Web Technology used in Design of Remote Healthcare Monitoring Center

Monalisa Samal[1] and Swastika Mishra[2]

[1]Assistant Professor, Department of Electronics and Communication Engineering, Gandhi Institute for Technology (GIFT), Bhubaneswar
[2]Assistant Professor, Department of Electronics and Communication Engineering, Gandhi Engineering College, Bhubaneswar

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***Abstract*—**Healthcaremustbeasefficientaspossible.Information and communication technologies (ICTs) have great potential to address some of the challenges faced by both developed and developing countries in providing accessible, cost-effective, high-quality healthcare services. Telemedical clinics use ICTs to overcome geographical barriers, and increase access to healthcare services. This is particularly beneficial for rural and underserved communities in developing countries – groups that traditionally suffer from lack of access to healthcare. This work proposes an embedded system design using web-based technology to provide wide range of services in Telemedical clinics which facilitates the provision of medicalaidsfromdistance.SoweimplementSensornodesCircuitfor collecting data and process them to extract useful body information. Sensors: are interfaced to microcontroller through analog module, the written software in the microcontroller processes data and the processing results are sent to the Laptop then to web-portal using Bluetooth connection and the flow chart of the written software is developed. The proposed system structure clarifies 4 components (Medical Sensors, CCU Interface, Communication module, Application Platform). One of medical sensors is the temperature sensor, we used the temperature Resistance Equation to build the Algorithm to get the temperature measurements. We implement web-service using PHP-Programming and MySQL DataBase: To update and plot the response of sensors to the real world Remote Healthcare Monitoring center. An experimental setup of embedded system of sensors is tested. It is an effective solution for providing specialty healthcare in the form of improved internet-access and reduced cost to ruralpatients.

***Keywords*—**Telemedicine, Internet of Things (IoT), eHealth, healthcare, medical center, information and communication technologies (ICT), rural health clinics.

I. INTRODUCTION

MORE than urban areas, rural communities depend on asystem of small clinics and health centers to provideprimary care services, often utilizing non-physician healthprofessionals. This system consists of rural health clinics(RHCs). Rural areas are facing limited supply of pharmacists,dentists and mental health professionals. Because trainingprograms have not kept pace with the rapid and growingdemand for pharmacists, there are relatively few pharmacistsavailable to serve rural areas [1]. Overall, the measured performance of rural physicians tended to be lower than performance of physicians in urban or suburban areas. Primary care physicians in both urban and rural areas identify diabetes, cardiovascular disease and cancer as major challenges and chronic conditions were major concerns. Mobile clinics equipped with new technology can move beyond traditional functions and provide broader range of clinics services. Advances in communications and information technology are transforming medical care by changing the way care is delivered and how people access medical services. One technology driving these improvements is telemedicine: the provision of clinical services using the electronic exchange of medical information, cross-site transmission of digital images andelectroniccommunications(e.g,remotemonitoringofvital signs and video patient consults with physicians). Rapidly emerging as a component of telemedicine is medical care that relies on mobile devices such as cellular phones, personal digital assistants and laptops (often referred to as mHealth). High resolution cameras, digital imaging, the use of smart phones and broadband high-speed connections have dramatically improved the scope and scale of telemedicine's applicability[2].

Corresponding author: Hafez Fouad (e-mail: *hafez@eri.sci.eg*).
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II. TELEMEDICINE USED IN RURAL HEALTHCARE

Telemedicine can expand capacity, foster coordinatedcare, improve the quality and efficiency of the delivery system and support more patient self-management. **Figure 1** shows the types of telemedicine that are most functional expand the capacity of the rural healthcare delivery system, making it easier for patients to be seen and treated, especially by specialists.

