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EMEDICINE -- ICT IN HEALTH CARE, SOLUTION FOR RURAL INDIA: THE SCENARIO WITH SOFTWARE & EMBEDDED SYSTEM

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Abstract:—Health Care sector in India has witnessed significant growth during the last few years, both in quality and capacity. In spite of such developments, heath care facilities in the country remain inadequate to meet the needs of the citizens, particularly in rural areas, where approximately 70% of the people live. To address this problem, the government has launched major national initiatives such as National Rural Health Mission, establishment of six new AIIMS like institutions, up gradation of existing public hospitals and labs, etc. As the health sector is poised for major growth in next decade, the sheer size of healthcare sector in the country will necessitate extensive use of information and communication technology (ICT) infrastructure, services and databases for policy planning and implementation. Such a framework would require services based on inter-operable and sharable technology, connecting various institutions and service providers. This paper states our vision & proposed solution for rural populace of India.

Keywords:—e-medicine, ehealth, health informatics, telemedicine, solution for rural India, embedded system, bioinformatics, ban

I. INTRODUCTION

Urban India has been on move over the last ten years and its growth has accelerated especially over the last five. However, the same can't be said about rural India. Urban Indians are full of confidence, but the rural Indians do not see much of a future for themselves. The only change in lives of many rural people is availability of some television, which in fact has created greater aspiration amongst them. They can now visibly see the difference between the lives in Urban and Rural India and can't understand why they are being left so far behind [1, 2].

Fortunately the Information and Communication technology (ICT) has the potential of being leveraged for transforming rural areas. If, along with ICT connectivity, a solution to connect to a urban doctor Instantaneously can be found, the basic infrastructure for transformation would exist. It is now time to build experiments and programs which can leverage these technologies, so that the efforts can be scaled as soon as ICT and basic healthcare facilities are available. The experiments need to be conducted today so that the stage is set up for scaling. But without deriving significant learning's from the experiments, scaling could be disastrous.

While these possibilities can indeed attain fruition with the help of Information and Communication technologies, significant amount of experimentation and hard work is required to covert the opportunities into scalable realities. ICT can and needs to be leveraged to promote the following in the rural areas:

- Education
- Healthcare

We will be keeping our focus on the solution for providing the basic primary healthcare solution with respect to ICT but at the same time will be addressing on the different opportunities available.

From an economic perspective, healthcare is an evolving market. It constitutes a complex system with a plethora of requirements specific to each stakeholder, e.g. patients and their families, health care

Professionals, health care providers (public and private), governmental agencies and insurance companies [6].

We will review telemedicine services & will conclude the paper with the proposed solution.

II. E-MEDICINE IN INDIA

E-Medicine is not an evolutionary concept but a revolutionary concept in itself. It represents a very innovative approach in providing quality health care whenever and wherever needed, but is seen lacking reliability, user friendliness & most importantly governmental support [3].

In fact the main challenge facing website administrators, software engineers, system developers & medical practitioners is to develop strategies that will give e- care a reliable environment to exploit opportunities and make it more feasible & cost effective.

What Is E-Medicine?

It has been defined "as the use of telecommunication" to provide medical information and services. It may be as simple as two health professionals discussing a case over the telephone, or as sophisticated as using satellite technology to broadcast a consultation between providers at two distant locations, using videoconferencing equipment.

"The simplest definition of E-Medicine is that it uses multimedia technology (voice, video and data) to deliver medical services. The lower cost of band- width and improvement in video and data compression standards have increased the number and types of medical services that can be delivered from a distance to include virtually every specialty.[4,5]

Figure 1: e-Medicine & its activity

Numerous health care systems are designed without consideration of user-centered design guidelines. Consequently, systems are created ad hoc, users are dissatisfied and often systems are abandoned. This is not only a waste of human resources, but economic resources as well. In order to salvage such systems, we have combined different methods from the area of computer science, cognitive science, psychology, and human–computer interaction to formulate a framework for guiding the redesign process.[7]

Our Vision:

Our vision is to use ICT as a major facilitator of heath care and knowledge management for the rural area of the country, which will enable various stakeholders to have easy and affordable access to information, whenever and wherever they need it.

The medical knowledge, technological knowledge, health care information generated and health care provided to rural populace as an outcome of this endeavor will significantly improve the health status of the people of India.

