2009 International Conference on Computer Engineering and Technology

Autonomic Computing in Medical Informatics: Accessing and Retrieval of EMR

K.Chandrashekharan,Ashwini Rao, B.Sruthi
National Institute of Technology,Suratkal
Karnataka,India
b.ashwini.rao@gmail.com
niyathicoolest@gmail.com

Abstract:

Medical informatics is an interdisciplinary field of research, where a great deal of collaboration is required to achieve efficient solutions. In this paper we bring in the concept of implementing autonomic computing in medical informatics. The work is in the aspect of maintaining and accessing patient's medical records and/or further retrieval of data in an efficient way with the role of autonomic computing in it. We exhibit a solution in the form of an automated system for EMR (electronic medical record), in this context.

Key words- autonomic computing, medical informatics, EMR.

1. Introduction:

Since the early times , a record of a patient's care, the medical record, has been kept. The record consists of a description of a patient prior to his illness, the symptoms and then a prescription of the patient's course and treatment. Over time the emphasis of the record shifted from the patient's observations to those of the doctor, supplemented by laboratory and radiographic results and hence the records became more and more complex. Clinical record delivery involves information retrieval, integration, processing and transmission. Computers are useful tools for the management of such large volumes of information as contained in the medical record, in form of electronic medical record and hence there is a shift from paper based to electronic medical records. In addition to monetary benefits, the improved methods of organizing and retrieving the large databases accumulated on individual patient provide a real and positive impact on the quality of care and medical treatment .

One of the reasons an attempt at instituting an electronic medical record partially failed was the technology and knowledge needed to access data and also sometimes to rectify if any problems appeared[1]. Up keeping of all clinical records is an automated approach with minimal human intervention that needs huge investment. There are reports on those inconveniences that are inherent in implementing these automated approaches with newer technologies. This paper explores the means of providing an efficient solution in this context by considering EMR[4] as it is an important clinical record while using an upcoming research domain in computing known as 'autonomic computing [6]. We will first briefly introduce autonomic computing in section 2, and then describe (in section 4) the proposed approach - how it is useful in medical informatics.

2. Autonomic Computing: A Brief Introduction

Autonomic computing[6] is domain of development, recently initiated by IBM. It can be seen as future information processing and networking technology with the following prominent features: self configuring, self-healing, self-optimizing and self-protecting. This approach has been inspired from human autonomic nervous system that controls functions like metabolism, modulation of blood pressure, respiration without any human conscious involvement. They are able to self-tune, self-repair and self-adapt. It is a technology that is developed to minimize human intervention in computing or information systems.

These systems are basically an integration of advanced concepts like artificial intelligence, ambient technology, advanced databases, intelligent monitoring, data mining, expert decision

978-0-7695-3521-0/09 $25.00 © 2009 IEEE
DOI 10.1109/ICCET.2009.208

based on environment conditions. Autonomic computing co-relates with pervasive computing which is a paradigm of computing where computers are designed to unobtrusive to the users.

These features of autonomic computing make it very useful in the field of medical informatics.

3. Medical Informatics: Present problems

The present computing systems in medical informatics are not utilising the technology[1] to get the best of it. Hence they face problems like:

- As the system and network size increases the workload of managing gets more tough and complicated and requires more skilled technicians. Hence the labour cost is increasing.
- Present IT environment has become complex, heterogeneous tangles of hardware, middleware and software. It has become difficult to install, configure, integrate, tune and most importantly maintain.

As the systems get more and more complex the doctors and other medical staff and even patients may not be able to easily access the medical information due to lack of the required knowledge and acquaintance.

4. Autonomic systems concepts in accessing and intervening with the EMR (electronic medical records)

Computer based patient record system is continuously expanding in order to serve more clinical activities. The data stored are medical documents relating to past, present physical condition of a patient, the results of various tests and examinations in various formats. Medical data are captured and transmitted, received or updated, stored or retrieved securely by users in geographically distributed organizations in distant locations.

