Monitoring of Physiological Parameters and Waveforms using Wireless Body Sensors and GSM Technology

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ABSTRACT: This paper presents a wireless sensor network system that has the capability to monitor physiological parameters from single patient bodies. The system can be used by elderly or the person at risk or even by a normal person for the monitoring of physiological parameters.This system proposes expert doctors to monitor vital parameters like body temperature, heart rate, ECG of patients in remote areas hospital the sensor nodes and a remote central control unit(CCU) that behaves as a base station are placed on the human body. The CCU communicates with another network standard (Mobile network) for a long distance data transfer. Mobile phone transfers the measured parameters as SMS to clinicians for further analysis and diagnosis. Also data can be sent to several doctors incase a doctor fails to respond urgently. The developed system has been optimized for power consumption. The complete system will help to monitor the person during day and night and will be suitable to elderly population living alone at home.

Index Terms- Body temperature Wireless sensor, ECG Wireless sensor, Zigbee, GSM, Labview.

1 INTRODUCTION

With the use of high performance and tolerant wireless devices, conditions like body temperature, heart rate, electrocardiogram (ECG) can be taken from the patients and stored in computers. The signals can be monitored through sensor from a single patient's body. A wireless body sensors are placed strategically on the human body as tiny patches or hidden in users clothes.The physiological data collected by the sensor networks can be stored for a long period of time and can be used for medical exploration. In case, if the patient is not in the network coverage area, the data regarding the health parameters would be continuously collected by microcontroller unit and then it is transmitted to the medical center as soon as patient reaches a coverage area. These data can also be sent to remote computers where medical consultants could monitor remotely. The advances in information and communication technologies enable technically, the continuous monitoring of health related parameters with wireless sensors, wherever the user happensto be.

In developing wireless recording and monitoring for real-time physiological parameters (e.g EEG, pulse oximetry,blood flow, blood pressure etc) from the human body. Patients are being monitored using a network of wireless sensors which provides an accurate, flexible, non-invasive, comfortable and reliable.

2.WIRELESS BODY SENSOR NETWORKS

Hardware electronics are developed on the WBSN as shown in Fig 1.

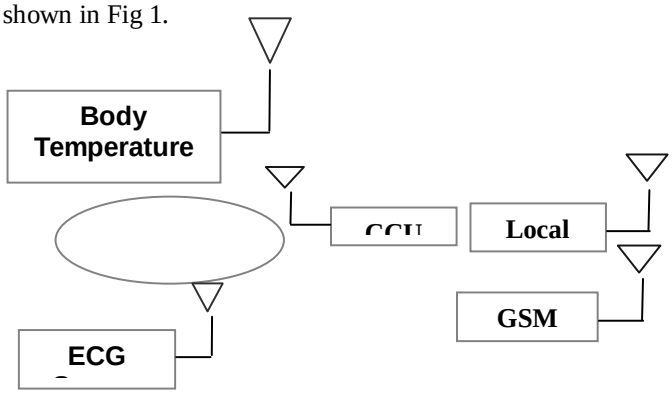

Fig 1. Block Diagram

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The wireless body sensors network comprises a sensor nodes, a central control unit (CCU) that transmits data to a local pc and GSM at a medical center. Patients can wear wireless devices that sense physiological conditions and send the sensed data to their doctors in real time. The sensor nodes and the CCU to provide a bi-directional communication, to control the wireless transmission and to prevent collision between sensor nodes.The data can be collected to the local PC is transferred to the network in a medical center. GSM based network for doctor to patient communication in the hospital and even to communicate and indicate the status of the patient through SMS.

3 SENSORS AND HARDWARE DESIGNS

A. Body temperature Sensor

Thermistor has been chosen as the body temperature sensor for this project. Thermistor is a non-linear thermistor with tolerance of ±0.2°C. It can measure temperatures ranging from 0°C to 50°C and has a fast response time and low power dissipation, which makes it ideal for such medical application.The sensor is small and can be placed anywhere on the body.

B. Electrocardiogram Sensor

The ECG (Electrocardiogram) sensor measures cardiac electrical potential waveforms (voltages produced during contractions of the heart).The sensor consists of Fourier Systems plastic sensor case and three electrode leads. The sensor comes with a package of one hundred silver/silver chloride electrode patches that can be attached to the skin. The sensor's circuitry isolates the user from the possibility of electrical shock.

Sensor Specification

Range:	0 – 5 V
Resolution (12-bit):	1.23 mV
Recommended Sample Rate:	100 samples/sec
Voltage Protection:	4 kV
Isoelectric Line (Gain):	1mV body potential = 1V sensor out put
Maintenance:	The electrodes should be kept refrigerated in a clean, dry, airtight container for storage

Fig 2. ECG Wireless Sensor

C. Zigbee Microcontroller

These Modules provide a possibility to build an easy to configure Network, with a high data rate up to 230400 Baud/s. The ZigBee/ZigBee-PRO ZB RF Modules are designed to operate within the ZigBee protocol and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between remote devices. They come in a preconfigured mode and establish the communication automatically. In addition they are powered by 2.7 to 3.3V. The modules operate within the ISM 2.4 Ghz frequency band are compatible with ZigBee. The ZigBee modules do not specifically require any external circuitry or specific connections for proper operation.(Fig 3)

