**
Medium	Sex	M	M or F
Medium	Age	74	00
High	Heredity	Y	Y or N
Medium	Weight	79 Kgs	65.00
High	Blood Pressure	120 / 91	120 / 80
High	Blood Sugar	150 / 99	120 / 99

The pre-processing denotes that out of 500 unique medical records related to Blood Sugar is reduced to 358 records after the pre-processing operation. Hence the result achieved is satisfactory.

V. RESULTS

After the prosed IIMMAF and MMA implementation to the controlled simulation environment, we study and compare the outcomes of existing agent and proposed agent performance in terms of seconds processing same tasks and sub tasks. The performance comparison is demonstrated here [Table – 4].

TABLE VIV: PERFORMANCE COMPARIONS OF THE EXISITING AND PROPOSED MMA

Number of Detections (In %)	Attribute Description		
	Time taken by existing agent framework (In Sec)	**Time taken MMA (In Sec)**	**Performance Improvement (In %)**
30	0.894	0.462	48.32
50	1.49	0.558	62.55
65	1.937	0.601	68.97
80	1.64	0.9616	41.37
90	2.682	1.0818	59.66

Hence the performance demonstrates a significant improvement over 50% in average. The time reduced by using the mobile agent model controlled by the static component will help the overall system time reduction and performance improvement.

VI. CONCLUSION AND FUTURE SCOPE

This work has analyzed the recent trade-offs of correct outcomes from the parallel researches for medical agent based architectures and understood the bottlenecks and proposed a novel architecture demonstrating nearly 50% reduction of response time. This work also understood the storage architecture in order to find the limitation factors for making the medical record inoperable and exchangeable. Thus in this work we proposed a novel architecture using biometric

property for medical record storage. The novel architecture demonstrates the use of Legendre moments for face recognition and consideration as primary identification parameter. Thus removes the limitations for information exchange. The improvement is also been understood in the light of data encryption in a low scale. The work also studies the existing data mining techniques and identified the bottlenecks of the approaches. These will help in identifying the most suitable predictive model for the medical records in further studies. The work also understand the existing pre-processing of the data to be considered as initial input to the predictive model and applied the same in order to identify the performance improvements. The future scope of the research indicates the research towards finding the most suitable pre-processing method for medical record and the most suitable data mining techniques for the same [14]. The outcome of the further research needs to be tested on multi-dimensional datasets similar to UCI medical dataset. Henceforth, the complete automation of the predictive system is to be carried out.

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