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Distributed Virtual Patient Record System

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Abstract: Distributed virtual patient record system is proposed for diagnosis and analysis. It permits physicians located at various places to consult on the status of the patient. In spite of patient data located at various sites, the data can be assembled and the patient record can be constructed dynamically by using the patient's Social Security Number (SSN). Later, a graphical model could be constructed through which consulting physicians can derive useful information about the current status of the patient. It uses modern distributed objects and emerging telecollaboration tools. In this study, we describe the meaning of distributed virtual patient record, the barriers for implementing the system, requirements of the system and services. In addition, an example named "TeleMed" which implements this concept has been described.

Key words: Virtual patient record, mobility, distributed health care, telemedicine, objects, authentication

INTRODUCTION

Information technologies have started to have a major impact on the various business and social applications. In turn these technologies have improved quality and lowered the cost of business processes. Healthcare is no different in this respect. A change in the way healthcare providers and payers manage patient information is needed to have cost effective and quality healthcare. For this, the patient data should be treated in an entirely different way (Philips, 1994). That is the patient's medical record should be thought as an entity that exists on the network in its aggregate form simultaneously collected from various locations. We refer this requirement for multiple entry points into the healthcare system as Distributed Healthcare. In this study we describe some of the motivations for change and include what we mean by a Virtual Patient Record. Also some results of early implementation of Virtual Patient Record.

Virtual patient record concept: For a long time healthcare providers and payers have realized that electronic records have real value and moving this digital data around to areas where it is needed is highly desirable (Dick and Steen, 1991). To support and implement this issue we move for Virtual Patient Record Concept. The Distributed virtual patient record system considers the medical record of patient as an entity that resides on the network as an aggregate form. The records can be populated from multiple locations as well as can be accessed from anywhere in the network. One of the applications of this concept is the Telemedicine.

At present most systems have been designed without the requirement of data sharing or exchange. Due to the increasing mobility of patient population and changes in the healthcare providers and payers, the patient's medical information are presented in different locations like Hospitals, HMO's and Doctor's offices. These information have no link between them. Due to these multiple entry of patient's information, only a fragmented portion of all information is available at a particular time and place which is not a beneficial one.

As the mobility of population increases continuously, it becomes necessary to access the patient data in an organized manner on a National and even global scale, independent of the healthcare provider or payers. The proposed system to serves this purpose. A number of organizations are working to standardize healthcare information and communication. Some of them are JWG-CDM (Joint Working Group for a Common Data Model), the Health Level 7 (HL7) group, the CPRI (Computerized Patient Record Institute), Object Management (OMG) (object Group Management Group 1991), etc.

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Virtual patient record concept: The concept of the proposed system is to consider the patient's medical record as an entity that exists on the network in its aggregate form simultaneously populated from multiple locations. According to this, a virtual medical record for patient is created. It would be assembled for their local medical records and various institutions that could be integrated at any point of care to enable the physician to provide the most appropriate care possible.

Virtual Patient Record System has captured the interest of the medical community, the Government and the public not only for its cost effectiveness for improving access to quality healthcare system but also for overcoming geographical boundary barriers. That means, in rural areas where specialized medical care may not be available, the proposed system can provide a large impact on the quality and the speed of the patient care.

Barriers of the proposed system: While many people acknowledge the practical advantages of the proposed system, not everyone is at case with the transmission of confidential patient data over electronic network.

The barriers to this system are large and involve substantial technical, political, social and economic issues. The political and social barriers are much more difficult to overcome, but may become easier to deal with once the capability of implementing a virtual medical record has been demonstrated.

Technical barriers: The technical barriers include establishing a common terminology, a common methodology for linking systems together and an interoperable securely process for protecting the clinical information. It will continue to be impossible for everyone to agree on a single set of terminologies in healthcare that will almost certainly vary from country to country, if not region to region and organization to organization. However, using a 'Translator', which will map the terms from one terminology system to another, can solve the problem. An example of this is Terminology Query Service (TQS) or Lexicon Query Service (LQS) of the Object Management Group (OMG).

