

MONITORING OF BODY TEMPERATURE AND SP02 WIRELESSLY USING ULTRA-LOW POWER MCU MSP430

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Abstract: In this paper we represent a Wireless Sensor Monitoring which integrates the three biological parameter of patient's body like: Body temperature and pulse oximetry (SPO₂), which is measured by ultra-low power MCU MSP430. It consumes <270 μ A in standby mode. The outcome of this work is to build a compact and cost effective device capable of monitoring several medical parameters while patients conduct their normal daily activities. All the sensor data wirelessly transmitted to the access point and Doctor can monitor patient's parameter on screen. A communication protocol and patient monitoring software are developed to store data that can be later downloaded to physicians' workstation for analysis and diagnosis.

Index Terms: MCU-microcontroller unit, AP-Access point, ED-End device, LPM-Low Power Mode, SAU-Sensor/Actuator unit, SPO₂-Oxygen saturation Introduction.

I. INTRODUCTION

Health monitoring systems become a hot topic and important research field today. Research on health monitoring were developed for many applications such as military, homecare unit, hospital, sports training and activity emergency monitoring system. The vital signs of health status that are the important parameter in health monitoring system consist of blood pressure, heart rate, oxygen saturation, body temperature and respiratory rate.[2] In this work, we consider two parameters of the vital signs which are temperature and oxygen saturation in blood. That vital sign can measure by using device namely; pulse oximetry. The pulse oximetry data are important for doctor to monitor patient's health condition. The data helps to prevent and protect the oxygen lack in monitored patient's blood stream. This condition will occurs when the brain does not receive enough oxygen is called cerebral hypoxia [3]. Moreover, pulse oximetry data can predict the patient's disease and accident situation now days the information and communication technology have many new application in medical field. The world is going to be green that's why energy saving is the biggest issue. That's why the focus of this work is completely on the low power hand held devices development. There are many projects that focus on this E-health topic. They provide the great efficiency of tele monitoring system. The goal of this project is to design a patient's different parameters like heart beat rate, SPO₂ and body temperature with a low power MCU MSP430F2274, which has 5 LPM Modes for its basic operation. The different sensors are placed on patient's body and these sensors are interfaced with wireless module (ez43-

ORF2500) powered by small battery. They will continuously monitor and supervise the patient's health status without restricting the patient's movement. When patient is in critical condition, the information from sensor will be sent to network through wireless technology. Doctor will be notified that the patient's health is in critical condition. In this paper, a wireless sensor network is proposed which can monitor the data from these 3 sensors.

Paper is organized as follows: Section-I introduces background and motivation. Section-II describes the system architecture with MCU unit and different sensors. Section-III determines the implementation results.

II. SYSTEM ARCHTECTURE

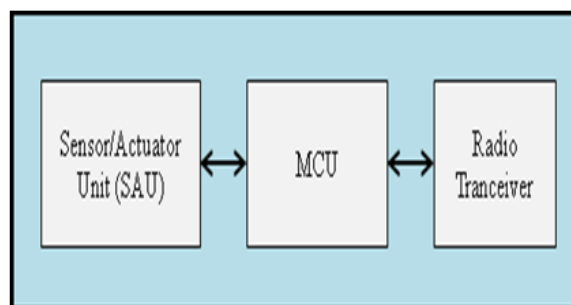


Fig-1: Basic architecture of Sensor network

A System architecture described in fig.1 is MEMS device with SAU and MCU unit and Transceiver. The sensing unit consist of a transducer that measure or detects a physical quantity such as temperature convert into electrical signal and conditioning this signal through amplification filtering and other forms of signal processing. While sensor measure real world phenomena and convert them to electrical from using ADC [1]. The MCU unit that is MSP430F2274 is brain of this experiment, the different type of parameters and features of MCU described in [2]. Radio transceivers are responsible of transmitting of data to the AP. Here TI's target board operate on 2.44GHz band and use the low power RF routing protocol which is SimpliciTI [4].

A. LOW POWER SENSOR NETWORK

For this experiment we are using SimpliciTI protocol for establishment of sensor network. The SimpliciTI network protocol is proprietary low power radio frequency protocol targeting simple small RF network (<100 nodes). It is designed to implement with minimum microcontroller resource requirements. Small LPRF network typically

contain battery operated devices, which require long battery life, low data rate and low duty cycle resulting low system cost [3].

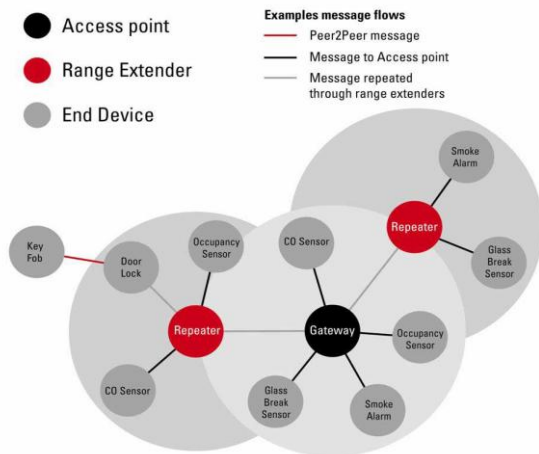


Fig-2: SimpliCI protocol with peer2peer topology

SimpliCI protocol supports End device in peer to peer network topology. Here we compare different RF network protocol existing in network [4].

