Multimedia Computing Environment for Telemedical Applications

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INTRODUCTION

Telemedicine (in short, e-medicine) is a means of delivering medical services to any place, no matter how remote, thereby removing the limitations of space and time that exists in today's health-care settings. Computers are indispensable in telemedicine, since they provide for efficient, relevant data gathering for large-scale applications. Besides providing immediate feedback of results to patients and doctors, they also can compare past patient records and evaluate relative improvement or deterioration. Further, they are readily available at any time, fatigue-free and can be more objective.

Five important application areas of telemedicine are:

1. Lifetime health care;
2. Personalized health information;
3. Tele-consultation;
4. Continuing Medical education; and
5. Context-aware Health monitoring.

For example, computers provide for multimedia imaging: ultra sound, digital X-rays, 3D spiral Cat Scanner, magnetic resonance imaging, PET scanning, and so forth, and can fuse them into a single multi-purpose image using fusion software. Adding mobility to computers enhances their role in telemedical applications considerably, especially at times of emergency since the patients, doctors, the data collecting and retrieval machines, as well as their communication links can always be on the move. Very simple, inexpensive mobile communication and computing devices can be of great help in telemedicine, as explained in the following:

- ***Low Cost Radio:*** Even the simplest of mobile devices, such as a low power radio that can transmit messages to a home computer from which medical data can be sent through telephone line and the Internet can be of great value in saving lives (Wilson et al., 2000).
- ***Personal Digital Assistants (PDA):*** The simplest of the computers, such as palmtops and PDA can assist the doctors for instant nomadic information sharing, and look for diagnosis of different diseases and treatment. PDA can help the doctors to figure out drug interactions, storing summaries of sick patients and their drug list. Further, PDA can provide for downloading suitable programs from the Web, and can be programmed for alert, sending and receiving email, jotting down pertinent points, and for storing immediately needed clinical results to carry out ward rounds. Also a hand held system can provide context-awareness to support intensive and distributed information management within a hospital setting (Munoz et al., 2003).
- ***Internet:*** The Internet is an important tool for medical professionals and will completely change the manner in which medical consultations are provided (Coiera, 1997); for further details on telehealth and telemedicine practice and their real life implementation issues, refer to Orlov and Grigoriev (2003), Jennett and Anddruchuk (2001), and Suleiman (2001).

For minor ailments, Internet-based consultations to doctors can provide prescriptions for medical/pathological examinations by laboratories. The results are then posted in the Internet for subsequent reading of the results by the concerned doctors who can prescribe medicines that can be posted on the Internet. This prescription can then be handled by a pharmacy to dispense the medicines to the concerned individual. Kim and Hwang (2001) have proposed a password controlled Internet-based medical system that brings in a variety of services to doctors, patients, pharmacists and health-care professionals. It allows people to receive medical examinations and medical advice.

BACKGROUND: TELEMEDICAL INFORMATION SERVICES

The first step in telemedicine is the telemedical diagnosis (or telediagnosis) based on information obtainable from medical images, blood, urine and other pathological test

reports. Usually, for diagnostic purposes, the doctor sends a patient for such examinations. The laboratory assistant takes the required X-ray or ultrasound images or carries out pathological tests and passes these images (or readings) on to a radiologist/pathologist who then makes analysis and sends a report to a doctor. These manual actions are totally sequential and slow. This whole procedure can be made cooperative and faster, if the images and data are stored in a database and these can be simultaneously retrieved by specialists in their offices or homes to make a cooperative diagnosis (Alfano, 1997; Coiera, 1997; Ganapathy, 2001; Gomez et al., 1997; Jameson et al., 1996; Kleinholz et al., 1994; Lauterbach et al., 1997).

Principal Aims

The principal aims of e-medical informatics are to:

(i) provide online services of patient records (medical and pathological databases) to medical practitioners and radiologists;
(ii) provide primary specialist diagnosis, offer second opinion, provide pre- and post treatment advice through email;
(iii) reduce the cost of imaging equipment, delay, and increase the speed and volume of diagnosis;
(iv) aid cooperative diagnosis and provide assistance for remote surgery;
(v) provide student /resident education;
(vi) reduce professional isolation, increase collaboration; and
(vii) provide home-care.

Advantages

E-medicine offers the following advantages:

(i) Provides health care to under-served and isolated areas so that we can make a better allocation and utilisation of health resources.
(ii) Since communication cost is much cheaper than the transportation cost, patients in remote areas can outreach physicians quickly.
(iii) Increases the speed of diagnosis and treatment especially when used for teleradiology, cardiology, psychiatry.
(iv) Allows access to specialty care using time-oriented clinical data.
(v) Real-time monitoring of public health databases to prepare and respond during epidemics, biological and chemical terrorism.
(vi) Internet can provide the following support:
a. Health information;
b. Administrative infrastructure;
c. Online health records;
d. Pharmaceutical information and sales outlets; and
e. Online training for telemedical professionals.

Prerequisites

The pre-requisites for a successful implementation of a telemedical system are:

- *Infrastructure:* A suitable infrastructure of health care providers, doctors, engineers, computing specialists, communication engineers, information technology professionals and medical statisticians to analyse outcomes and suitable outreach clinics with telemedical facilities.
- *Communication Network:* Reliable, inexpensive and readily accessible communication network from outreach clinics to hospitals, doctors and patients and pathological laboratories.
- *Low-cost Computers:* Suitable low-cost hardware-software and a good communication bandwidth to transmit medical data in different modes; for example, radiological images, video images of signals and text. While using wired in or wireless mobile devices and monitors, the effect of electromagnetic interference (EMI) and radio frequency interference (RFI) on data collection and transmission, and the side-effects on patients, both physiological and psychological aspects, have to be taken care of so that improper diagnosis does not result.
- *Training Facility:* Training of personnel to provide proper maintenance of equipment and safety standards to patients.
- *Security, Reliability, Efficiency:* Reliability, Efficiency, Security, Privacy and Confidentiality in handling, storing and communicating patient information.

Economic Necessity

In densely-populated countries (e.g., India), the rate of growth in hospital beds to cope up with the increasing population is economically unsustainable and technically not viable, since the number of medical specialists also cannot grow to meet this demand (Ganapathy, 2001). The use of telemedicine avoids unnecessary strain involved in travel and associated expenses, provide immediate attention and care, can avoid hospitalization, and allow the patients to stay home enjoying family support. Chan et al. (2000) describe a real-time tertiary foetal ultrasound telemedical consultation system using standard integrated system digital network (ISDN) that operates in Queensland, Australia. This consultation system has gained acceptance from the clinicians and patients.