The common methodology for linking systems together presents an interesting technical challenge today, primarily, because of the rapid technological changes that are occurring within Internet community. An object-oriented framework has existed for a number of years, which provides a complete communication mechanism for linking heterogeneous systems together. It is the Common Object Request Broker Architecture (CORBA) of the OMG. It has been used successfully in many large-scale applications and has been deployed commercially.

Economic barriers: Though technical solution is feasible now a day, the cost of implementing the system remains a major obstacle. When deriving the cost of the proposed system, a number of factors should be kept in mind. First, most systems have been designed without the requirement of data sharing or exchange. In addition, systems have been designed primarily for the large hospital environment and customized for each facility.

This results in heavy costs because of the customization work that is required for different facilities.

Solutions for the independent physician are much less expensive, but usually have no capability for networking or interoperability with other systems. These tend to be stand alone systems for a single practice.

To implement this advance technology, the implementation cost must be feasible for a single physician practice as well as for a large medical facility. So an open source technology can be used to implement the system.

However, the social and political obstacles may still remain. The demonstration of the value of a virtual medical record in practice has to go a long way to mitigate these social and political barriers.

Requirements of the proposed system: To implement the proposed system efficiently, a number of issues have to be taken care of. These are

- For accessing of information by end users such as physicians and patients, the patient's information must appear to the user as a unified set of data even though it may be spread all over the country.
- Creation of the virtual patient record must be done with minimum compromise in the integrity of the data while maintaining high accessibility.
- The proposed system requires high quality network connection, but it is not necessary unless large amount of images or video data need to be moved.
- The proposed system requires a robust security infrastructure to support authentication, confidentiality and data integrity so that there is no single point of failure that, if compromised, would give access to all the information. To provide multiple access capability and to provide a universal but secure way to identify and locate patient information, various replication servers are also required.
- Virtual patient record might be configured differently at different locations, but these must be mapped into a common format at the time when the record is required.
- To access the virtual patient record, the patient must be identified uniquely and securely. A Master Patient Index (MPI) can meet this requirement.

Proposed system services: The proposed system will provide the following core services:

- A security infrastructure that supports authentication and secure transmission of private and confidential patient information, utilizing high-bandwidth communication and secure communication technologies (encryption, authentication, etc.).
- Transparent and easy access to distributed patient information through a distributed virtual master patient index.
- A secure workflow in the context of patient treatment, using common patient record model.
- A secure consultation service with voice, video and shared applications for patient information and treatment.
- Other services that we will plug into this backplane to provide custom support features to specific providers include:-
- Real time or near real time access to information gathered by instruments monitoring a patient.
- Seamless access to clinical decision support systems and on-line knowledge repositories, such as MedLine.

It is now possible to implement the Virtual Patient Record concept if all stakeholders, government, public and private cooperate in making it a reality in the everyday practice of medicine. Many of the standards are being put into place, but more standard representations of the medical objects are needed. This is one of the goals of the new Healthcare Task Force created by OMG.

Example of proposed system: TeleMed is one of the systems that is based on the "Distributed Virtual Patient Record System" concept. The system has been constructed by a joint cooperation between Los Alamos National Laboratory, Los Alamos, New Mexico and National Jewish Center for Immunology and Respiratory Medicine (NJC).

The proposed system permits physicians at different places to simultaneously see, edit and annotate a patient record at remote locations. It is also capable of handling multimedia data including CT imaging and audio annotations. The technology behind the system is Object Request Brokers (ORBs) that provide the persistent object storage of the multimedia data. The proposed system implements object level security to provide authentication and encryption for confidentiality.

During testing and evaluation, the system had been deployed at the NJC, the NTH and at the TMC. Physicians at these institutions can simultaneously view, edit and annotate the patient data stored at multiple locations. Each physician can see the data that has been entered by other physicians.