TABLE I
 DIFFERENT WIRELESS SENSOR NETWORK

Parameters	Wireless Networks		
	Zigbee/SimpliCI	Wi-Fi	Bluetooth
IEEE	802.15.4	802.11a/b	802.15.1
Freq Band	2-4 GHz 868/915 MHz	2.4 GHz, 5GHz	2.4GHz
Range	10-100m	100 m	10m
Channel Bandwidth	500MHz	22 MHz	1 MHz
Key Attribute	Reliable, Low Power, Cost Effective	Speed Flexibility	Cost, Convenience

B. TARGET BOARD ez430-RF2500

Ez430-rf2500 target board contains MSP430f2274 microcontroller and USB debugging tool and two radios TRXs. which transmit data by 2.4GHz. They are known as AP and ED. Both AP and ED contain MCU and 18 available pins for experiment purpose.

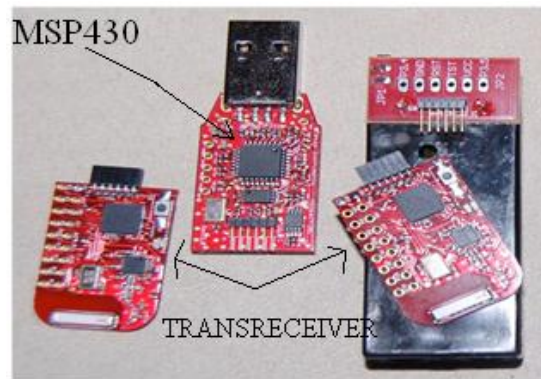


Fig-3: EZ430-RF2500 SimpliCI evaluation module.

Target board consist of AP and ED both act as transceiver radio channel. Some features of target board. Like USB debugging and programming interface featuring a drive less installation and application back channel. 21 available development pins. Highly integrated ULP MSP430 with 16 MHz performance. Two general purpose I/O pins connected to green and red LEDs for visual feedback [5].

C. MCU MSP430F2274

The device attached to a person should be treated as a mobile sensor node (MSN). It is also called patient's node. The requirements for MSN are following. Portability, light weight, high supply, easy operated interface. Here we use MSP430F2274, which is designed 100nA storage mode, < 500nA standby current, <1µA RTC mode, 0-16 MIPS, 10 bit ADC and 2 op-Amp on chip. It is paired with CC2500 multichannel RF transceiver designed for low power wireless applications. Here, we give comparison between PIC24F and MSP 430 regarding power consumption [2]. As from comparison MSP430F2274 is low power compared to PIC24F in all mode of operation [4]. At measured 700nA in a true 3V standby mode with self-wakeup, PIC24F is 75% high power compared to MSP430F2274 at 400nA.

TABLE II
 COMPARISON OF DIFFERENT MCU CURRENT

Parameters	PIC24Fxx	MSP430Fxx
Standby WDT	0.8 µA	0.6 µA
Standby 32kHz	0.9 µA	0.9 µA
1 MIPS starting	3 µs	<1 µs

D. DIFFERENT BIOLOGICAL SENSORS

1. BODY TEMPERATURE SENSOR.

Body temperature measurement has very important meaning in clinic diagnosis and treatment. Due to the traditional artificial measurement style has many disadvantages such as long measurement time and long measurement precision etc... This is hard to automatically and accurately monitor patient's body temperature in real time.

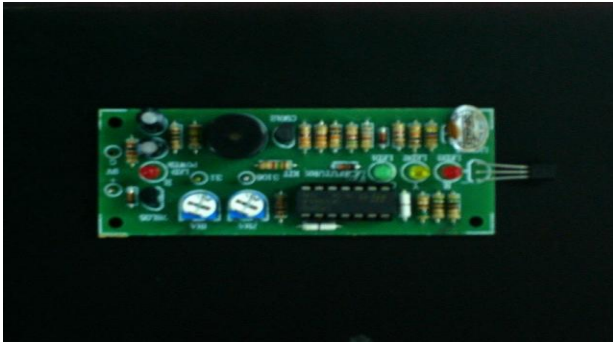


Fig-5: Temperature Sensor Module.

Here we use body temperature measurement sensor which can be implemented with finger clip sensor and the output of the sensor which consumes 38 mA maximum and give the alarm if the body temperature rise above 38 °C or 99 °F [7].

