ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

Real Time Patient Monitoring In a Telemedicine System for Emergency Medical Services Using Internet of Things

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ABSTRACT: Telemedicine emerges as a complementary system in EMS that may provide expertise and improve quality of medical treatment on the scene. It also involves the use of advanced and reliable communication techniques to deliver biomedical signals over long distances. In such systems, biomedical information is transmitted using wired or wireless communication systems. Here we integrate the real time patient monitoring system with internet of things to build a telemedicine system which enables on-scene EMS staff to consult with specialist in a remote location. We make use of sensors such as temperature sensor, blood pressure sensor, MEMS sensor and heart beat sensor collects the inputs from patient who are in emergency room and the data are collected and transmitted with the help of the microcontroller and displayed in LCD. The vital parameters are also transmitted to the tele consultant and doctor .The main objective of this project is to monitor patient in real time and promotes remote access of patient condition.

KEYWORDS: Microcontroller, Temperature sensor, Pressure sensor, Heartbeat sensor, LCD, IoT

I. INTRODUCTION

Telemedicine is the use of telecommunication and information technologies to provide clinical health care at a distance. It helps eliminate distant barriers and can improve access to medical services that would often not be consistently available in distant rural communities. It is also used to save lives in critical care and emergency situations. Telemedicine also refers to the provision of remote clinical services, via real-time two-way communication between the patient and the tele consultant[11].

In primary care, telemedicine is usually in the form of phone calls, where the patient seeks the doctor's advice about non-emergency medical problems which don't require the doctor to see the patient. It doesn't replace face-to-face consultation when it is needed, but complements it. The real role of telemedicine at present lies in the convenience it offers to patients and practitioners by obviating the necessity for a physical visit to get medical advice or treatment. It is cost-effective, in comparison to the process of waiting to see a doctor or other practitioner. It can help select urgent calls after a doctor's office is closed. It is of immense value in the follow-up of patients with chronic diseases such as diabetes, high cholesterol, or high blood pressure. Such patients have no immediate medical problem, but require help with dosage adjustments, lifestyle regimens, prescription refills, or even just access to group support.

The Internet of Things (IoT) is the network of physical objects—devices, vehicles, buildings and other items embedded with electronics, software, sensors, and network connectivity—that enables these objects to collect and exchange data. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure,creating opportunities for more direct integration of the physical world into computer-based systems.

Internet of Things in Medicine, According to tech experts, the Internet of Things is becoming more and more an integral part of our everyday life, and that includes health care. Wearable devices[14] have made it possible for health providers to monitor a patient's health remotely using actuators, sensors, and other mobile communication devices.

Patient monitoring would qualify for this kind of IoT application, where a patient may wear a sensor that monitors their temperature, blood pressure or other vital health signs.

Telemedicine solutions[13], like applications in many other industries, are benefiting from the rise of the Internet of Things (IoT), which brings a multitude of physical objects

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into the connected world via the Internet.

II. RELATED WORK

There were many previous works carried out on patient monitoring system. The goal is to transmit the signals or the vital parameters from the emergency room to the teleconsultant inorder to send to the specialist for the consultation through IOT technology via internet.These are the few concepts which helped us to get some ideas.
A Novel Emergency Telemedicine System Based On Wireless Communication Technology[1].This paper proposes to develop a portable medical device that allows tele diagnosis, long distance support and tele consultation of health care providers by expert physicians. This device also can bring an expert specialized doctor at the site of medical emergency and allow him/her to evaluate patient data and issue directions to the emergency personnel on treatment procedures until the patient is brought to hospital. It uses GSM (Global System for Communication) telephony network that allows transmission of vital bio signals and still images of the patient from emergency site to the consultation site. Security and confidentiality of stored information are verycritical issues to medical archiving systems. Recommendations by users for future system development include the integration of all systems like bio signal monitor, mobile unit, and image acquisition device in one module with possibly less weight. Additional recommendations include the integration of the system with a GIS/GPS system for ambulance vehicle control and management.
A Joint Organisational And Technical Telematic Rescue Assistance System For German Emergency Medical Services[2].This paper traces the joint organizational and technical development of the Telematic Rescue Assistance Systems (TRAS) based on a consistent user involvement into the development process. The TRAS provides the real time transmission of voice communication, vital parameters, pictures and videos from any emergency site using mobile radio networks. Medical and mission tactical data is transmitted via 3G mobile radio networks from the place of emergency or the ambulance vehicle to the remote emergency physician in the Competence Center (CompC), communicating with the staff at the place of emergency via audio connection. The technical components on site are connected to a communication which connects to the ambulance vehicle via an 802.11 network or directly to Public Switched Telephone Network (PSTN) and the Internet through GSM/TETRA and GPRS/UMTS.The user groups from different emergency department differ in handling instrument, so requirement from user groups have to be refreshed consistently. The challenge of future enhancement is implementing in parallel regions.
Telemedicine by mobile communication [3].This paper was proposed by K. Shimizu in the year 1999.The technology implemented here is mobile and satellite communication. Reliability is the major advantage and the legal problems faced in this paper are violation and protection of personal privacy. These defects can be enhanced in future by Concept of conventional telemedicine by changing it from static to dynamic and by enlarging its scope from local to global area.
Employment of telemedicine in emergency medicine [4].This paper was proposed by the following authors M. Czaplik, S. Bergrath, R. Rossaint, S. Thelen, T. Brodziak, B.Valentin, F. Hirsch, S. K. Beckers, and J. C. Brokmann in the year 2014.The implementation is about 2G and 3G technologies.The advantage of this paper is reliability and usability under test field conditions and the poor connection while sending photos and videos adds to the disadvantage in this paper.These defects can be rectified by implementing real time monitoring with advanced technologies.