During testing, it gives a illusion to the physicians that all the data are in their own computer and no multiple databases are invoked. The system also supports video teleconferencing depending on the availability of the bandwidth.

Overview of the proposed system: By looking at a series of user interface components that are available to the user, we can illustrate the capabilities of the proposed system. Here a TeleMed session begins when the user selects a database site from the interface shown in Fig. 1. This action generates an event, which collects all patient record objects from the selected site and provide to the requesting client, as shown in Fig. 1.

By double clicking on the patient name in the interface, the corresponding patient's medical record could be seen.

A graphical representation of TeleMed objects in Fig. 2 has been provided to understand the coordination of distributed object activities with user interface activities (Orfali *et al*., 1996). In this diagram, the arrows represent an inheritance relationship and the other lines represent a reference on containment.

The user interface manifestation of the Observation Battery, Treatment and annotation objects in Figure2 is called a Graphical Patient Record (GPR) and is shown in Fig. 3.

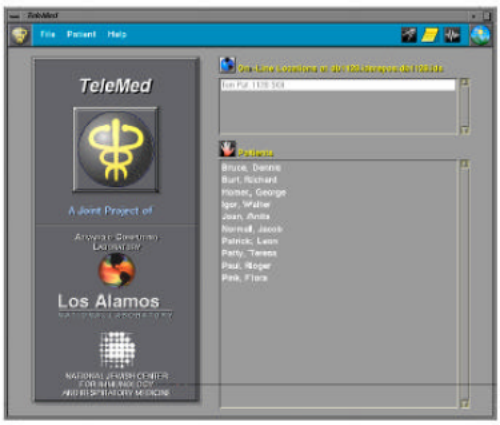

Fig. 1: Initial tele med interface

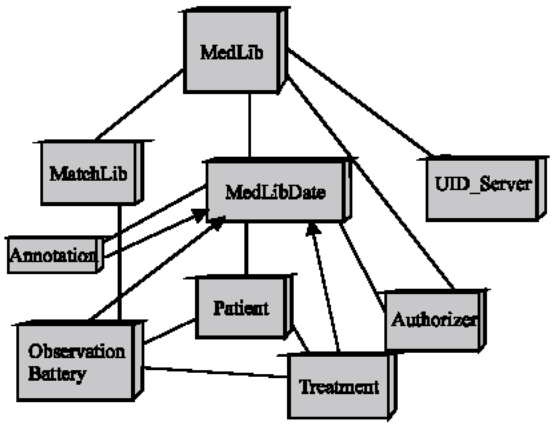

Fig. 2: Telemed object

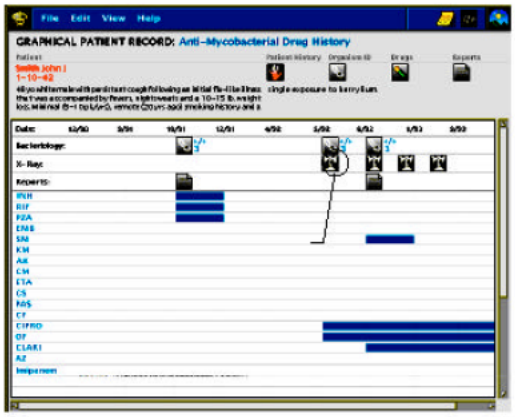

Fig. 3: Telemed graphical patient record

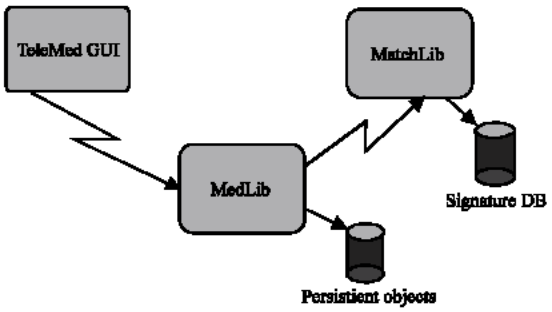

Fig. 4: Telemed object distribution

The GPR is nothing but a patient record that remains empty until it is dynamically populated through distributed objects on getting a request from user. The object in Fig. 2 contains the necessary information for harvesting the data from all appropriate sites. When all patient data are retrieved, icons representing various information like laboratory tests, radiographic studies, drug treatments, etc. are drawn on the GPR template. Each of the above mentioned icons are mouse-sensitive and when clicked, provides more detailed information.

