



CHF PATIENT MONITORING USING MSP430 CONTROLLER AND WIRELESS SENSORS

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ABSTRACT

Chronic heart failure (CHF) is a major cause of hospitalization in elderly people. Millions of people in industrialized countries like Europe and U.S are affected by this chronic disease. Wireless Sensor Network enables to monitor alterations in patient's physical parameters for detection of chronic disease in early stage. Set of wireless sensors with microcontroller send health status data to home server via low power ZigBee communication protocol. Home server is responsible for the sensor data acquisition and signal processing. For different parameters like temperature, ECG, pulse oxymetry, blood pressure threshold levels are set and compared with monitored parametric values. Processed data is transferred to remote healthcare system using General Packet Radio Service (GPRS). Critical situations can be identified and alert message can be forwarded to medical staff/caretaker & accordingly necessary action can be taken. Wireless communication helps to speed up the process of detecting destabilization signs. Proposed system provide many benefits like reduction in lengthy stays in hospital, avoid frequent visits to hospitals for regular checkup, reduction in medical staff's workload. Home based healthcare system is introduced which is convenient for patient as well as the physician.

INTRODUCTION

Many times the reason for a patient's lengthy stay in hospital is not the need of actual medical treatment but the continuous observation. Therefore attempts are made to avoid this problem. This system provides special comforts to elderly patients who are unable to visit hospital more often. Multi patient monitoring at the same time is possible with this patient remote monitoring system. The platform of health at home connects the patient with healthcare system both situated at different locations. Patient's health is monitored with Wireless Sensor Network (WSN) consisting of temperature sensor, SpO₂ sensor, ECG. Power consumption is kept minimum with the use of ZigBee technology, MSP430 controller. GPRS is used to improve communication coverage and speed of process. This system replaces sensor network hardwired to bedside monitors. Paramedical assistant is not required to keep track of record for the patient's health. In case of detection of abnormal condition of patient's physical parameters alert message is send to physician which provide real time feedback to take immediate necessary action.



LITERATURE SURVEY

Hospital admissions due to the heart failure have doubled in previous 20 years [1]. It causes large economical and societal issue, contributing 2% of total hospitalizations [10]. The CHF patient management contributes 2% of the total health system's expenditure [11][12]. Recent Technology in digital electronics advanced for sensors, power, microprocessor results in ultra-low power, lightweight sensor monitoring devices [6] [7] [8]. These sensors have ability to sense, process and transmit physical signals using with the help of wireless technology [9]. A highly reconfigurable and flexible platform for domestic physical signs acquisition & processing along with information system in hospital is presented in this paper. Home based follow up technique improve the results for heart patient monitoring with less mortality, decrease in hospital stays, reduced hospital admissions and raise patient satisfaction.

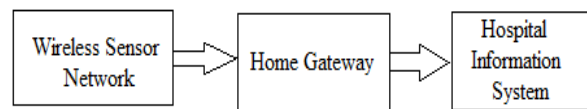
This system has been introduced in the project of health at home by Ambient Assist Living program. It considers recent guidelines for roadmap [13], future challenges about telecare [14] and recent AAL solution studies [15][16].

The health at home concept target at bridging in hospital care with out of hospital follow up by family caregiver/patient integrated with Hospital Information system.

SYSTEM OVERVIEW

System consists of 3 stages as shown in figure1: Wireless sensor network, home gateway, Hospital Information System (HIS). Wireless sensor network consists of set of temperature sensor, SpO2 sensor, ECG. Sensors sense the physical parameters like temperature, oxygen level in blood, ECG.

Figure1:



Overall System

This sensed data is given to home server which processes all these physical parameters. Normal, abnormal, critical values of different parameters are studied. Sensed data is compared with these values. All the health information is send to Hospital Information System for further analysis.

If any signal crosses safe limit then Email/SMS is send to physician/caretaker. So that immediate action can be taken.



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SYSTEM ARCHITECTURE

Figure2:

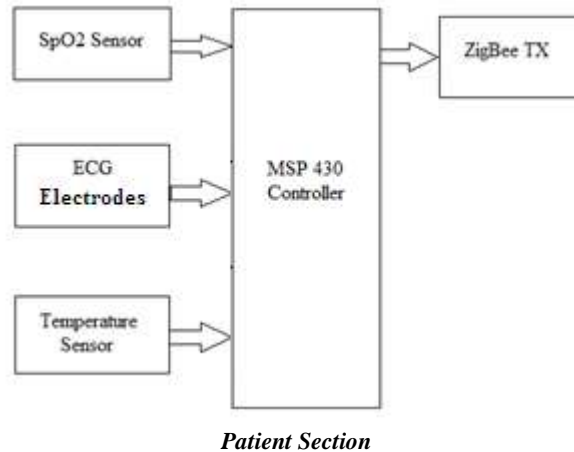
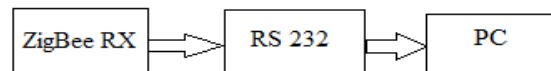


Figure3:



Monitoring Section

ECG: Electrocardiographic signal is obtained to find minimum, maximum and average heart rate. It also detect presence of atrial fibrillation. Whether detected QRS is valid QRS or not is evaluated.

