# E-SANJEEVANI: A Mobile Village Hospital

R. V. V. Prasad Rao [1]*, D. Balakrishna[1], S. Sandeep Goud[2], M. Sujeeth Nanda[1] and R. Damodaram[2]

**ABSTRACT**

*We present in this paper a Low Cost Medical Facility to rural villages, bringing the urban expertise to rural villages with the help of Information and Communication Technology (ICT). The health care system consists of two machines one at an URBAN CENTER where an Expert doctor is available and the other is a Mobile Hospital which is a Bullock Cart mounted Mobile unit shuttling between various clusters of Villages operated by wind power with in GSM coverage area. Audio, Video, Vital signs and patient's records are transmitted in real time. Hygienic Homeopathy medicine dispensing mechanism, On board Global positioning system (GPS) aids in location of mobile unit.*

***Keywords:*** ICT- information and communication technology, Vital signs: temp, heart beat, pulse, respiration etc, Low cost Telemedicine, Mobile Hospital, Village Hospital.

## 1. Introduction

"India lives in villages" said Mahatma Gandhi. 70% of Indian population lives in villages which are scattered clusters along the length and breadth of the nation. These rural masses are illiterates and often live at places, having no proper roads, communication, Educational facilities and most important Medical Care. Under these conditions it is very difficult for them to reach nearest cities in right time passing through inhospitable terrains due to lack of proper transport. In the conventional system patient's have to travel longer distances to meet the doctor. The treatment is costly and not affordable by ordinary men. Particularly when it comes to agricultural laborers it means loss of daily wage as well as costly medicines. Due to several such reasons and lack of education the rural people are forced to approach nonqualified, ill-trained health workers (non professional medical practitioners) which must be addressed at all costs. In Particular women during pregnancy are most vulnerable. Statistics reveal that most of the fatalities do occur during and immediately after delivery. The major hurdles for telemedicine are the absence of low cost interfacing equipment compatible with low band width connectivity. The most modern and sophisticated health care services are only available to urban rich, where as the rural poor are still deprived of basic medical facilities.

The affordability is also a major issue, which needs to be tackled at the earliest. The Doctors are not willing to work in villages for various reasons best known to them, but they do have a desire to serve the rural masses, provided the right kind of infrastructure back bone is in place. The privatization of Telecom sector by the Govt. of INDIA has spurred the enormous growth of wireless and wired Communications, the services have become very much affordable due to competition among the service providers. Further due to

[1] International Institute of Information Technology, Hyderabad, India
[2] Mahaveer Institute of Science and Technology, Hyderabad, India
* *Corresponding Author:* **(**Email: esanjeevani@yahoo.co.in, Telephone: 91-9247436405)

the world's biggest market, major telecom Giants have setup cell phone manufacturing units in INDIA. This resulted in falling prices of cellular phone handsets another welcome feature. The competition among operators has resulted in ever increasing coverage of small towns and villages of the country. This has solved the most important connectivity issue which was the bottle neck in bridging gap between urban and rural INDIA. This paper presents a model that overcomes most of the above issues with indigenously developed low cost telemedicine solution measuring B.P, E.C.G, Heart Sounds, pulse, temperature. Communication is through a very low band width connectivity. The paper also discusses the evolution of this concept and how it was translated into a reality with can be managed by training a layman in short time. Live video and audio conferencing, medical records storage, access and print capabilities are also available.

## 2. Design problem and requirements

The main objective of this project is to provide medical facility to rural village people, bringing the urban expertise to rural villages with the help of ICT. To Design and develop a common infrastructure backbone interface through which we could easily deliver a range of healthcare services, educational, promotional for semiliterate people. This, results in a low cost mobile village hospital solution, which is sophisticated yet affordable and user friendly. The fundamental requirements for the "E_SANJEEVANI" remained flexible throughout the design process hence the product is evolving continuously. The fundamental objectives of the system include:

- Correctly measure the vital parameters.
- Reliable communication network.
- Medicine dispensing capability.
- Audio and Video transmission capability.
- A printout facility for prescription, referral case etc.
- Should measure Heart Beat (Pulse), Temperature, ECG, Blood Pressure, Digital Stethoscope.
- Meet the safety requirements and standards.