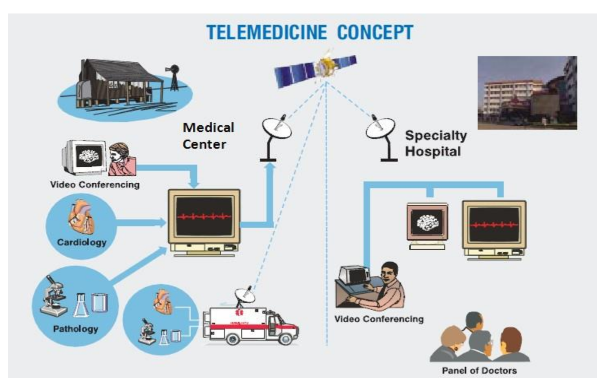

Figure 1 Telemedicine usage in rural [3]

The Telemedicine Embedded System

• **Transmission of data or images for analysis**. Clinical information is "stored" with patient record and then forwarded to provider for further review. Store and forward technology also supports ongoing remote patient monitoring and management of key medical indicators inpatients.

• **Consultations between patients and Doctors**. Video consultations extend the reach of scarce specialists; interactive capabilities provided by video support the technology's use in behavioral health care. It allows patients to connect to more than one provider at a time: a primary care physician can join with specialist to confer with patient. If physicians andpatients are not available at the same time, either one can prepare a videoreportthatcanbeaccessedatalatertimebytheother[3].

• **Support for patients managing their own health**. Patients can use the internet to obtain specialized health information and to access online discussion groups for peer-to-peer support. Surveys show that patients are often willing to manage their personal health information over smart phones and are interested in pursuing other types of care delivery via mobile devices [2]. When connected to portable medical devices, phones can capture blood glucose levels, blood pressure values and vitals, and transfer information to personal healthrecords.

• Remote monitoring is used to track changes in important patient vital signs such as, body temperature, blood pressure and heart rhythms. Patients wear monitors or use devices such as scales located in their own homes and connected to their physicians' offices, making it possible to monitor patient's health without an office visit.[2].

• Intensive Care Unit (ICU) Telemonitoring (e-ICUs). These programs extend the reach of critical care providers. Specialist physicians and critical care nurses staff round-the-clock tele-ICU centers (or tele-hubs) that receive datafrommonitoringdevicestrackingpatientsinICUsinsmall hospitals, including those in ruralareas.

• **Tele-pharmacy**. Remote rural clinics may not be able to provide full-scale pharmacy, but access to electronic connection to pharmacy and pharmacist can help patients receive both medications and medication counseling. By connecting pharmacies at urban hospitals to small rural hospitals, pharmacists can guide dispensing technicians to fill prescriptions [3]. In some cases, legal requirements that pharmacists be present for dispensing of medication may complicate this practice[4].

III. Requirements in MedicalCenters

- Tele-consultationroom
- Patient engagement facilities (bed, scopes,etc.)
- Medical equipment, IT compatible, with interface to Telemedicine and/or other software /hardware
- Computerhardware/softwareplatform(PC,switch,etc.) and IT electronicsequipment
- IP Video conference kit
- DigitalECG
- A3 filmscanner
- Digital microscope & camera
- Glucometer &haemogramanalyzer
- Non-invasive pulse & blood pressureunit
- Connectivity device &router
- Video conferenceequipment
- Accompanied by data and image transfer(live)
- Commonsoftwareusageatbothends,thusglobalization of a single databasesoftware
- Role of trained technical personnel is equally important and necessary at the patientend.

Figure 2 Requirements in medical centers

Distant Site: The Centers for Medicare and Medicaid Services (CMS) is the telehealth site where the provider/specialist is seeing the patient at a distance or consultingwithapatient'sprovider.Otherscommonnamesfor this term include – hub site, specialty site, provider/physician site and referral site.

DigitalCamera(stillimages): Adigitalcameraistypically used to take images of a patient. General uses for this type of camera include dermatology and wound care.

Document Camera: A camera that can display written or typed information (e.g., lab results), photographs, graphics (e.g., EKG strips) and in some casesX-Rays.

Patient Exam Camera (video): is used to examine the generalconditionofthepatient.Typesofcamerasincludethose that may be embedded with set-top videoconferencing units, handheld video cameras, gooseneck cameras, camcorders,etc.