The problem associated is that the clinical output and records are in variety of formats. Furthermore each medical facility tends to have its own method of storing data. Hence when records are transferred from one place to another, there is no conformity among each of the types of data. And also that current communication system utilizing complex multimedia data continues to be designed and manufactured with little or no consideration for a common unifying architecture resulting in a fragmented and incompatible set of technologies and products. These systems are typically incapable of adjusting to the end-user's needs, the dynamics of the underlying network, and to new technologies and devices without a costly development cycle. As the electronic medical record evolves to include various types of information such as embedded video, voice, images and text, a unifying architecture is needed to allow for the exchange of this data regardless of format and location.

Many methodologies have been proposed in the last decade for integration and exchange of medical data[3]. However, little progress has occurred due to the few reasons. In our work, we propose to make the individual system components more self-managing especially the servers, database management systems and the storage systems. Our proposed system is a set of integrated autonomic elements identified at multiple levels that concurrently execute several functions while deriving services from several others. These levels and the integration among them are as follows:

- Data level: Here there is a requirement to access data associated with a particular application and present it to the users of some other kind of application, for which tools required must be capable of data level integration.
- Application level: The requirements of application integration can take many forms: translation of data, standardisation. It also involves data routing and data mapping.
- User level: This involves self-customization like data-presentation, format conversion which is based on the user's preference.

We concentrate only on intra-institution EMR exchange which is more feasible and we assume that the fundamental security, confidentiality and integrity are retained during the exchange. Our

approach doesn't attempt to define the semantics of the exchanged data but just provides a basic syntactic framework to allow exchange of complex data like EMR. Rest of the paper discusses the proposed approach and the above diagrammatic representation of it, in detail. We use the term 'modules' to mean the functionalities of the autonomic elements and their integration.

The modules of our proposed system are:

a. *Auto- search* of the relevant documents of the patient based on the specialisation of the doctor.

b. *Auto configure* the list system in the EMR (electronic medical record) based on the speciality field. There is a component known as inference component that consists of set of modules that will setup the rules for the arrangement of the data that depends on the specialty field.

   And *self-rearrangement* of the patients record accordingly. This is done using a priority list .

c. *Auto-detect* the format of the record and self-match it with the formats readable in the doctors system.

d. *Auto-convert* the format of the clinical record to the compatible one. Text documents, images (x-rays etc), graphs and spreadsheets.

4.1. Auto-Search:

When we deal with a patient's complete health record, it happens that a few doctors would require certain part of his medical record, and the rest some other details. The required report may or may not be available in the database. So whenever a doctor is searching for the patient's past history, depending on the specialisation of the doctor, referring to the database the corresponding reports are to be displayed on the doctor's screen. If not available, an appropriate message is displayed and the doctor is provided with an alternative. For this we employ an effective auto-searching algorithm[2] which is able to handle million records without noticeable delay (within 2 seconds). The IP of the doctor's system is given as an input to the system identifier component which on referring to the pre-defined list checks the availability of the relevant documents required for the corresponding department that the doctor belongs to. If the relevant documents are available it proceeds to the next stage of auto arranging the documents in the predefined order that is according to the institution. Else it aborts and displays a suitable message. The whole procedure is represented in the form of a flow chart as shown in figure1.