In addition to meeting these goals, we also intended to create a design that would Come as close to a real-world product as possible**.** This means designing a device which meets the general biomedical safety standards of the local government. During the design and implementation of the system, certain constraints were identified that limited our ability to successfully meet the specifications to implement a real-world interface. Specifically, limitation on resources available would not allow us to test our design using real biomedical equipment. In addition safety is a big issue when testing a design on a live human being. Testing on real communication channel was prohibitively costly As a result, an added level of complexity was added to our project, which was to simulate a phone line using Electronic Portable Branch Exchange (EPABX).

## 3. Functional Description

- The patient approaches the mobile unit and requests for medical help.
- Electronic Admit card/prescription is made and he waits for his turn.
- When the doctor is free the patient explains his problem to the doctor via audio video link.
- Doctor requests for tests/examination the Health worker helps in examination and the results are made available in electronic form to the doctor, after the analysis of the results doctor makes prescription and the prescription is printed using mini printer.
- The desired medicines are given to the patient and next consultation date and time is informed to the patient.
- While on the travel and on installation spot the mobile unit uses wind mill to charge its batteries.

In every design, there is always a range of alternatives that could be utilized in arriving at a solution. These alternatives can be in the form of components, approaches, or algorithms. Some design alternatives for the E_SANJEEVANI system include the following:

- Web based telemedicine solution
- Satellite connectivity based telemedicine.

## 4. Design & Implementation

The design involves hardware and software modules. The hardware consists of microcontroller and data acquisition interfaces, Signal processing and communication. Software involves the front end interface of both doctor and Patient terminal, Data base linking and reports generation etc. Dial up modems establish a communication channel between two locations using physical telephone line or through wireless module that has comparatively larger band width.

Microsoft HyperTerminal comes bundled with Microsoft XP. You can use it to send AT commands to your GSM/GPRS modem and the procedure to test is as follows.

- Create a dialup connection and configure modem for dialup/GSM connectivity.
- Insert the valid SIM card into GSM/GPRS modem and connect it to RS232 port of PC.
- Select free COM port, Max speed, Data bits, parity, stop bit and select flow control etc

Type appropriate "AT" commands in the terminal window for establishing connection & comm'n.

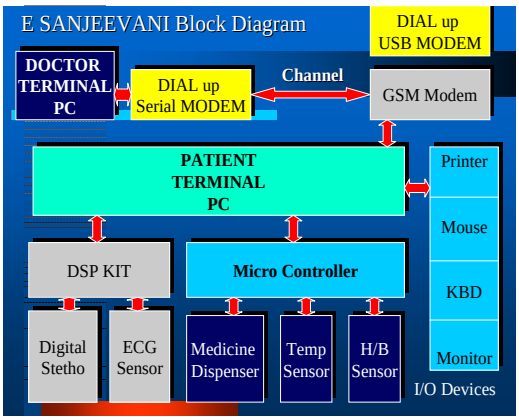


**Figure 1:** E-sanjeevani Block Diagram

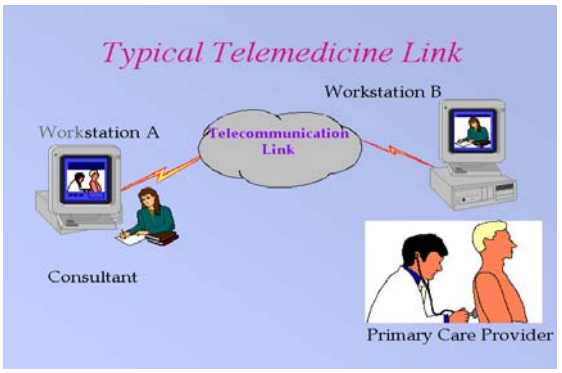


**Figure 2:** Typical Telemedicine Link

Microsoft "LIFE CAM" is need for providing audio & video communication which is controlled by both doctor and health worker. Technical Specifications includes:

- 1.3 mega pixels High Definition photos interpolated show you in the best light.
- The built-in microphone automatically picks up your voice with good clarity.
- The pan and tilt functionality make's it convenient for the Doctor to get right snap.