SpO2 Sensor: It detects maximum, minimum and average level of oxygen in the blood. Oxygen lowers quickly in CHF patients; therefore SpO2 monitoring is necessary frequently.

Temperature Sensor: LM 35 is used to sense the temperature. Its output voltage is proportional to the Celcius temperature. It measure temperature more accurately than a thermistor. LM 35 generates a higher output voltage



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compared to thermocouples. There is no need of amplification of output voltage. It has low self-heating capability. Self-heating causes less than 0.1 Degree Celcius temperature rise in air. It draws 60 microamperes from the supply.

Blood Pressure Sensor: Blood Pressure is pressure created by circulating blood on the blood vessels walls. Blood pressure changes between systolic (maximum) and a diastolic (minimum) level. Variations in the normal value of blood pressure for short period of time causes manifestations of the cardiac instability. So blood pressure monitoring is very important for heart patient.

MSP 430 Microcontroller: It is a ultra-low power mixed signal microcontroller. It has 5 modes of low power for more battery life in case of portable application. Some of the features are: 16 bit CPU of RISC architecture, register of 16 bit, 16 bit in built timers, 10 bit in built analog to digital converter, serial communication interface for in built communication. It takes analog signal from sensor system, convert it to digital one and transmit to host system.

ZigBee Module: It has low data rate, long range from tens to hundreds of meters, low power consumption, reliable data transfer capacity. It can handle sensor networks upto the 65000 nodes. This technology is scalable and secure.

Home Server: Home server take input data from sensor network. It processes all data related to patient health and transmit it to healthcare system for further analysis. In case of physical parameters crossing the threshold limits indicating critical condition Email/SMS is send to medical staff/ caregiver.

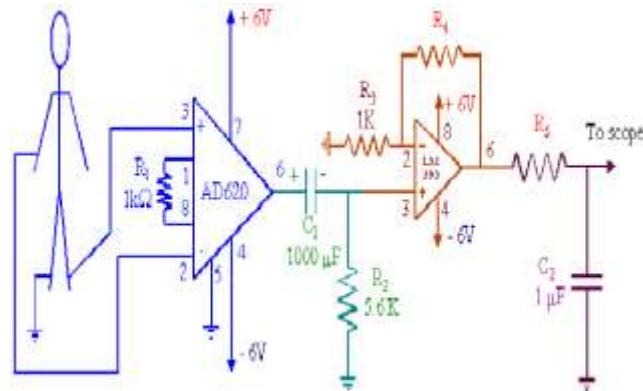
RS 232: for serial communication protocol RS232 is used.

General Packet Radio Service (GPRS): GPRS has higher B.W (bandwidth) and data speed than GSM. It reduces cost by efficient use of network resources. It has continuous and instantaneous internet connection. It is a packet based data service for wireless communication. We can send and receive data as text, graphics and video.

SET UP FOR SYSTEM

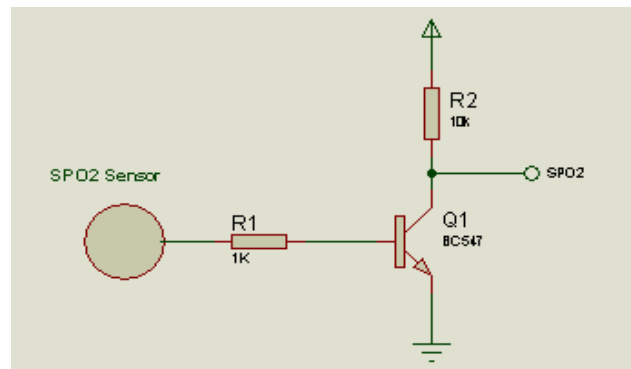
Implementation of Hardware

Figure4:



