

Tele-Health and Artificial Doctor: Two Technological Hands for Remote Villages in INDIA

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Abstract: Today, we are much cautious about our health care. Modern face of medical science makes a great effort in making distinction in health care. In India though we have so many technologies available with us but still health care is the sizzling issue in the rural areas of the country, where we found the lack of expert advice and timely treatment. Computer science and telecommunication are two widely used branches of science may help medical science in achieving the objective and bring a solution for this scorching problem. Here we are suggesting two technological tools, telehealth and artificial doctor as two technical hands for the future doctors. Telehealth uses the telecommunication resources and provides the medium for the data communication between remote villages and far located well-equipped city hospitals. The advancement in computer technology has encouraged the researchers to develop software for assisting doctors in making decision without consulting the specialists directly. The software development exploits the potential of human intelligence such as reasoning, making decision, learning (by experiencing) and many others. Artificial doctor based on concepts of artificial neural network is an innovation in software Industry. It provides the best possible alternatives for the treatment of the patient for any unknown disease on the basis of its previous training on thousands of cases of various diseases.

Key words: Telecommunication, Artificial neural network, Telehealth, Artificial Doctor.

1. Introduction

Lives are not secure these days. We fight with continuous attacks of several virus diseases spread over our surroundings. We spend a lot of money and time in caring ourselves from these diseases. Living in rural areas of India is often a curse even in the twenty first century. There are no medical facilities available in such villages due to which the peoples are facing many problems with their health care. The nearest hospital is very far from such villages. Peoples also can't afford to get better treatment from costly and well-equipped far located city hospitals. Hence we loose valuable lives due to the lake of medical facilities in these areas.

In most of the developing countries like India inadequacy of medical expertise, especially in remote villages, has increase the transience of patients suffered from various diseases. We will never prevail over inadequacy of medical experts or specialists within a short period of time. The institutions cannot produce as many doctors as we required every year. However, while waiting for students to become doctors and the doctors to become specialists or experts, we will loose many valuable lives. Current practice for medical treatment required patients to consult specialist for further diagnosis and treatment. General medical practitioner in remote area may not have enough expertise or experience to deal with certain high-risk diseases or sudden outbreaks. However, the waiting time for treatments normally takes a few days, weeks or even months. By the time the patients see the specialist, the diseases may have already spread out. As most of the high-risk disease could only be cured at the early stage, the patients may have to suffer for the rest of their life.

The solution for this sizzling problem may be found with two technological tools, Telehealth or Telemedicine and Artificial doctor. Telehealth uses telecommunication resources for providing the far distant communication between remote villages and far located well-equipped city hospitals and Artificial Doctor uses the training and testing capabilities of artificial neural networks for providing the best diagnosis for an unknown disease. In this paper, we are focusing a ray of light on both the technical achievements.

Over the past 5 years many of the developed countries has been considerable active in implementing computer-based solutions to assist healthcare practitioners. As a result the first paperless hospital has been implemented in Malaysia. There are a number of challenges in implementing a paperless hospital change management infrastructure, lack of communications infrastructure, and integration into healthcare practice and privacy issues related to health data. If we overcome all these drawbacks, then only we can save valuable lives in remote area villages of India.

Today we are developing Computer programs or software by imitating human intelligence. They can be used to assist the doctors in making decision without consulting the specialists directly. The software was not meant to replace the specialist or doctor, yet it is develop to assist general practitioner and specialist in

diagnosing and predicting patient's condition from certain rules or "experience". Patient with high-risk factors or symptoms or predicted to be highly effected with certain diseases or illness, could be short listed to see the specialist for further treatment. Employing the technology especially Artificial Intelligence (AI) techniques in medical applications could reduced the cost, time, human expertise and medical error.

Computer technology also helps reducing the cost and time during registration process. While diagnosing the patient, doctor can refer to patient's history record for a history treatment. A prescription of medicine can automatically sent to the dispensary. Using the technology, problems in preparing the medicine and drug complication can be avoided¹.