IV. Telemedicine's Effect on Cost and Outcomes

Telemedicine technology can reduce readmissionsto hospitals, avoid unnecessary visits to physician offices, improve medication compliance and strengthen communication between patients and healthcare professionals hold significant promise in practice. Policy makers, researchers, healthcare professionals and consumers are interested in the widespread adoption of telemedicine technologytoreducecostsandimproveoutcomes.Researchon cost-effectiveness and health outcomes is, however, starting to generate some initial results:

- An extensive literature review reported that telemedicine reduced time-to-diagnosis, improved access to care for patients in remote areas and improved patient satisfaction [5].
- A Veterans Affairs study in Florida showed 50 percent reductioninhospitaladmissionsandan11percentreduction in emergency room services using home telehealth services [6].
- A review of 13 tele-ICU studies found that telemedicine in the e-ICU reduced ICU mortality by 20 percent and reduced the average length of ICU stays by an average of 1.26 days[7].

V. Strategies to Improve the Use of Telemedicine

We discuss strategies to make full access oftelemedicine:

A. Expand broadbandconnectivity

Toenablegrowthoftelemedicineadoption,physiciansmust have the necessary infrastructure access to broadband, video-conferencing technology and telemetry-enabled medical-devices.

B. Encourage physicians to incorporate telemedicine into theirpractice

While telemedicine has the potential to benefit physicians and their patients, education and support are needed to easethe transition for many providers. As with electronic health record adoption, the adoption of telemedicine will also require structural changes in many practices: staff composition, work schedules and record keeping are all likely to evolve in practices that use telemedicine extensively [8]. Health plans, employers and public purchasers of care can all encourage providers in their networks to use telemedicine by educating them about its ability to serve patients better by combining telemedicine encounters with face-to-facecare.

C. Use telemedicine to build primary Carecapacity

Rural areas without ease of access to specialists use telemedicine to provide care without the need for transporting patients from small hospitals or physician offices to urban centers. Through video conferencing, physicians located in urban hubs can visit with, treat and prescribe medications for patients in distant rural locations [9].

D. Increase access choices for ruralbeneficiaries.

Employers canprovide greater choices for rural residents in how they communicate with health care professionals by making available telemedicine applications, such as video consultations, online care and patient kiosks. Telemedicine broadens the scope of care and types of provider networks available to rural residents and makes it more convenient[10].

E. Improve care coordination and patientsafety.

Providers should consider adopting telemedicine to aide in efforts to improve patient safety and care coordination. Telemedicine can improve health system efficiency by connecting professionals to each other and to pertinent data (medical records, data from remote monitoring systems, and images). It can also enable greater follow-up with patients post-surgery. Remote patient monitoring in ICUs can improve patient safety and reduce the need for patient transfers. Data transfers from ambulances to hospitals can improve the speed and effectiveness of emergency care [11].

VI. Proposed Embedded system Design forRemote health monitoringcenter

Sensor Nodes Circuit Implementation

It is data processing center. It is responsible for collecting data from different nodes through "Wi-Fi" network and processesthemtoextractusefulinformation.Itmustalwaysbe active since the arrival of information is random. This is why hisenergyshouldbeunlimited.Inalargesensornetworkwhere the charge is a little higher, we can find two or more Sink to lighten theload.

Sensors are interfaced to the microcontroller through the analog module, the written software in the microcontroller processes data and the processing results are sent to the Laptop then to web-portal using Bluetooth connection and the flow chart of the written software is shown in **Figure 4**.

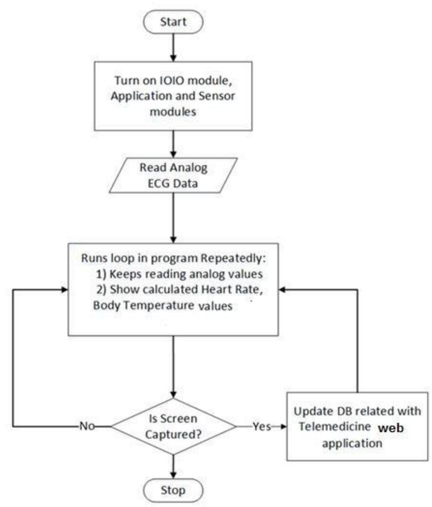

Figure 4 Flow chart of embedded software

Analogmoduleisusedtogettheelectricalmeasuredvalues from the real physical world and serve it to the brain (the microprocessor) into an understandable format for the processingphase.