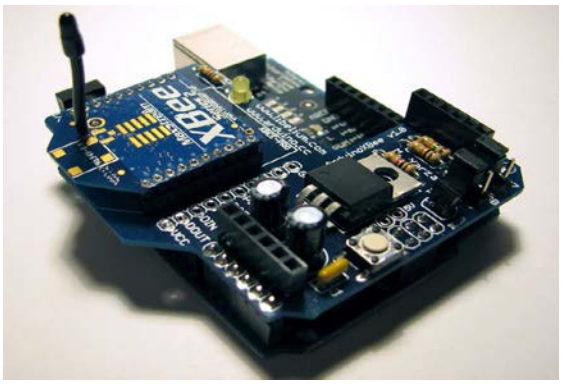

Fig 3. Zigbee Microcontroller

D.GSM

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like an ordinary dial-up modem. The difference between them is that a dial-up modem and receives data through a fixed telephone line, while a wireless modem sends and receives data through GSM. GSM modem can be an external (USB/COM) device or a PC Card. Like a GSM modem phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. It displays the response it receives from the mobile phone or GSM modem on the screen. Using a mobile phone or GSM modem to send SMS messages has a major drawback, that is the SMS sending rate is too low. Only 6-10 SMS messages can be sent per minute. The performance is not affected by the connection between the computer and the mobile phone or GSM modem.

E. Hardware Implementation

The hardware implementation part is rather large and complex and the present is moving towards the miniaturization, thereby an efficient design flow is necessary, which was implemented using Labview. The signal is taken and fed to an instrumentation amplifier that amplifies the signal. The amplifier is used to set the gain and it also amplifies very low amplitude ECG signal into perceptible view. Then the signal goes for analog to digital conversion for the sake of easier transmission. The amplified signals are then sent for filtering processes.The ECG signal is acquired with the help of electrodes that are connected to the patient and the signal is fed for further processing like instrumentation amplifier, Analog to Digital converter, micro controller, and filters. After acquiring the signal, different signal analysis techniques using Labview software where various abnormalities are to be checked for and finally display the problem in ECG of a particular patient. The adaptive noise filtering is used for removal of 50 Hz that is the power line interference because, the ECG signal also contains 50 Hz signal and if normal band reject filter is used, then the 50 Hz signal which is very important in the ECG signal will be lost. Therefore by opting adaptive noise filtering, the power line frequency can be eliminated at the same time retaining the 50 Hz signal in the original waveform.

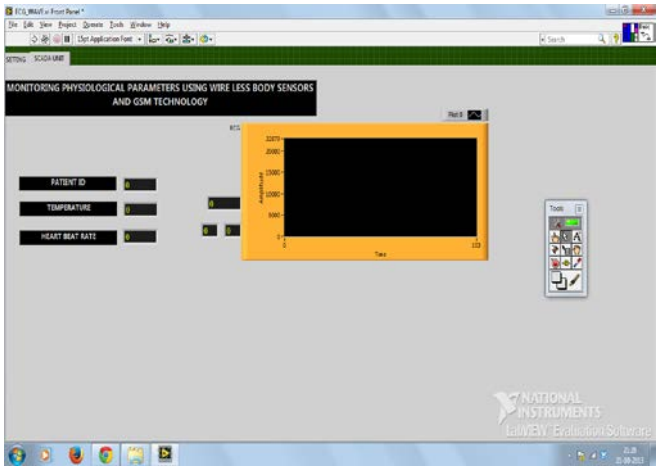

Fig 4. Labview Software

Fig 5. PCB Layout

4 Results

The physiological parameters and signals like body temperature, heart rate, Ecg signal is obtained in the output of signal conditioning circuit. Using this wireless signal the devices are controlled by microcontroller.The figure below illustrates the outputs given below.

Patients	Body temperature (°c)	Heart rate (bpm)
1)	23	67
2)	25	72
3)	23	75

5. Conclusion

I have successfully implemented monitoring of physiological parameters and waveforms has been discussed in this paper. The use of ZigBee as wireless technology has enabled low power consumption and secured transmission.ZigBee enables mobility to patients. The measured parameters can be accessed using GSM as the system is network enabled.

6. Future Scope

Future work also involves in including more sensors to monitor other vital signs such as blood pressure, oxygen saturation level, EEG, etc. The system can also include the evaluation of physiological parameters by the software package at the local pc before transmitted to the medical center. There is also possibility to extend the capability to automate alerts which can get attention of the health professional as soon as they are needed.

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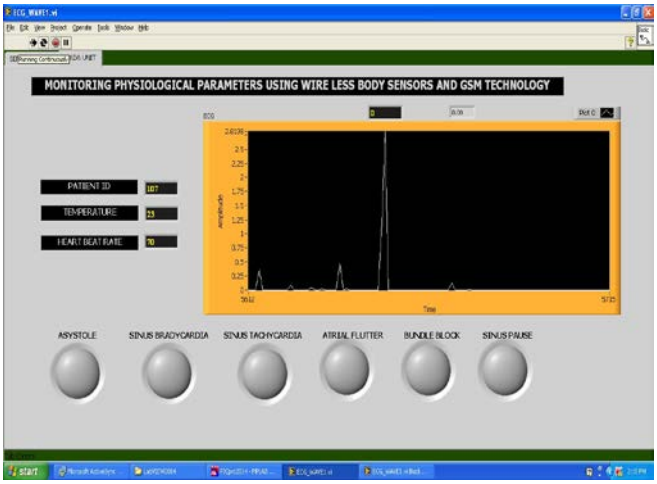

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