2. Telehealth

Today's, excellence in healthcare is a burning concern in medical sciences and world's outflow for this concern is substantial. Current achievements in the fields of computer sciences and telecommunication afford a technical hand for future doctors by mounting a magnificent technology termed as telemedicine. Telehealth brings the world's paramount medical information from a well-equipped metropolitan city hospital to any rural hospital. Worth medical care is mostly far for the remote villages. The nearby hospital is very far from such villages. Therefore, we are losing valuable lives due to the lack of expert advice and timely treatment in such areas. Providing the best medical care for these rural areas are very expensive. The solution for this sizzling problem is to promote telehealth, which provides the prominent medical care to any remote areas by using the telecommunication resources.

Today, Telemedicine or Telehealth can be defined as the integration of information technologies, medical and health technologies, telecommunication technologies and human-machine interface technologies to deliver healthcare and to promote the health status of people. The CHIC (collaborative health informatics center) provides a broader definition of telemedicine as "health care at a distance", which encompasses the use of telecommunication technology in the health sector. As an innovative health delivery system, telemedicine involves changes in both technology and the health care organizations.

In technical terms medical data which includes patients records, x-rays, radiological images and other medical information is processed and transferred as electronic signals from one place to another by using any type of communication resources (may be wired or wireless). Telemedicine can also be auxiliary defined as the integration of telecommunication and computer technologies to arrange medical expertise and services to distant locations at considerably cheaper cost. In fact telemedicine is to provide health care services to remote areas where the medical resources are very insufficient. Telemedicine leads a hospital-to-hospital communication in which the expert advices with the best treatment can be shared. It also provides the communication between the medical personals and researchers for education training and research. It allows real time consultation with experts positioned at distant places. India suffers from unexpected outbreaks of several infectious diseases like dengue, plague, and malaria etc. where personal contacts becomes unattainable, there this technical hand may do marvels job by providing medical services.

NASA played a significant responsibility in the early developments of telemedicine². STARPAHC (Space Technology Applied to Rural Papago Advanced Health Care) was one of the most primitive technologies in this field. HIS (Hospital Information Systems), PACS (Picture Archiving and Communication Systems), DICOM (Digital Imaging and Communication in Medicine), HL7 (Health Level 7) are some standards of this technology. Indian government applied this technology for Kailash Mansarovar Yatra, where isolated experts are providing the medical support to the pilgrims.

There are various advantages of the telemedicine as a home care nurses visit elderly patients through two-way video to check on their condition and to help administer shots and medication. These electronic visits reduce costs by over 50% in an arrangement that satisfies both patients and nurses³. A rural area doctor consults with a radiologist located hundreds of miles away on a puzzling x-ray. This long-distance consultation saves valuable time and money of because he needs not to go to the big hospital for the treatment. Such scenarios are not limited to science fiction; they are occurring as part of a renewed interest in an old field.

Patients from rural areas can get the same quality of health-care as those in big city. As an example patients suffered from heart attack do not have to consult cardiologist directly. Local doctors or medical practitioners could perform the diagnosis with the help of cardiologist using communication channel such as Internet, telephone line and others. The approach reduces the cost and time for both patients and doctors.

Electronic records have several benefits; by this we can get enhancement in traditional records, fast storage and retrieval. We can also promote telemedicine and encourage research in medical applications.

3. Technologies used in Telehealth

We are living in world of technological development. Technology grows up in solving our routine problems. Technology advances also play an important role in the development of telehealth industry. Following technologies of modern science are frequently used for telehealth purposes:

- (i) Video-conferencing
- (ii) Audio-conferencing
- (iii) Audio-graphics
- (iv) Interactive Multimedia
- (v) Computer Networking (LANs/WANs)
- (vi) Internet
- (vii) Interactive satellite television

4. Advantages of using Telehealth as health care tool

Proponents of telehealth believe that many benefits can be gained by applying advanced computer technology to health care delivery. One of the most cited benefits is that patient and doctor need not to be at the same geographical location. This is especially useful in providing high quality health care to rural areas. In addition, telehealth technologies offer a useful tool for delivering education to health care professionals. Training in new techniques and technologies can be enhanced through a telehealth network. Contact with other professionals through videoconferencing reduces the sense of professional isolation for those who work alone.