Mobile Telemedicine – A Survey study[5]. This paper was proposed by C.-F. Lin in the year 2012.Mobile satellite system, mobile cellular systems, short distance wireless systems are the technologies used here. Delivery of bio-medical signals over long distance, high speed and high delivery are the advantages .These can be implemented and rectified in future by Advanced mobile communication techniques which enable improvement in diagnosis and Qos of mobile Telemedicine systems.

Multi purpose health care tele-medicine systems with mobile communications link support[6].This paper was proposed by the following authors E. Kyriacou, S. Pavlopoulos, A. Berler, M. Neophytou, A. Bourka,A. Georgoulas, A. Anagnostaki, D. Karayiannis, C. Schizas, C. Pattichis,A. Andreou, and D.Koutsouris in the year 2003.GSM with Satellite links, POTS are the technologies implemented in this paper. The major advantage is that it can be used in rural health centers.The drawback of this paper is about low transmission of data. These defects can be rectified by implementing advanced technology in future.

Clinical assessment of wireless easy transmission in real time cardiac monitoring[7] .Wireless channel model using RETP protocol is the technology used here. Store and forward real time transmission adds to the advantage and this

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can be implemented only for ECG transmission which is the drawback in this paper. These defects can be modified in future by introducing other sensors for calculating pulse rate and blood pressure.

Secure and reliable communication for Tele-medical applications in emergency medical services[8] .This paper was proposed in the year 2013.Cellular networks is the technology implemented here[12].Secure and reliable communications, voice communication is the major advantage of this paper. It can be modified in future by increasing the reliability of audio communications.

III. PROPOSED WORK

The proposed model includes the components such as Microcontroller and different sensors. Sensors analyse the vital parameters from patient. Sensors are interfaced with LPC2148 ARM7 micro controller.

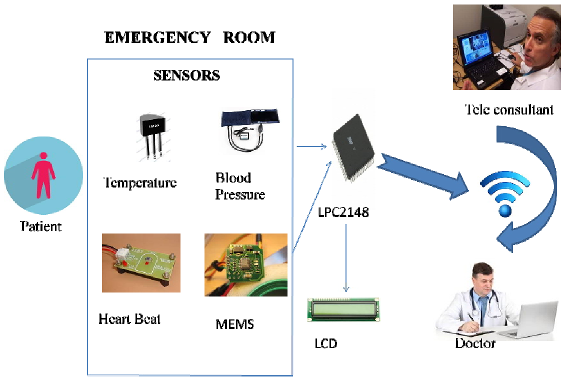

Fig 1.1 System Architecture Diagram

Then the parameters are displayed in LCD for reference. Those parameters are sent to teleconsultant and to doctor through internet.

A.ARM7 Microcontroller:

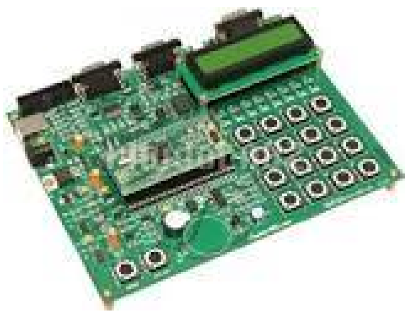

Fig 1.2 ARM7

Features:

- 16/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 or HVQFN package.
- 8/16/32 kB of on-chip static RAM and 32/64/128/256/512 kB of on-chip flash program memory.
- 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 µs.
- The LPC2131/32 contain one and the LPC2134/36/38 contain two ADCs. These converters are single 10-bit successive approximation ADCs with eight multiplexed channels.
- Measurement range of 0 V to 3.3 V.
- Each converter capable of performing more than 400000 10-bit samples per second.