Our Objectives:

1. Fabrication of needed hardware for the purpose of providing immediate health assistance to rural populace.
2. Development of need based software to be used for acquiring health data to be passed on to the main doctor for prescription.
3. Use of existing ICT infrastructure and services for the use in health care.
4. T**o** develop inter-operable health management systems through the use of appropriate technologies, which may also necessitate the use of open technologies and standards in some cases.
5. To collaborate with anybody ready to help rural populace in managing their health.
6. To make high quality healthcare available to traditionally under privileged population.
7. To save the time wasted by both providers and patients in traveling from one geographic location to another to avail services on time.
8. Reduce costs of medical care

In the proposed system, various sampling rates and quantization levels are used when the biomedical signals are digitized before sent to the hospital server.

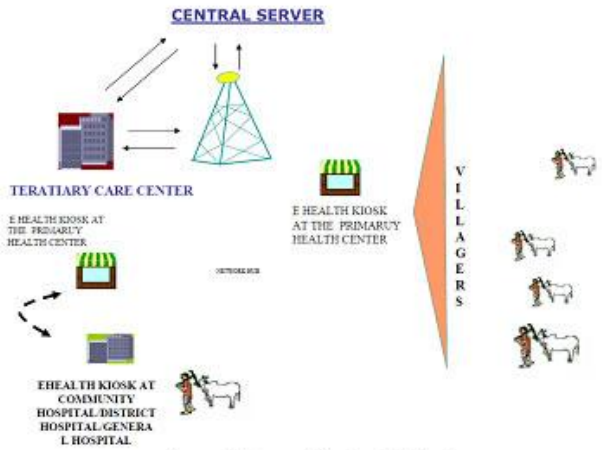


Figure 2: Proposed System Architecture

Major Stakeholder of the System:

- Citizens
- Health care providers and payers
- Education, research institutions and investigators
- Government departments and institutions
- Public health agencies and NGOs
- Pharmaceutical industry and medical device makers
- Telemedicine institutions
- Software and hardware developers

Challenges:

- Leadership
- Standards
- Connectivity
- Privacy and Security
- User Needs
- ICT and Domain Knowledge
- Funding

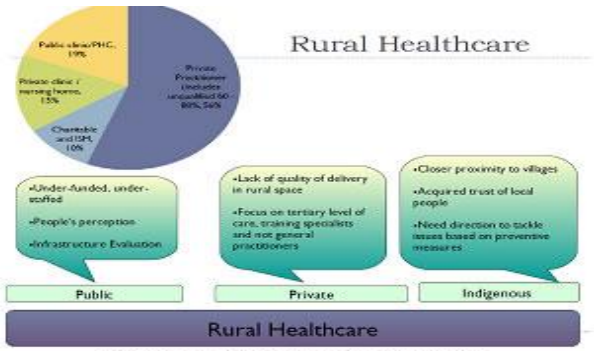


Figure 3: The layout for healthcare roadmap

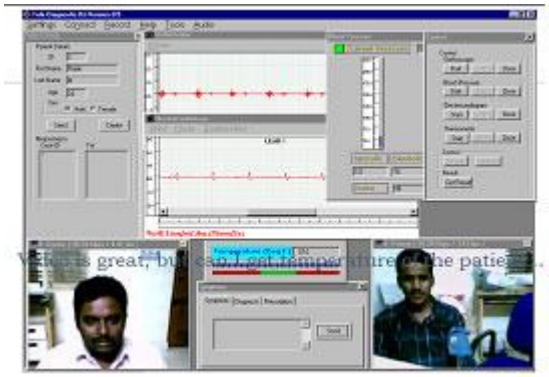
Initiatives Taken By Healthcare Organizations:

There are many activities that are going to contribute to the spread of E-Medicine in India. Of which APOLLO (Hyderabad) and ASIA HEART FOUNDATION (Bangalore) are emerging as key players. Madras Medical College is the first government medical college to have E-Medicine installed in INDIA. Organizations such as ISRO, have taken innovative approach to facilitate healthcare delivery by launching an exclusive health satellite. It provides almost100% uptime, making it the best medium for a country such as ours with diversity in terrain. General Electric and Wipro are also undertaking e-medicine stations in Chennai and Hyderabad.