Microcontroller contains the microprocessor and the peripherals necessary for the operation.

UARTisthecommunicationmodulebetweentheBluetooth module and themicrocontroller.

Bluetooth module is responsible for decoding andencoding data with Bluetoothstandard.

Web-portal is using PHP web-Programming and MySQL DBtoupdateandplottheresponseofsensorstotherealworld.

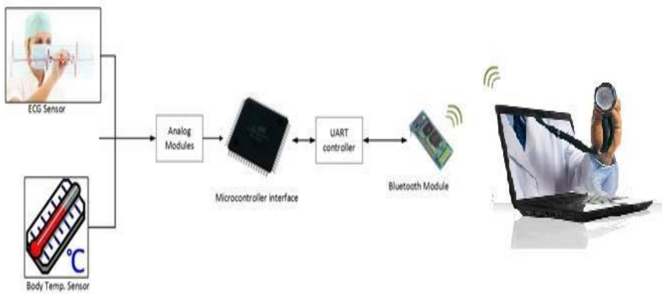

Figure 5 System structure to clarify 4 components (medical sensors, CCU interface, communication module, and application platform)

One of these sensors is the temperature sensor. We usedthe Temperature Resistance Equation to build the algorithm to get the temperature measurements. The resistance of thermistors changes dramatically and sensitively with temperature, satisfyinganexponentialrelationship.Toconvertthemeasured resistance to temperature, once can use the followingequation:

$$R_{TH} = \alpha\, e^{\beta/T_{abs}} \qquad (1)$$

where$T_{abs}$the absolute temperature is in °Kelvin. The values of α and β depend on the thermistor used. We used a Yellow SpringsTypeYSI400thermistorasanexample.Thisparticular thermistor has a calibration point resistance of R_o = 2252 Ω at T_o = 25°C. Transforming the above equation to a ratio of thermistor resistance to resistance, R_o, at a reference temperature of T_o=25°Cproduces,

$$\frac{R_{TH}}{R_o} = e^{\beta\left(\frac{1}{T+273.15} - \frac{1}{T_o+273.15}\right)} \qquad (2)$$

whereR_{TH}istheresistanceattemperature,T(nowmeasuredin °C) and R_o is the calibration resistance (2252 ohms) at the calibration temperature, T_o, of 25 °C. The β in the equation isa parameter that represents the semiconductor's temperature slope. If the above equation is fitted to the chart data at thetwo temperatures of 25 °C and 45 °C to find the best slopebetween those two points, then the equation fits just about perfectly for 25 through 45 °C, and fits within ±0.1 °C for the 15-55 °C range, using β=393. Inverting the equation produces the equation you could use in an instrument to convert the measured resistance value to temperature in°C,

$$T = \frac{1}{(1/\beta)\ln(R/R_o) + 1/(T_o + 273.15)} - 273.15 \qquad (3)$$

But sometimes, you may need even greater accuracy. A commonly used formula used to fit thermistors uses a fifth order polynomial in the logarithm of the resistance, as,

$$T = \frac{1}{a + b\ln(R/R_o) + c\left(\ln(R/R_o)\right)^3 + d\left(\ln(R/R_o)\right)^5} - 273.15 \qquad (4)$$

Theparameters, *a*, *b*,*c*,and*d*,arefoundbycurvefittingthe equation to the thermistor data over the temperature rangeof interest. Afterward, the above equation is used at run-time to compute temperature from the thermistor resistance [12,13].

```
private void valuesconversion(final float HR_val,final float TMP_val) {
    float measuredvolt,Rv,measuredtemp,measuredtemp_new=0,tempdiff; // temperature
    float measuredrate; // heart rate variabless
    measuredvolt=(float) ((TMP_val*1023)*(3.3/1024)); // map the input digital val
    Rv=(float) ((1000*measuredvolt)/(3.3-measuredvolt)); // get the value of the m
    measuredtemp_new=(float) ((1/(0.0002545*Math.Log(Rv/2252)+0.0033535))-273.15);
    tempdiff=(measuredtemp_new-measuredtemp_old);
    measuredtemp=measuredtemp_new;
    if(tempdiff>0.2){
        measuredtemp=measuredtemp_new;
    }else{
        measuredtemp=measuredtemp_old;
    }
    measuredtemp_old=measuredtemp;
```