Vital Parameters includes Temperature, ECG, Heart Beat, Blood Pressure, and Pulse

The above parameters are measured at the Patient terminal (PT) for Diagnosis. Individual modules are interfaced to Micro controller and Digital signal processor for signal processing & output generation.

With the advent of the new MCS-51 range of 8-bit Micro Controllers and the high performance, low cost software. A project can take literally few weeks to progress from initial conception to final prototype.

Developing a MCS-51 based project takes only eight easy steps:

- Finalize product specifications.
- Design and simulate the circuit.
- Wire up the circuit
- Type in the program
- Assemble the program into a binary file
- Simulate the program and debug it
- Load the binary program into the flash memory
- Switch on and test.

Dot net Technologies drastically reduce the software development time.

*Admit Card Window:*

- Patient's photo along with patient's data is entered in the respective fields by the PT.
- Registration number is auto generated so as to ensure no duplicates entries.
- Patient's name, Address, Age, Sex and complaint is entered in the respective fields by the PT.

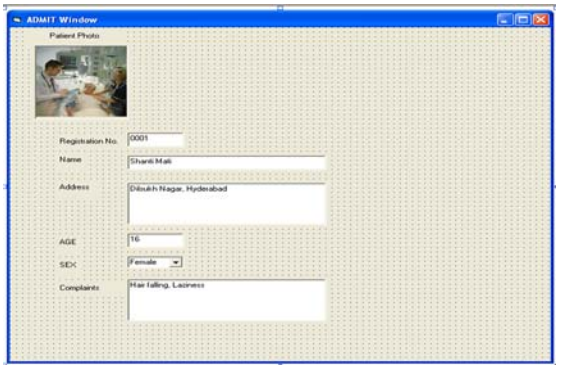


**Figure 3**: Admission Window

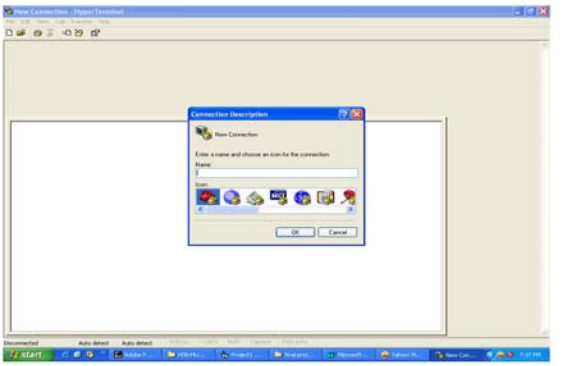


**Figure 4:** Communication Window

*Communication Window*

- Hyper terminal is popular communication software developed by Microsoft for all serial communication.
- This application is embedded in our software for communication between Doctor terminal (DT) and Patient terminal (PT).

*Diagnosis Window*

- The main Diagnosis window displays the both Doctor and patient's photo.
- Doctor photo is selected using the combo box.

*Displays Patient data for Example.*

- Blood pressure in mmHg,
- Heart beat as pulses per minute
- Temperature in Degree/Fahrenheit.
- Weight in Kilo grams.
- The "ECG" Button: Opens a separate window to display ECG analysis.
- The "DT Ready" Button: Sends a code to the PT stating that Doctor and setup is ready.
- The "PT Ready" Button: Sends a code to the DT stating that PT and setup is ready.
- The "EDIT" Button: Enables data to be edited, but default data fields are not editable.
- "ADMIT CARD" Button: Opens a separate window to enter new patient or old patient data.

- The “UPDATE” Button: Updates all the data entered into the respective data fields.