Need Of The Hour:

1. Fabrication of sensors and devices suitable to be connected to laptops and mobile phones in the form of USB device. The USB device should be able to note parameters like temperature, blood pressure, heart rate, ECG, blood sugar, triglyceride etc.
2. Development of need based software to be used for acquiring health data to be passed on to the main doctor for prescription. The software should support transport and store of actual data.
3. Use of existing ICT infrastructure and services for the use in health care. The existing infrastructure of service providers of internet and mobile telephony will have to be kept in mind by the developer so that immediate service may be started.
4. To develop inter-operable health management systems through the use of appropriate technologies, which may also necessitate the use of open technologies and standards in some cases?
5. To collaborate with anybody ready to help rural populace in managing their health.
6. To make high quality healthcare available to traditionally under privileged population.
7. Save the time wasted by both providers and patients in traveling from one geographic location to another to avail services on time.
8. Reduce costs of medical care

Figure 4: Future aspects for the solution



Connectivity

- Connectivity forms the most important component for ICT enabled healthcare for health management information system, telemedicine, inventory management etc. The requirements are both for online interactions and store and forward data transfer.
- For store and forward data transfer a bandwidth as 128 kbps may be sufficient at the PHC level
- Video conferencing is the primary requirement for telemedicine which also normally needs higher bandwidth connectivity for quality of service. At the Primary Health Care level a low bandwidth 256 kbps maybe sufficient for normal video conferencing. However of availability of higher bandwidth can
- Enhance the quality of Video Conferencing
- Better packaging with advanced compression techniques could help to decrease the bandwidth requirements.
- An intelligent combination of wired (fiber), wireless (Wi-Fi and Wimax) and satellite technologies would meet the requirements of connectivity.
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What We Propose?

Considering the above facts & scenarios we tried to build a model using Body Area Networks, embedded system 7 software guidelines for healthcare service providers.

The Test Case Put To Use

The goal in the design of user-centered software is to create systems that are modeled after the characteristics and tasks of the users. Employing cardinal axioms of good design early and throughout the design life cycle gives rise to systems that are easy to learn, increase user productivity and satisfaction, increase user acceptance, decrease user errors, and decrease user training time.

In converse, not doing so often requires the redesign of a system. Redesigning interfaces is not only time consuming, but costly and frustrating for both the users and designers. Health care software developers often overlook relevant user characteristics, user tasks, user preferences, and usability issues, resulting in systems that decrease productivity or simply remain unusable.

Human–computer interface design methods

There are well-published guidelines and principles for designing systems that provide comprehensive utility or functionality and usability. The ‘‘Logical User-Centered Interactive Design Methodology’ and others propose valid user-centered methodologies. Although their methods focus on the design methodology required to build user-centered software from the product conception stage to full roll-out of the software, our methods focus on redesigning deficient health care software that has been previously rolled-out. Typically, once a software product has been conceived and the user population identified, the next step is to conduct the following analyses: a user analysis, an environmental analysis, a task analysis, a functional analysis, and a representational analysis. Each of these analyses provides different, but necessary components in order to design the initial prototype or redesign a flawed system. Following are the major aspects of a healthcare system which were being considered for the design:

- User/environmental analysis
- Task analysis
- Representational analysis
- Functional analysis

Our sample healthcare scenario addresses the proliferation of self-management schemes for long - term & short - term diseases. Clinicians and developer users work together to bring about a wealth of smart devices and low power sensors in wireless, self configuring body networks which semantically interface to legacy health care systems. The systems are reliable and safe and doctors increasingly rely on access to remote information, not only to perform diagnosis but also in order to make long term risk assessments. The statements above are reflected in a typical disease management scheme which is partitioned into the following elements:

- **Device configuration**: before doing any measurements, the sensors and the other devices, including the applications, need to be configured in a convenient and preferably automatic way.
- **Application configuration**: building on the configuration of the physical setup of the measuring environment, various parameters of the application such as conditions for triggering alerts will have to be defined. Such conditions may constitute a context which requires specific actions when reached.
- **Monitoring**: in this part of the scenario, biodata once sensed is automatically (i.e., with minimum user interaction) transferred to some background system recording the data and providing secured access to privileged users, e.g. the health professionals (physician). Completely different communication channels can be used for transferring the data, such as ordinary stationary Internet or asynchronous transfer via cellular networks through SMS for example.
- **Data management and analysis**: in order to prepare for temporary off-line situations, data will have to be locally cached, thus transferred in bulk mode to be synchronized with the background system. Analysis of the collected data will be offered not only to the health professional but also to the adequately educated patient.

We will now describe how, by using Aarogyadham, the scenario for the monitoring of the patient's blood pressure, ecg as sensitive bio-data can be implemented taking into account the requirements. Adaptations to other types of bio-data (glucose level metering, ECG, blood sugar & weight measuring etc.) are straight forward.