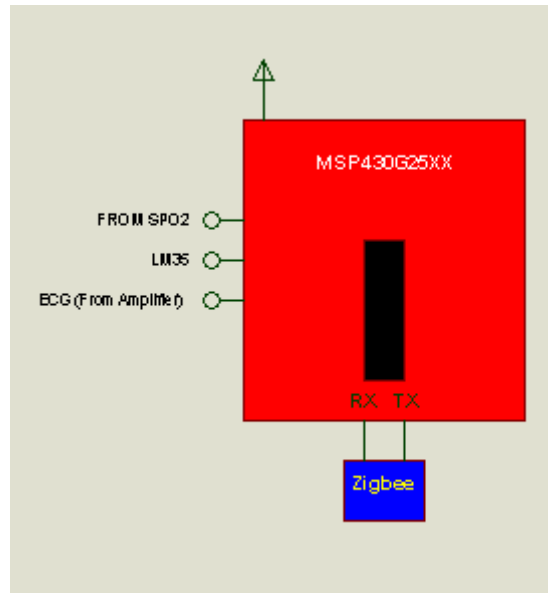
Signal conditioning Circuit for ECG Wave

Figure5:



Circuit for SpO2

Figure6:



Connection diagram for MSP 430 Microcontroller

In the circuit fig.4 three electrodes are used to measure the ECG waves in which two electrodes are fixed with left hand and right leg and other one is fixed to left leg which acts as reference ground. Electrode 1 & 2 pickup ECG wave which is further given to instrumentation amplifier section.

Instrumentation amplifier circuit consists of AD620 low cost, high accuracy instrumentation amplifier which is used as a differential amplifier. It amplifies difference between its inputs. It is followed by voltage amplifier LM393 which further amplifies detected ECG signal in single ended mode. Output of this connected to ADC of microcontroller.

Circuit fig.5 consists of CE amplifier with unity gain which removes negative part from incoming wave. Thus it converts bipolar output to unipolar output.

All sensor outputs are then connected to MSP430 microcontroller which is transferred to PC via Zigbee S1 module as shown in fig.6

Software Implementation

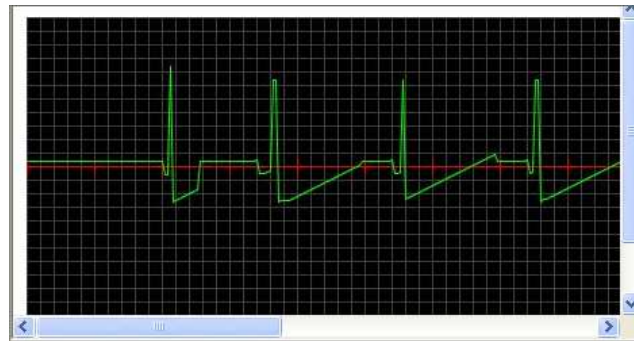
For software implementation windows operating system is used with Java 1.4, 7.0 version netbean along with Apache Tomcat web service. To make hardware interface we use Java Com API and hardware is connected using USB to serial cable to Comport.



RESULT AND DISCUSSION

Sensor data is processed by the home gateway which is send to healthcare system via GPRS wireless communication. So alterations in the patient's parametric signals can be immediately notice by the physician. Normal, abnormal, critical conditions for different signals are as follows: for temperature 37 Degree Celcius is the normal range, more than 38 Degree Celcius is abnormal value. Normal value of pulse rate is 72 Pulses/min and above 74 pulses/min is considered as higher pulse rate and below 68pulses/min is considered as lower pulse rate. SpO2 sensor senses the oxygen saturation level in the blood. It should be in the range of 90 to 100% in normal case. If it is below 90% it is considered as a critical case. And alert message can be send to the physician when any of these parameters are beyond normal range. Normal range of blood pressure is 120 mmHg and above 140mmHg is abnormal blood pressure. Following fig.7 & fig.8 shows experimental results and ECG waveform.

Figure7:



ECG Wave

Figure8:



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Name	ratna
Date/Time	2015/05/25 17:22:15
B.P	145
Pulse	75
Temperature	35
Weight	20
Age	7
SPO2	91
Remark	High pulse Abnormal BP
<input type="button" value="SAVE"/>	

Name	Date	B.P	pulse	Temperature	SPO2	Weight	Age	Remarks
ratna	2015/05/25 17:22:15	145	75	35	91	20	7	High Pulse Abnormal BP -- AbNormal SPO2 -- Normal Temperature -- Normal

Experimental result table

CONCLUSION

Proposed system is the complete information and communication system based on health at home concept. It is beneficial to both patient and physician. Physician can remotely monitor more than one patient at a time. It reduces unnecessary hospitalization, reduces re-hospitalization cost, avoid frequent visits to hospital for regular checkup. So it is very convenient to the elderly patients who are unable to visit hospital frequently.

Wireless communication increases the speed of process for early detection of destabilization signs. Proposed system reduces stress on healthcare system and workload of medical staff providing real time feedback.

This will link in hospital care with the out of hospital follow up strategy.

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