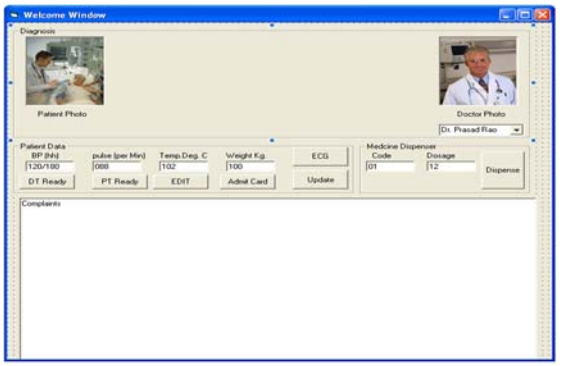


**Figure 5:** Diagnosis Window

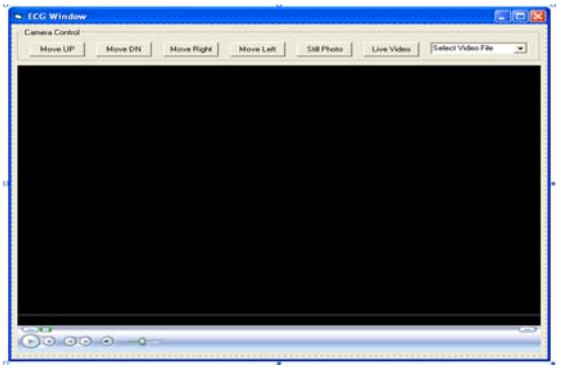


**Figure 6:** Video Window

*Video Window*

- Displays the video received from the PT.
- The camera is mounted on pan and tilt mechanism which is controlled by Doctor.
  - The “MOVE UP” Button: Moves the camera upward (elevation control)
  - The “MOVE DN” Button: Moves the camera Downward (elevation control)
  - The “MOVE RT” Button: Moves the camera towards Right (horiz. control)
  - The “MOVE LT” Button: Moves the camera towards Left (horiz control)
  - The “Still Photo” Button: The web cam is enabled to take High resolution still photograph by either or DT.
  - The “Live Video” Button: The web cam is enabled to take Low resolution live video by either PT or DT.
- “Select video file” Combo box
- Selects the required video file to be played in media player.
- The Microsoft media player application is embedded in the form


**Figure 7:** ECG Analysis Window

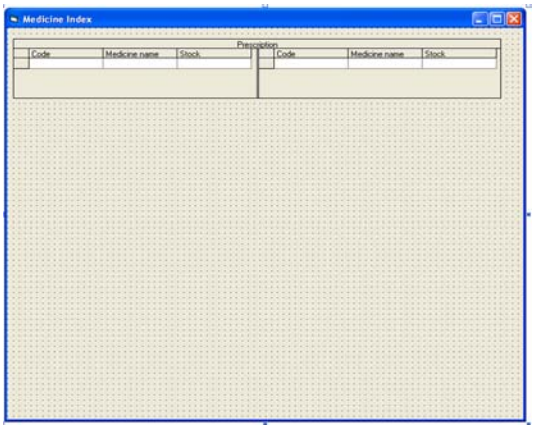


**Figure 8:** Medicine Index Window

- The doctor analyzes the ECG recorded at the PT.
- It has edit, Zoom, Cut, Play, Freeze facility

*Medicine Index Window*

- The form contains an index of all the medicines, their code number along with the existing stock in Hand. The medicine stock is auto-updated whenever the medicine is dispensed or fresh stock is added.
- The doctor refers the table before remotely dispensing medicine.

*Prescription Window*

- The prescription contains patient's details like BP, pulse, temp, weight etc.
- Doctor name, Doctor Diagnosis, medicines prescribed, medicine dosage and next visit date etc.
- This is a printable report, which can be given to patient in case the need arises.