Measuring Process and Data Provisioning

On demand, the patient attaches the BPM to his upper arm and activates the device. The bpm, while being in master mode, measures the patient's systolic and diastolic blood pressure (including the pulse) values and transfers them together with the meta-data (timestamp, sensor ID, etc.) to the application server via the gateway. By analyzing the user context (i.e., being 'on the move' or 'at home), the gateway is automatically determined. This can be done implicitly, because if the stationary home gateway is not available the mobile phone is used. The application server offers a service for storing health records together with a user ID. When transmitting via the PC-based gateway, the Network Manager is used to send the patient records to the application server. When using the mobile phone, the bpm triggers the mobile phone via AT commands over the Bluetooth interface. The mobile phone then sends an SMS to a cellular network interface attached to the application server where the message is unpacked, and the service storing the health record is supplied with the according information.

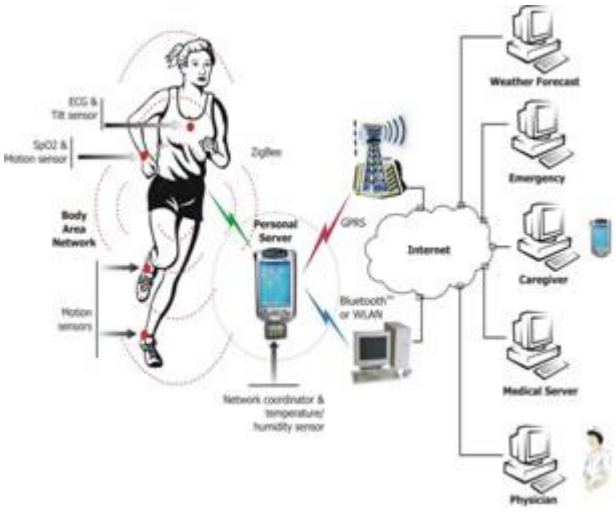
In a similar fashion we take the ECG of the patient. The hardware developed has an USB interface wherein the user is advised to use it under the supervision of a technical consultant to get the accuracy, once the patient is trained he can use it as and when required.

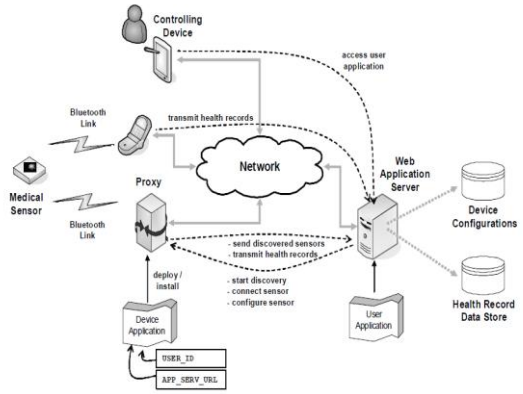
The three lead ECG is used to take the count & the same protocol is applied for transferring.

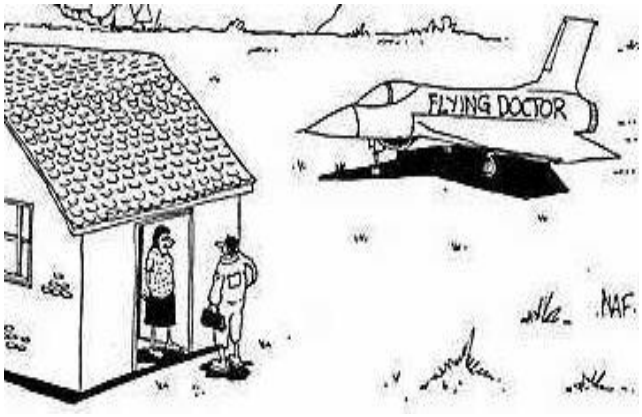
In similar fashion blood sugar monitor also functions.

We have used a tablet PC for the development. The whole software is developed using .NET & A/D Convertors are used for transferring the data to PC.

Android is used for mobile development & a interface is provided.







III. CONCLUSION

To witness a successful revolution in E-medicine, the need of the hour is to bring above array of activities together. If the experiment works here over the next few years, the vast rural population will be winner and bear the fruit of our initiative. Perhaps the slogan "Health for all by 2000" which was forgotten towards the end of last century can still be achieved by the year 2020 by making "The E-Medicare Revolution" happen in India.

Triggered by the shift from reactive and interventional healthcare towards prevention, systems supporting ambulatory monitoring and treatment of people suffering from long term diseases are gaining increased interest. Wireless sensors in clothing, shoes etc. yielding bio data will leverage possibilities for mashing up entertainment and supervised self-care. This will eventually become part of everyday life

The three layer approach in the middleware ensures structured application design and future extensions (through additional managers). Future iterations concerning the use of Aarogyadham in the health care domain, as well in other domains (building automation and agriculture), will yield indicators on the effectiveness of the approach. It will turn out if Aarogyadham can be established as a platform for Health Care ecosystems integrating foundation as well as third party services.

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