Reduced costs are also associated with some aspects of telehealth. Travel costs for both patients and medical professionals can be greatly lessen. Telehealth can also reduce costs by decreasing the duplication of services, technologies, and specialists. For example, one pathologist can provide services to a number of locations using telepathology⁴.

Despite the initial expenditure in the computer hardware, it is anticipated that there are considerable savings to be made in the long term, by decentralizing patient care and moving it from the hospitals to the Research centers. Remote patients who would not otherwise have received speedy treatment can be dealt with easily, and medical data can be transferred instantaneously, saving time and energy.

In short, Telehealth improves the mobility of patient care, and assists the access to all kinds of medical information. The patient gets improved treatment, and scarce resources are used more efficiently.

5. Intricacies in adoption of Telehealth

There may be a question arises by anybody that if telehealth can improve the overall quality and delivery of health care, equalize the distribution of medical resources and services, and reduce costs, why not it is widely used? Despite the widely acknowledged benefits of telemedicine, substantial barriers exist. These obstacles include infrastructure planning and development, telecommunications regulation, reimbursement for telemedicine services, licensure and credentialing for medical personnel, malpractice liability, and privacy of patient records. The lack of rigorous research and evaluation on telemedicine delivery has also been cited as an impediment to its wide adoption. Professionals have fear of loss of position and status. They are also worry about their lack of training in the use of advanced technologies. Patients, on the other hand, want to be assured that they are receiving care from a certified professional and that their medical records remain confidential. Finally, despite some proof to the contrary, hard evidence is lacking to show that telehealth saves money.

Overall, we have to overcome all of these issues of intricacy in widely adoption of this technological miracle. It will definitely helpful in providing quality health care in remote villages of India, which is the today's need.

6. Artificial Doctor

Now we would like to extend the idea of telehealth with the most modern technology of computer science i.e. Artificial Neural Network (ANN)⁵ and introduce the concept of "Artificial Doctor". This will be an expert system based on learning and testing techniques of artificial neural network, capable of diagnosing and suggesting the best possible treatment for any kind of disease. Artificial neural networks have been lucratively applied within medical domain for clinical diagnosis⁶, image analysis and interpretation⁷, signal analysis and interpretation and drug development⁸.

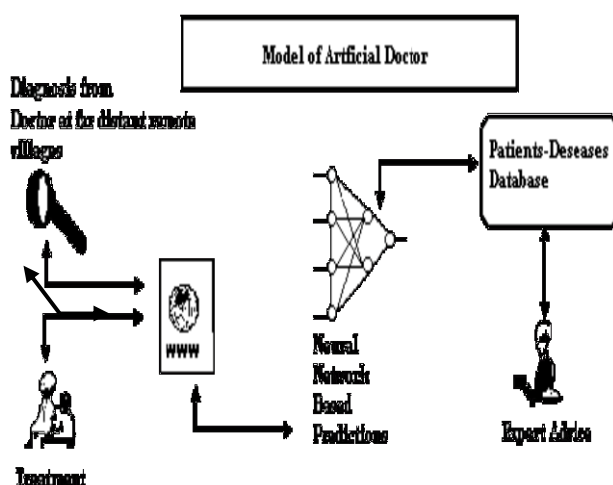
Artificial neural networks are computational paradigms based on mathematical models that dissimilar conventional computing, has a structure and operation that resembles with the functioning of brain. It is an interconnecting system of neurons (processing units)⁹ that can adapt the features from its surrounding

environment. It performs in two different modes learning (or training) and testing (or predicting). During learning a set of examples is offered to the network and the network is enforced to produce the correct example. Learning is merely an adaptive process during which the connection strengths associated to all the interconnected neurons updated in order to afford the best possible retort to all the observed stimuli. Learning in neural networks is possible in two traditions supervised and unsupervised. In both the traditions once the network achieved the desired performance, the learning phase is ended and the connection strengths will be frozen. The learned or trained network can be used to classify new and previously unobserved inputs. In testing mode, the network receives the input signals and processes it to generate the output. If the network learned the examples properly, the output produced by it should be roughly analogous to the outputs produced during the learning phase for the same inputs.