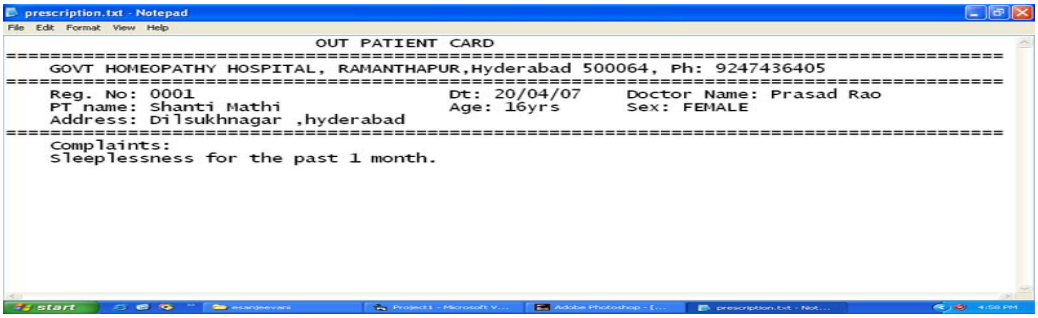


**Figure 9:** Prescription Window

*Pc Software Algorithms*

PT: Run PT initialization
Delete testcodes.txt if found in program folder.
For common ailments like fever, headache, body pains, cough and cold etc. let the medicines be given by village health worker/ driver of e-sanjeevani (mobile Hospital).

PT: (Patients form a queue and wait for their turn)
PT makes manual call to doctor and request to start consultation by giving acknowledgement.

DT: select the Doctor name in combo box and click B_doctor ready.
(Doctor ready code along with doctor data is written into file DT2PT.txt. and Send to PT by comm_win

PT: "DOCTOR READY" message flashes,
A/V msg1 "DTRDY.Wav file is played ("Doctor is ready call patient for consultation")
Doctor photo corresponding to the doctor ID received is displayed. This marks the start of consultation.
If new patient:
Ask questions and fill data in admit card, take patient's photo by LIFECAM and add photo path with complaint.
If old patient
Select his record from grid of "admit card" which ever is having focus that record is selected for diagnosis.
Now enter BP, pulse, temp, weight, complaints and Clk B_UPDATE
(The existing prescription file is appended with current vital parameters and complaints)
Flash msg. "sending PT2DTPID.txt to DT "

DT: SELECT RECEIVE MODE IN COMM_WIN
After file is received automatically it is added to prescription QUE.
(Doctor received the old prescription file with latest vital parameter data)

Examines the vital parameters, write prescription and Send file "APP_PRSC.txt"
To dispense medicine enter the medicine code and Clk B_dispense

PT: receive the file and explains prescription to the patient.
If print out is required select content and send to printer.
Based on the MED_CODE received the LED on the corresponding container blinks to identify the medicine and announce the medicine name & dosage sequentially
Next visit date is informed to patient.

*Field Trials*

The system was subjected to field tests at two locations in Hyderabad.

1. Bandlaguda village near mahaveer engineering college.
2. Nandhi musalai guda village in Hyderabad.

With the collaboration of a team of doctors and students of Government. Homeopathy college Ramanathapur, Hyderabad. The system performed well with some minor problems and the feed back gathered was very useful to carry further modifications and fine tuning of the system.

## 5. The Future Scope

The scope for expansion is enormous… We would like to take up the following in a phased manner.

Provide Satellite connectivity by designing a VSAT (very small aperture terminal) which can expand the service area of Esanjeevani by many folds, such connectivity provides high bandwidth utilization with resource allocation done dynamically and at reduced cost and of course freedom to take it any where and use it. Vsat is Advantageous as its services can be deployed anywhere having a clear view of the sky. It provides a wireless link completely independent of the local terrestrial/wire line infrastructure, can be deployed in hours or even minutes, it enables customers to get the same speeds at all locations across the entire globe.

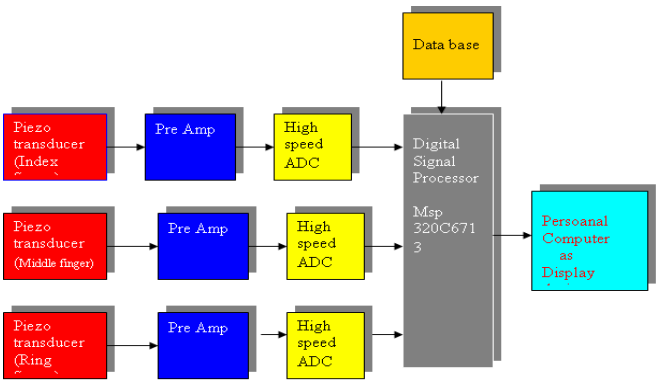


**Figure 10:** Digital Nadi

If good signal processing algorithm is employed we can do away with most of costly diagnosis. (Human brain has excellent analog signal processing capability,) A similar method is practiced in aurveda where the vaidya acharya does nadi pariksa/sodana a simple test which provides volumes of information about the state of body and mind of the patient. An ancient medical diagnosis system being practiced in India for the past 4000 years, where in the pulse is measured using a three finger technique. Which gives complete state of body and mind of the patient to an experienced vaidya acharya (Ayurvedic Doctor). The above system can be implemented using Digital Signal Processing as explained in Figure 10.