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B.STUDY OF SENSORS

TEMPERATURE SENSOR

The LM35 series are precision integrated-circuit temperature sensors[10], whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

Importance Of Temperature Sensor:

- Can measure temperature more accurately than using a thermistor.
- The sensor circuitry is sealed and not subject to oxidation, etc.
- This sensor generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.

Features :

- Suitable for remote applications.
- Low cost due to wafer-level trimming.
- Operates from4 to 30 volts.
- Less than 60 µA current drain.
- Low self-heating, 0.08°C in still air.

BLOOD PRESSURE SENSOR

- The sensor produces an output voltage that varies in a linear way with pressure.
- The Blood Pressure sensor has a memory chip (EEPROM) with information about the sensor.
- Through a simple protocol (I2C) the sensor transfers its data: name, quantity, unit and calibration to the interface.

Features:

- Simple to install and operate .
- Easy to integrate in test rig applications and existing control systems.
- Advanced digital signal electronics for lowest noise combined with highest sensitivity
- 5Hz to 22 kHz frequency response .
- Velocity up to ± 500 mm/s (3 ranges).

HEART BEAT SENSOR

The Heart Beat Sensor provides a simple way to study the heart's function. This sensor monitors the flow of blood through ear lobe. As the heart forces blood through the blood vessels in the ear lobe, the amount of blood in the ear changes with time. The sensor shines a light lobe (small incandescent lamp) through the ear and measures the light that is transmitted. The clip can also be used on a fingertip or on the web of skin between the thumb and index finger. The signal is amplified, inverted and filtered, in the box. By graphing this signal, the heart rate can be determined, and some details of the pumping action of the heart can also be determined.

Features:

- Indicates heartbeat by a LED.
- Provides a direct output digital signal for connecting to a microcontroller.
- Possesses compact size.
- Works with a working voltage of +5V DC.

MEMS SENSOR

MEMS sensor provides unprecedented stability at zero rate level and sensitivity over temperature and time. It includes a sensing element and an IC interface capable of providing the measured angular rate to the external world through a standard SPI digital interface[15]. An I2C-compatible interface is also available.

Features:

- Selectable Sensitivity (1.5g/2g/4g/6g).
- Low Current Consumption: 500 ìA.
- Sleep Mode: 3 ìA.
- Low Voltage Operation: 2.2 V – 3.6 V.

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- 6mm x 6mm x 1.45mm QFN.
- High Sensitivity (800 mV/g @ 1.5g).
- Fast Turn On Time.

2X16 LCD

- It can display up to one 8-character line or two 8-character lines
- The low power supply (2.7V to 5.5V) is suitable for any portable battery-driven product requiring low power dissipation

IV. RESULTS AND DISCUSSION

Patients who are in the emergency room gives the input through the different sensors in the form of heart beat rate, blood pressure rate, temperature values ,which in turn send to microcontroller that converts the analog values into hex file and finally they are displayed in LCD and those values are send to tele consultant and doctor for further consultation.

The output of this system displays the parameter values of the patient detected by different sensors. It displays output in the web browser. The parameter value of any one of the sensor is displayed initially and then after refreshment of page, it displays the parameter values of other sensors. By issuing the IP address ,the doctor can easily monitors the condition of the patient and provides further improvement or prescription of the patient.

V. CONCLUSION & FUTURE WORK

With the wide use of internet this work is focused to implement the internet technology to establish a system which would communicate through internet for better health monitoring . Internet of things is expected to rule the world in various fields but more benefit would be in the field of healthcare. From the above work, this project scope enables on-scene EMS staff to consult with the specialist in a remote location and also provides real time patient monitoring. The continuous monitoring of patient parameter values is implemented in the system and its need of the hour. In order to implement the on-scene EMS real time monitoring system, we have used different sensors and microcontroller for implementation purpose. The methodology we used is about interfacing microcontroller with sensors and code dumping is done with flash magic. The entire output of the system is constant monitoring of the patient parameter values by the tele consultant and doctor.

The Future work of the project is very essential in order to make the design system more advanced.This work can be enhanced in future by adding more number of sensors than we specified in this system and also different medical devices. In this model, we are monitoring a single patient at a time, but it can be implemented by monitoring multiple patient at a time. The record of patient parameter values can be stored in database for further references and queries.

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