To understand the concept, we have taken the relationship between the client process (TeleMed GUI) and the two controlling objects- MedLib and MatchLib. Here the entities can reside at any location. The TeleMed GUI can communicate with any number of MedLib objects, which, in turn, can call upon the services of any number of MatchLib objects. This is illustrated in Fig. 4

Now if the user clicks on the CT study icon of the GPR in Fig. 3, a request is sent to the current MedLib to retrieve that patient CT study from the corresponding persistent object store.

Inbuilt security features: The system has a security infrastructure layer which intended to provide the security services necessary to allow access control for patient data. For any medical system, it is the primary consideration to protect patient confidentiality and also to protect against unauthorized additions, deletions and modifications of patient's data.

The system uses the authentication and key exchange protocol. Here the user register RSA public/private key pairs with the key server, while the DES secret keys are registered for CORBA objects.

For allowing convenient remote access by users, the encrypted RSA private keys are stored in the key server. There is no need for the user to store their keys on a local file system. Here the private keys are encrypted with a DES secret key before submission to the key server. So it is not possible for the system administrator to get private key.

The authentication mechanism of TeleMed is implicit. Here users authenticate their identity by virtue of their ability to successfully decipher the encrypted session key. Again the server authenticates their identity by virtue of their ability to successfully decipher the encrypted ticket. The ticket server authenticate its identity by signing the session key and ticket it produces by using an RSA private key.

Capabilities of proposed system: The system has a number of advanced capabilities. One of them is Data Mining. It supports basic data mining by providing abilities to compare images with Similar features and also to virtually navigate through a image database. This feature allows a user to perform a Query By Example search of an image database.

In this system when the user clicks the FindMatch button in the upper right of the Fig. 5, the selected slice is used as the query image. The result of the query operation is displayed in Fig. 6. Here the result of the

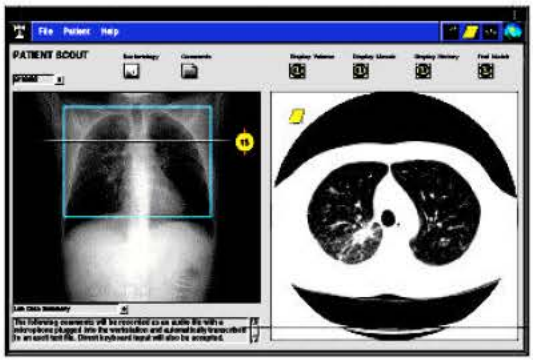

Fig. 5: Telemed CT study Interface

Fig. 6: Telemed image matching interface

match is summarized by the thumbnails in the lower scrolling window. If we click on a selected thumbnail, full size representation appears.

Similar projects: There are some more examples of systems that are based on this concept. One of them is MedAbiliti DMR. It is a XML enabled technology that integrates existing, diverse repositories of medical data with privacy and security controls.

DMR stands for Distributed Medical Record. DMR is a framework for degitizing medical data based on open architecture and open standards.

CONCLUSION AND DISCUSSION

The "Distributed Virtual Patient Record System" can be extended to a variety of clinical and diagnostic areas. However to implement it, all stakeholders, Government, public and private must co-orporate. They must have to come forward to build a common infrastructure and also standards for implementing it. This not only change the quality of service, speed and reduce cost but also it will create a new business opportunity for the global market as well.

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