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Telemedicine and e-health: Today and Tomorrow

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Abstract: Telemedicine is a generic term referring to all forms of medical information exchange, including a variety of telecommunication technologies. Applications in health and medical care include tele-communication, data and information technique are used to transfer medical information. The challenges facing developing countries (like India) in delivering high-quality medical care during the next century are great. Overcoming poverty, difficult access to medical care, governmental instability, lack of trained physicians, and a large burden of existing and emerging diseases all appear at times insurmountable.

Keywords: Telemedicine, e-health, Decision support system, Store & forward architecture, Patient records, Medical data, Multi agents.

I. INTRODUCTION

Very small portion of world's total population is living in urban areas and have access to medical facilities. People living at remote places don't have access to all medical facilities, hence a need to develop a system that eradicates the geographical constraint so that facilities are available to remote areas easily. A system known as "*telemedicine system*" is designed.

American Telemedicine Association gives Telemedicine's definition as "Telemedicine is use of medical information exchanged from one site to another via electronic communication for health and education of the patient or healthcare providers for the purpose of improving patient care". The main objective is to enhance the public health by making medical services available to everyone despite of geographical & economic constraints. Key objective or intent is support the concept of equality. Telemedicine bridges the distance between people residing at remote areas.

Telemedicine provides medical facilities from specialized doctors located at urban areas so that people living in remote areas can avail the medical facilities. Telemedicine's aim is to provide good quality medical services and timely access to these medical facilities (i.e. regular access without geographical constraints).

II. HISTORY OF TELEMEDICINE SYSTEM

The first trans-telephonic "electrical stethoscope" was demonstrated in England in 1910 which amplify the sounds from a stethoscope & transmitted them through a telephone network. After some year transmission of images and ultrasound images via a computer modem also included.

The National Aeronautics and Space Administration (NASA) played an important part in the early development of telemedicine. NASA's efforts in telemedicine began in the early 1960s when humans began flying in space. Physiological parameters were transmitted from both the spacecraft and the space suits during missions. Some call centers are also established in some developed countries. These services are having large numbers of registered nurses and only these can have access to emergency healthcare services and provide appropriate levels of care and information about providers' availability.

Nurses follow computer driven protocols to give advice about a wide range of problems. In UK NHS-Direct began in 1997 & 65% of UK population has 24 hour access (i.e. services available 24 hours and 7 days a week).

III. EXISTING SYSTEM

The existing architecture of telemedicine system consists of a mobile telemedicine unit and a rural telemedicine unit. Mobile unit may be portable (easily movable) and located at the patient's site, and secondly is a base unit or doctor's unit located in a medical monitoring hospital these are connected to city hospital, which consists of various physical

workstations and is dedicated to a specialized doctor, through communication links.

Communication between the two units can be established using wireless digital cellular, radio packet or ordinary fixed telephone lines.

A. Telemedicine Workstation

In order to provide medical care, especially in remote areas, we need to use a flexible cost-effective telemedicine workstation. The purpose of telemedicine is to link district hospitals, city clinics, and remote locations to enable health care providers to exercise their expertise at the location of the patient or other doctors using a combination of video, audio, and externally acquired images. The telemedicine system should give remote telemedicine unit a better access with urban health units and help to manage limited health care resources more effectively. Possible application of this unit includes ultrasound examinations, radiology, pathology, dermatology etc.

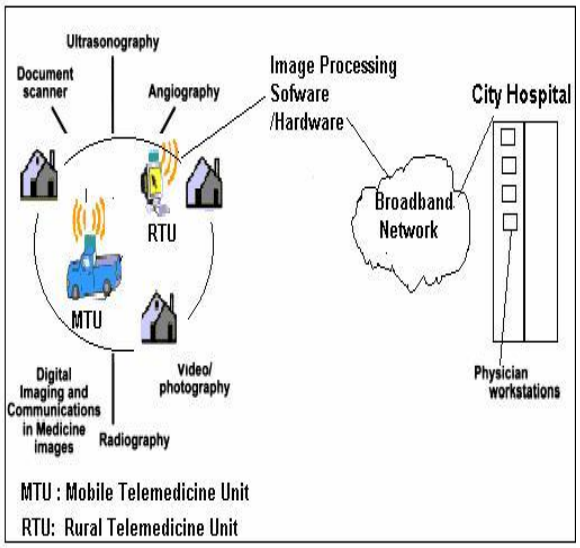

Fig. 1. Architecture of Telemedicine System

B. Telemedicine Data Transmission Network

The telemedicine workstation should be a single board multimedia system capable of digitizing audio and video displaying up to 1280 x 1024 pixels, on high processing operations per second using a multimedia video processor.

Workstation will use a network card such as an asynchronous transfer mode (ATM) interface adapter, so that the system should be able to transmit and receive video, audio, and medical images on a fast speed.

For high-bandwidth applications, the workstation should encode video using the Motion Picture Experts Group (MPEG) standard and for low-bandwidth links, the International Telecommunication Union (ITU) H.320 standard for video conferencing can be used.