## 6. Concluding Remarks

The westernized costly medical system is not affordable to poor villagers, we need to bring flexible, low cost and village ready technology to bridge the gap between urban and rural Indian health care. Systems like E-sanjeevani should be considered as one of the strategic components in the national health care system because it facilitates the delivery of equitable health-care and educational services irrespective of distance and availability of specialized expertise. E-sanjeevani can be an efficient and cost effective solution to fill the gap created by the lack of highly qualified experts in different fields of medicine in rural and remote areas, and even in urban areas of some developing countries, especially in remote & rural areas, for those on the move and for those who might not otherwise have access to the quality of care available in urban hospitals. Field trails have justified the commencement of a pilot, proof of concept validation, clinical study.

## References

1. *Apolo Telemedicine*
2. Hall. *Microprocessors and peripherals* 6th Edition, Tata Mcgraw-hill.
3. http://www.telemedicineindia.com
4. MSDN. *Dot net Tutorial 2005*. by Microsoft.
5. Oppenheim, Schafer & Buck. *Discrete time signal Processing*, 2nd edition. Prentice hall.
6. Ramesh Babu. *Digital Signal processing*, 2nd edition. Scitech Publication.
7. Reffered case sheets and formats of general medicine at CARE HOSPITAL, Hyderabad.
8. Sawarkar, Rajeev Kumar, Elizabeth Alexander &Ganapathy. Akiosk based scalable and self sustainable telemedine solution for Rural India.
9. *VISION 2020* by Dr. Abdul Kalam, president of India website.

### *About the Authors*

*R.V.V. Prasad Rao*, a student at IIIT-H and is pursuing MS in ECE. He is a TA at IIIT-H. He has a decade of experience in telecommunication Research and is well versed with MCS-51/PIC/AVR micro Controllers and PC software Development. Guided several B.Tech and M.tech Projects. Worked as RA at Dr. HSN Murthy's Research Group pursuing rural health care. Achievements include participation in several state/national level competitions and won prizes in almost all events. participated in Texas Instruments Design contest'06 and IBM GREAT MIND CHALLENGE 06.

*D. Bala Krishna*, student at International Institute of Information Technology, Hyderabad and is pursuing 2 year Post Graduation (MS by research) course in ECE. He is a TA at IIIT-H. He loves to play with Humanoids. He has good research experience in the field of telemedicine. Some of his achievements include, participation in several state/national level competitions and won prizes in almost all events. participated in Texas Instruments Design contest'06 and IBM GREAT MIND CHALLENGE 06.

*M. Sujeeth Nanda* is an Internship trainee student at International Institute of Information Technology, Hyderabad.He is a TA in robotics Course at IIIT- He did his B.Tech in ECE. Some of the Achievements are He won prizes in state/National level competitions and IIT's too. He also participated in IBM Great Mind Challenge'06 and Texas Instruments Design contest'06

*R. Damodheram* did his B.Tech in (ECE). Some of the Achievements are He won prizes in state/National level competitions and IIT's too. He also participated in IBM Great Mind Challenge'06 and Texas Instruments Design contest'06

*S.Sandeep Goud* is pursuing B.Tech (ECE) at Mahaveer Institute of Science and Technology,Hyderabad, AP, His ability to innovate concepts makes him special. He is a member of the team e-sanjeevani, that developed a project on Telemedicine which earned wide recognition and was adjudged 1st in many national level symposiums.He has a first class academic record throughout his career. Won best novelty prize for humanoid robot at IIIT-H