Hence we can retrieve an expert system which will be capable of diagnosing and suggesting the best possible treatment for unobserved diseases by using the learning and testing capabilities of artificial neural networks. Database of such an expert system can be constructed by maintaining the records of previous history of thousands of patients for various diseases. These records includes all the medical information about the diseases i.e. symptoms, previously provided treatment, experts advice, suggested laboratory tests (includes data, graphs, images) for the diseases by the expert practitioners. The expert system do the learning by these records and test for diagnosing and suggesting the best possible treatment for unnoticed diseases.

7. Centralized Database with World Wide Web-Internet Technology

In past, mostly the systems were developed of individual applications with specific databases for certain diseases. This implies that patient's information in one system can only be used by that particular system. On the other hand, other systems require another databases for other patients or for the same patients whose records were kept in other databases. Another problem with impartial database is that, the database for the same system in another places would differ as the number of patients using the systems increases. This problem affects the knowledge gained from the databases and thus influence in diagnosing for a disease by the system. For a system using with AI techniques, the large number of patients, the system will produce more accurate results compared to the system with less number of patients. The patient's records are valuable information for the knowledge-based system. The current patients data would enhance and strengthen the validity of the system reasoning¹⁰.



Artificial doctor model

Current advancements in information technology such as development of information superhighway inevitably encourage many countries to develop electronic medical information source and make it available on the World Wide Web-Internet. The local practitioners can use the information from the source and monitor the risk level of the patients from their town or village without going to a far located well-equipped city hospitals for consulting the experts. However, the proposed model do not meant to replace the specialists for the disease, rather to assist clinician in making diagnosis and prediction of patient's illness. This will enable the clinician to access the system and provide the consultation as specialists does regardless of the location. Thousands of patients record or patients-disease database could be installed at the main

server. It contains all the information about the patients, diseases, and suggested treatment by the specialists. The electronic record could be accessed by local practitioners and the data could be stored and updated frequently. By using this method, the system knowledge will always be updated and upgraded. The interface for the interactions between the database (and the system) and the clinician (local practitioners) would be through World Wide Web-Internet.

The Internet provides two-ways communications between users around the world at a bare minimum cost. In medical domain, communication is very important as new information or new discovery is the key for the future survival¹¹. In addition, communications helps specialists sharing their knowledge or expertise¹². As an example, a specialist from Mumbai can provide on-line medical assistance to a local practitioner situated at a village in Mizoram who is treating a patient that suffers from serious cancer problem. Another practitioner from other part of country such as Delhi can share his experience dealing with the same cases. Communications between practitioners or specialist from other region helps doctor at a village in Mizoram diagnosing his patient and provides appropriate treatment. In telehealth, Multimedia and Internet (or computer network) are two of the main tools that support the collaboration and distribution of information. Multimedia is a combination of media such as text, audio, visual and graphics can be used in medical application such as in image transmission (X-Ray images, pictures and etc.).

8. Neural Network application in medical domain

Artificial Neural Network (ANN) is one of the powerful AI techniques that have the capability to learn a set of data and constructs weight matrixes to represent the learning patterns. ANN is a network of many interconnected simple processors or units. It simulates the function of human brain to perform tasks as human does. ANN has been employed in various medical applications such as coronary artery¹³, Myocardial Infarction¹⁴, cancer^{15, 16}, pneumonia¹⁷ and brain disorders¹⁸.

A lot of work has been done in implementing the neural networks to medical domain. Several commercial neural network based computer programs are available in market. "Pepnet" is such neural network based computer program for assisted screening of Pap (cervical) smears. A Pap smear test examines cells taken from the uterine cervix for signs of pre-cancerous and cancerous changes. Early detection of Pap smear has almost 100% chance of cure. Conventionally, Pap smear testing relies on the human eye to look for abnormal cells under a microscope and hence it is unavoidable that some abnormal Pap smears will be missed during the inspection.