Figure 6 Algorithm used to get body temperature measurements

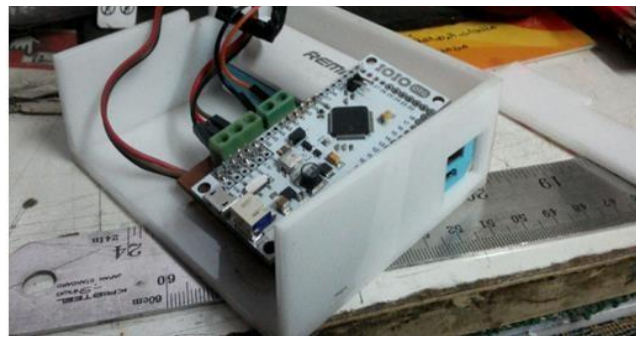

Figure 7 Experimental setup of embedded system of sensors

VII. Proposed web-applications of Remote Healthcare Monitoringcenter

Figure 8 indicates the proposed telemedicine web-process through Medical center, is implemented in 4 main stages as follow:

A. First:Registration

Medical center Representative can register in web-portalby enteringpatient'sinformation(name,address,email,username, password and specialty), the center's information (center's name, address, image, specialty and Commercial No.), and doctors'informationwhoworkinthecenter(names,graduation year,emails,specialtiesandTradeunionfigure).Thesitesends email to confirm registration then the site includes thismedical center to database then center will appear to all users insite.

B. Second: DoctorAddition

The medical center can search for doctor by (name, specialty, graduation year, experience,...). They can see doctor's profile then he can booking of time and if the doctor confirms that, the site will send confirmation message to the medical center.

C. Third: Booking anAppointment

The medical center can search for doctor by (name, specialty, graduation year, experience,..). They find doctor's profile and see available timeslots and if these suitable to patient, he will insert patient's information and book a timeslot and if the doctor confirm that ,the site will send confirmation message to the medical center and doctor including the video conference link

D. Fourth: MakeVisit

Firstthemedicalcenterwillreviewtoday'sreservationsand if it's the 2nd time for patient and he hasrequired examinations or digital data so he will send them to the doctor then open the link of video conference and when the reservation ends thesite will send a file contains the status of this patient, the required examinations, X-rays anddrugs.

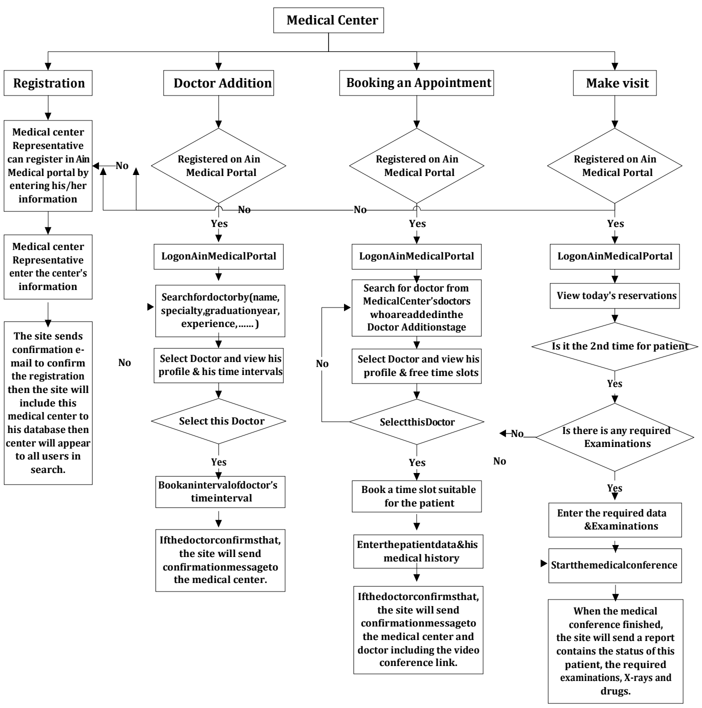

Figure 8 Proposed web-implementation of remote healthcare monitoring center for telemedicine system