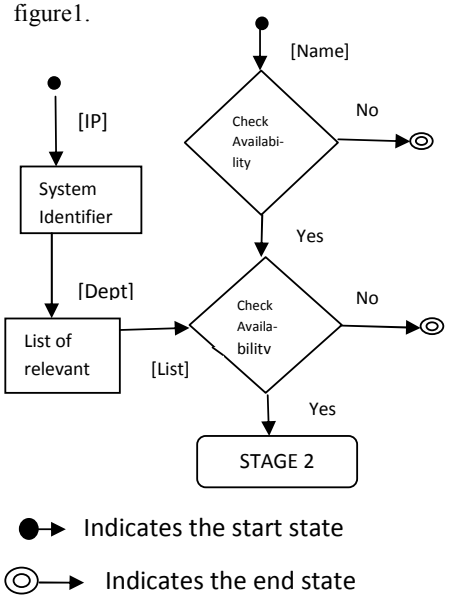

Figure 1: Flow chart representation for the auto-search process

4.2. Auto-Configure:

We already have an EMR of the patient saved in our database. Suppose now a doctor from a certain department is about to access the patient's record, then he might need the details of the patient in a particular fashion. So for this, when a particular doctor or department is accessing the data, our central server detects the server invoking it, and thereby according to that there is an inference component that has a predefined set of modules which have the required order of arrangement and the arrangement is done accordingly. While it would be possible to replicate the entire record in each department (with resulting data coherence problems) a distributed architecture in which portions of the record are sent when requested by auto-selecting those portions based on the department, would be more efficient. It is explained diagrammatically in figure2 in the form of a flow chart.

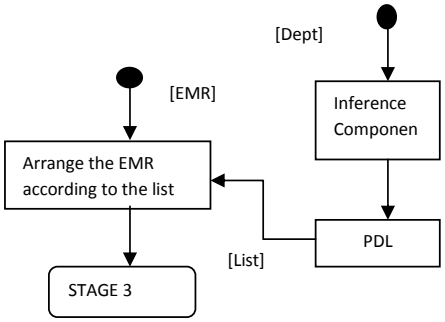

Figure 2: Flowchart representing auto-arrange process

4.3. Auto-Detect:

Generally a doctor prefers opening a file in a particular format. There will be a sensor like software on doctor's system which keeps a record of the frequently used formats in a priority list. So whenever the doctor is trying to open a file, it opens the file in the generally used format. If that is not compatible then it tries to open with the available formats. In case nothing on the doctor's system is compatible then it takes appropriate action.

Priority list: The list stores all the formats of all files that are accessed on that system and the storing is based on the frequency.

Hence whenever a file that is obtained from the server has to be opened, the comparator first checks whether the format of that file is in the frame-priority list. If yes then it uses the corresponding application to open it as done in figure 3.

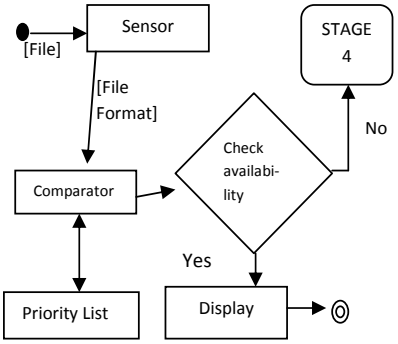

Figure 3: Flowchart representing the auto-detect process

4.4 Auto-Convert:

The first portions of the patient's medical record are usually the name and personal information of the patient and also some numbers like the insurance coverage and medical aid number etc. These figures are mostly in the known forms either floating point type or integer. In rare cases even if they are not in the required format then they are easily reduced to the format needed by using various tools available already in the financial field. But the later portions of the medical record that are clinical data and results may not be in the required format and it may not open with any of the word processors available in the doctors system. Then it becomes irritating for the doctor to search for a converter or alternative reader. Here our proposed system(refer figure4) comes in use and frees the doctor from this burden.

Nowadays the relational databases are used for EMR which consists of only four enumerated types of data that are integer, floating point, boolean and text. So whenever complex data is encountered it has to be converted to a readable format. Conversion can be done by numerous converters that are already available.

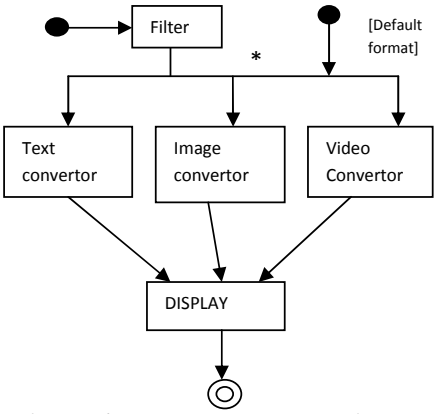

Figure 4: Flowchart representing the auto-convert process

5. Motivating Scenario:

Here we present a scenario which provides a practical picture of our proposed system. The scenario is based on a situation where patient say Mr.ABC is asked to undergo a heart surgery .When the patient is moved to the cardiology department, the doctor in charge wants to refer to the patient'sprevious records and tests while preparing for the surgery.