2. PULSE OXIMETERY SPO₂ SENSOR:



Fig-6: Finger Clip Sensor for SPO₂

Oxygen binds the haemoglobin in red blood cell when moving through lungs. It is transported throughout the body as arterial blood. A pulse oximetry use two frequency of light to determine the percentage of haemoglobin in blood that is saturated with oxygen. The percentage is called blood oxygen saturation or SPO₂. Pulse oximeters were first used for vital sign monitoring during operation and Anaesthesia. So, they are used in hospitals, out patients, clinic, home visit nursing etc.... Usually level of SPO₂ is ranging from 96 – 99% in healthy individuals. However, when patient has chronic diseases at time SPO₂ may decrease. SPO₂ lower than 90% is defined as respiratory failure. When SPO₂ drops by 3-4% from its usual level even if it is not less than 90 %, as acute disease may be suspected [8].

III. HARDWARE IMPLEMENT AND SIMULATION RESULT



Fig-7: AP & ED Interfacing with PC.

As shown is fig-7 we have ED and AP, ED is connected to the different modules or sensor PCBs. All the sensor data is wirelessly transmitted on 2.4GHz band. It transmits 1 frame/second to the access point and MCU goes into LPM mode on each frame transmission. So, it consumes very little power, <220 µA in standby mode.

A. TEMPERATURE SENSOR:

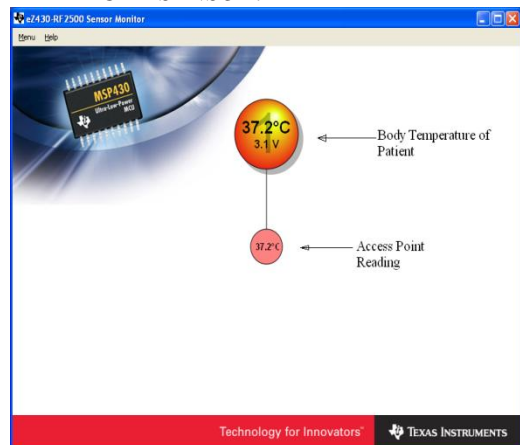


Fig-8: GUI reading of body temperature.

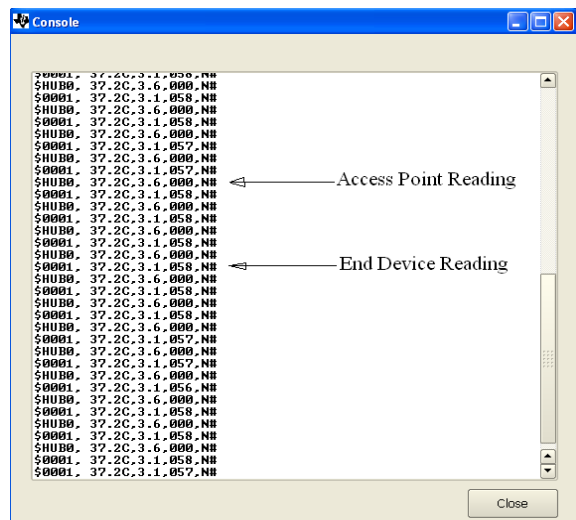


Fig-9: Readings on Hyper Terminal.

As shown into figure, finger clips are connected to patient and the sensing data is given to the access point and it will transmit the frame serially to the PC. As shown in figure, we can simulate the result on hyper terminal,, which give the original body temperature of patient [9].

B.SPO2 SENSOR

As from simulation diagram, finger clip sensor is fitted to patient’s finger and the output is connected to the AP and from AP to SPO₂ monitor. We can display the SPO₂ level with percentage as shown in figure.



Fig-12: SPO₂ reading with monitor.

TABLE III
 PRACTICAL RESULT FOR SENSOR

Sensor	Actual value	Projected reading
Body Temperature	30-38C	32.4-38C
SPO2	90-99%	95-99% for the healthy people

IV. CONCLUSIONS

In this paper we proposed and examined wireless monitoring of patients biological parameters. The whole systems capabilities was successfully built and tested. The system was able to acquire, transmit, sensor data to the remote monitoring station and doctor can monitor the patient, while patient do their normal activities. We monitored the different parameters like heart beat rate, body temperature and spo₂ on the TI’s simulation software/GUI Sensor monitor. The outcome of this project is we can develop very low power medical hand held devices which very cost effective and more efficient based on MSP430F2274.

V. FUTURE WORK

As the technology improves, it is expected that the size of the health monitoring system will become much smaller, while the function would become more powerful. Nearly everyone’s health information could be well monitored

continuously. In the future, sensor data transmission may most likely depend on 4G network in order to handle the mass traffic and increase speed of the transmission. It is hoped that such a monitor would bring a better service to patients and more readily information to doctors. Patients’ health status can be remotely checked by doctors who will allow them to serve a greater number of patients. Sick patients can leave the hospital more relaxed knowing that even when they are outside of hospital they are still being monitored by a medical.

VI. ACKNOWLEDGMENT

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