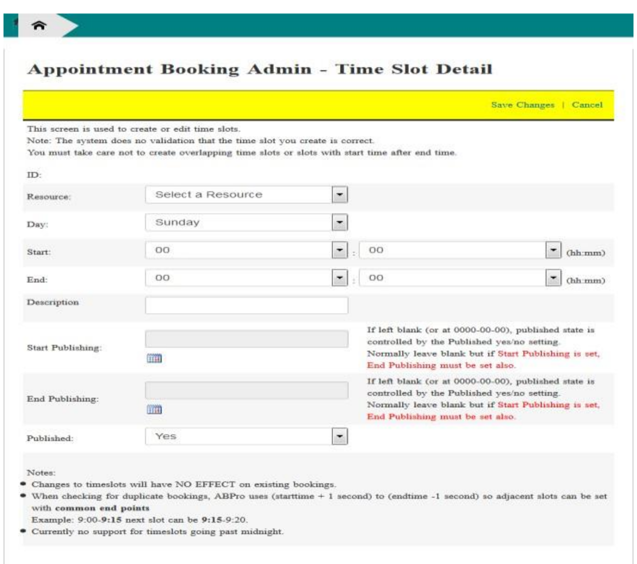

Figure 9 Screen shoot of web service for booking

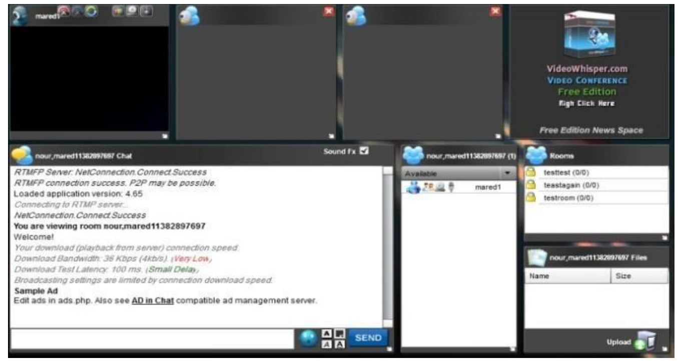

Figure 10 Video conference screen to start telemedicine service

VIII. CONCLUSION

TheProposedImplementationofEmbeddedSystemDesign for Remote Healthcare Monitoring center for Telemedicine system through web-Portal www.AinMedical.comis achieved andrunning.Theequippedsystemwithnewtechnologyisused to provide wide range of services in Telemedical center which facilitatestheprovisionofmedicalaidsfromadistance.Itisan effectivesolutionforprovidingspecialtyhealthcareintheform of improved access and reduced cost to the rural patients and the reduced professional isolation of the rural doctors. Telemedical centers can enable ordinary doctors to perform extra-ordinary tasks. While some forms of telemedicine, such as store and forward applications for imaging reads, are commonly in use, other uses of the technology are still in developing. So we implement Sensor nodes Circuit for collecting data and process them to extract useful body information. Sensors are interfaced to microcontroller through analog module. The proposed system structure clarifies4 components(MedicalSensors,CCUInterface,Communication module, Application Platform). An experimental setup of embeddedsystemofsensorsistested.Itisaneffectivesolution for providing specialty healthcare in the form of improved internet-access and reduced cost to ruralpatients.

IX. FUTURE WORKS ANDOUTLOOK

Other telemedicine technologies hold promise for the future, although their full realization may be some way off as:

• **Robotics**. Telemedicine robots allow doctors to travel virtually to a patient's bedside. Robots are also beginning tobe used in remote surgery, although most robotic surgery is still carried out by on-sitesurgeons.

• **Mobile Clinics**. These care sites may become a tool to bring medical care directly to patients and help increase access in areas with limited broadband connectivity. When fully realized, mobile clinics should be capable of taking biometric readingsandallowingindividualstouploadvitalsignswiththe eventual providing full diagnostic evaluation and recommendations for treatment without the use of on-site personnel.

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