Traditional approach:

1.The doctor searches for the EMR of the patient.

2.After downloading the EMR of the patient from the database of the central server which takes considerable amount of time, he then manually searches for the relevant records like the x-rays , blood report etc.

3.Then since the records are in .docx format and it is not compatible with his system , if the doctor is skilled enough in computer field he might use some convertors to convert it to compatible format or else he might refer to the technicians which is again time-consuming.

Our approach (Automated approach):

1. The doctor enters the name of the patient in the interface on his system.The name is sent to the main server where the autonomic components detect the department and searches for the patients records that are needed for the cardiology department.

2. After finding relevant records, the inference component of the autonomic system arranges the reports in the order say x-ray, blood report and a summary of heart-related medical data.

3. Then it refers to the other autonomic component present in the doctor's system that keeps the track of the formats that are generally used by the doctor say he uses .doc format and .jpeg format for images.

4. Now the images present in the EMR in the .jpeg form but the text is not in the .doc form but it's in .docx format. Then the autonomic component uses middleware convertors that convert the .docx form to .doc form and displays the arranged and formatted EMR to the doctor.

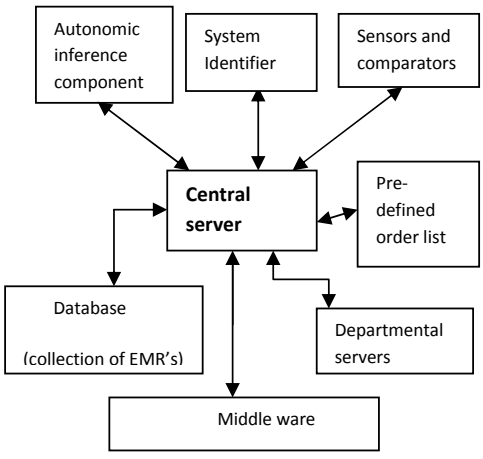

Figure 5: Architecture of the proposed system at the Central Server.

The above diagrams[figure 5] represent the total working of the autonomic concept which we are trying to put in as a whole.

6. Conclusion and Future work:

There are numerous technical issues in medical informatics. Many of them are being taken up by various institutions. We have observed a set of fundamental problems. We have proposed some practical approaches employing number of advanced technologies which we hope will lead to more satisfactory solutions in the long run. Enabling autonomic infrastructures to communicate and exchange medical records is a very challenging task when it comes to inter-medical centres. Data integration, resource consumption, network bandwidth, and security due to the nature and sensitivity of medical data, all present major problems. But we have already proposed a stepping stone to this by providing an efficient way for intra-medical centres which can be further improved and applied in the case of inter-medical centres. Such efforts will complement the technological work that is underway.

References:

[1] Ifay F. Chang IBM TJ. Major Technical Issues in Medical Informatics Computer Technology Systems and Applications. Watson Research Centre.

[2] Glenn B. Bell and Anil Sethi.Matching Records in a National Medical Index .

[3] Naomi Sager, Lynette Hirschman, Ralph Grishman and Cynthia Insolio. Transforming medical records into a structured data base.

[4] Vagelis Hristidis, Peter J. Clarke, Jeffrey A. White, Redmond P. Burke,MD . A Flexible Approach for Electronic Medical Records Exchange.

[5] Jeffrey O.Kephart David M. Chess IBM Thomas J. Vision of Autonomic Computing. Watson Research Center.

[6] A.L. Rector, W.A. Nowlan, S. Kay, C.A.Gob1qT.J. Howkins. " A framework for modelling the electronic medical record", Meth inform med,vol. 32, 109-119, 1993.