C. Medical Image Processing Unit

Basic image manipulation functions such as 90 degree rotations, horizontal and vertical flip are essential to correct the errors in image acquisition and assure that images can be presented to the clinicians in a way that they are accustomed to viewing them.

Zooming and panning are necessitated by the limited spatial resolution of CRTs when compared to X-ray films. Real-time window/level (brightness and contrast adjustment) is required by the need to interactively examine medical images with more than 8 bits/pixel by adjusting the range (window) and the center position (level) in the wide input dynamic range. In the case of diagnostic video, manipulation functions such as play, record, pause and rewind are important for simulating the VCR environment often used in ultrasound consultation.

D. Store and Forward Architecture

The first telemedical consultation probably dates back to the time when the telephone was invented. Even today, consultations over telephone are probably the most frequent form of tele-consultations between patient and health providers.

One technology that has certainly impacted telemedicine is video conferencing. The life transmission of image and voice of two partners has often been regarded as a key necessity for telemedicine consultations. In reality, the importance of video conferencing is depending on the specific type of telemedicine. While video conferencing is ideal for a tele-psychiatry consultation, videoconferencing technology have never been widely used e.g. in Pathology.

One often overlooked limitation of video conferencing is that the consultation must necessarily be held in real-time with all partners sitting together at the same time. With busy schedules of modern medical work the planning of appointments with all partners can be difficult, especially if some partners are not located in the same time zone. Additionally, the live use of technology makes the application also prone to technical problems. Technical problems at one partner's side tend to block everyone else.

An alternative to real-time consultations is so called store-and-forward telemedicine where the partners work in an asynchronous way. The non-expert or submitter will prepare his question and the necessary material (store) and then transfer it to the expert for review (forward). The expert can review the material at a later time and write a report back to the non-expert. A consultation sent by email is a very basic form of store-and-forward telemedicine.

With the medical knowledge constantly increasing and diagnostic methodology as well as treatment options multiplying, clinical decision making is getting more and more complex. Involvement of appropriate sub-specialists and communication between different partners in the healthcare systems are becoming more and more important. Email is often not appropriate to organize structured communication in a larger group. Thus, specialized often web-based applications are more readily being used for telemedicine. In contrast to email and especially to video conferencing, web-base and database driven applications simplify the archiving of the telemedical process.

IV. DATA SECURITY-CONFIDENTIALITY AND AUTHENTICITY OF DATA IN TRANSMISSION

While the data is transmitted from remote hospital to a hospital in urban area there is possibility that data get delivered to some unauthorized party or sometime it is hacked.

To avoid this problem we can apply encryption scheme. Each person gets a pair of keys, one called the public key and the other called the private key. The public key is published, while the private key is kept secret. The need for the sender and receiver to share secret information is eliminated, all communications involve only public keys, and no private key is ever transmitted or shared. Public key encryption scheme is used in this public key of receiver is known to everyone and sender encrypt data using receiver public key and then use digital signature on this data. Then data is sent. At receiver end receiver knows the public key of sender. Then receiver first decrypts the data using sender's public key and again decrypts the data using own private key corresponding the public key by which data get encrypted by sender.

A digital signature scheme typically consists of three algorithms:

- A key generation algorithm that selects a private key uniformly at random from a set of possible private keys. The algorithm outputs the private key and a corresponding public key.
- A signing algorithm which, given a message and a private key, produces a signature.
- A signature verifying algorithm which given a message, public key and a signature, either accepts or rejects.

Thus applying encryption and digital signature on data ensures confidentiality and authenticity.

V. TELEMEDICINE IN INDIA

Telemedicine, an upcoming and very high potential field, is in relatively nascent stages right now in India as compared to Western world. However, some exemplary work has been done to improve access to less privileged sections of society, which is expected to accelerate in near future.

The Apollo group of hospitals was a pioneer in starting a pilot project at a secondary level hospital in a village called Aragonda 16 km from Chitoor (population 5000, Aragonda project) in Andhra Pradesh. Starting from simple web cameras and ISDN telephone lines today, the village hospital has a state-of-the-art videoconferencing system and a VSAT (Very Small Aperture Terminal) satellite installed by ISRO (Indian Space Research Organization). Coupled with this was the Sriharikota Space Center project (130 km from Chennai), which formed an important launch pad of the Indian Space Research Organization (ISRO) in this field.

VI. CONCLUSION AND FUTURE WORK

Telemedicine can be utilized to bring high-quality information and medical care to locations previously limited by lack of finance, inadequate training, and geographic distance. Decision support system (DSS) and application of multi agent system, intelligent agent will help people as there is automatic redirection of data. This redirection of data to a hospital having a specialized doctor can help in getting a patient diagnosed.

Telemedicine and e-health technologies permit communication between patient and medical staff with both convenience and fidelity. Telemedicine and e-health technologies also permit the medical transformation, imaging and health data transfer from one site to clients and cooperation with all of applied agents.

Multi-agent system can not only integrate the medical knowledge and clinical experience and make decision support, but also adapt the system rapidly to the change in environment. So multi-agent approach can effectively tackle the complexity of telemedicine systems.

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