Computer program known as **Medical Decision-Support System (MDSS)** was designed to help health professionals make clinical decision¹⁹. The system deals with medical data and knowledge domain in diagnosing patient's conditions as well as recommending suitable treatments for the particular patients.

Patient-Centered Health Information Systems (PCHIS) is a patient centered medical information system developed to assist monitoring, managing and interpret patient's medical history²⁰. In addition the system provides assistance to patient and medical practitioner. The system serves to improve the quality of medical decision-making, increases patient compliance and minimizes iatrogenic disease and medical errors.

For efficient detection of pre-cancerous and cancerous cells in the cervix the neural network based computer program is used. An Entropy maximization network (EMN)²¹ is also a neural network based computer program, which has been successfully applied for predicting the metastases in breast cancer patients. Bruke et al²² made comparison study in prediction accuracy of neural network based computer program with other traditional statistical methods available for detecting breast cancer and found neural network based computer program are more perfect in predicting 5 years survival out of 25 cases. Fraser et al²³ conceded a study to scrutinize the efficiency of radial basis function networks as an alternative data driven diagnostic technique of myocardial infraction. The study included clinical data of 500 cases. Results demonstrate that the network performs with 85.7% of accuracy. A multilayered feed forward neural network trained with Back propagation learning rule has been successfully applied for differential diagnosis of brain diseases (multiple sclerosis and cerebrovascular disease). The training data consists of 22 type symptoms of the disease and diagnosis for 689 cases. A multilayer Perceptron model has been trained with preoperative data of 54 patients for early prognosis of hepatocellular carcinoma²⁴. It proved to be a trustworthy gizmo for prognosis and assessment of extent of hepatectomy of patients. Egmon-Peterson et al successfully applied Pattern recognition techniques of artificial neural networks in image analysis of radio graphical images, ECTs, MRIs, etc. Hall et al²⁵ compared neural networks and fuzzy clustering techniques for segmentation of MRI of brain. Both approaches were found reliable in diagnosis. Rajapakse et al²⁶ had implemented self-

organizing network Multilayered Adaptive Resonance Architecture (MARA) for segmentation of CT images of heart. Daschlein et al²⁷ had implemented two-layered neural network architecture system for segmentation of CT images of abdomen. Waltrus et al²⁸ examined domino effect from the application of tools for synthesizing, optimizing and analyzing of neural network to Electrocardiogram (ECG) monitoring task. Dokur et al used Kohonen self-organizing neural networks to detect ECG waveforms. The network was learned for MIT/BIH Arrhythmia Database. The database is made of two days ECG readings of patient. Weinstein et al⁸ at the national cancer institute, USA implemented neural networks for drug development. The neural network efficiently classified 91.5% of inspected anticancer agents (drugs) according to their mechanism of action. Most of the research that employed ANN yields between 70% to 80% accuracy. ANN has been shown as a powerful tool to enhance current medical diagnostic techniques. Sarle²⁹ describe the usage of ANN in three main ways, typically, as models of biological nervous systems and “intelligence”, as real-time adaptive signal processors or controllers implemented in hardware and as methods for data analysis. Hence, we can summarize the advantages of artificial neural networks applications³⁰ as Ability to process a massive of input data, Simulation of diffuse medical reasoning, Higher performances when compared with statistical approaches, Self-organizing ability-learning capability, Easy knowledge base updating.

9. Conclusion

Suggested here two technological gizmos; telehealth and Artificial doctor, may dream about as technical hands for future doctors. Artificial doctor will capable of diagnosing and suggesting the treatment for any kind of diseases using the learning and testing capabilities of artificial neural networks while telehealth communicate the medical information from one place to another using telecommunication resources. It will really help in providing treatment to remote area villages of India where we find the lack of expert advice and timely treatment.

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