Vital Signs Monitoring in Human Body

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Abstract— Vital signs monitoring system embeds the data acquisition of vital signs such as ECG, respiration rate, temperature and glucose level in the blood of the patient. In this work, a system is designed for acquiring and monitoring several vital body parameters. These signals are transmitted to the user through Wi-Fi. The device receives the body temperature reading from standard thermometer and the glucose level in the blood from standard Glucometer via Bluetooth. The ECG, Respiration rate, Temperature readings and Glucose level readings are processed using ARM microprocessor and transmitted to the receiver such as Personal computer/Mobile/Tab through Wi-Fi module. It is a wearable battery equipped device which allows the user to operate effortlessly. It also includes the Beeper/Audio codec to signal or alert the user when abnormal ECG or respiration rate is sensed. All these can also be visualized through LCD display.

Keywords- ECG; BLE;Wi-Fi;PC; PMIC; DDR3 SDRAM;wireless transmission.

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I. INTRODUCTION

In recent days people are facing a lot of health problems due to the increase in pollution and adulteration of food. They are spending their time and money for their health. In this paper we are going to enlighten about the vital signs which includes ECG, respiration rate, temperature, glucose level. With these the general vital signs also includes heart rate and blood pressure. Since common people cannot afford the frequent ECG checkups which is costly, this Vital Signs Monitoring System helps them to check their vital signs and send these data to the doctor.

Electrocardiogram[7] is one of the biopotential which is generated by the muscles of the heart. It is the graphical recording of electrical activity of the heart over time. It is commonly used for diagnosis of some heart diseases by analysis of recorded signal. The normal ECG waveform is shown in Figure 1.

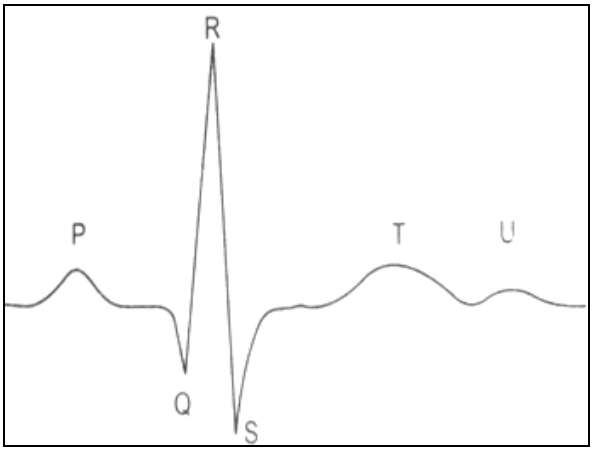

Figure 1: Normal ECG waveform

This paper provides an intelligent system incorporating the ECG and respiration rate measurement of the user/patient. The data is processed in the Arm Microprocessor unit and transmitted to the user's PC/Mobile/Tab through Wi-Fi module and then to the doctor via GSM or otherwise. In addition, the standard Thermometer can be used by the user to measure the temperature and standard Glucometer to measure the glucose content in the blood. These readings are received by the system through Bluetooth module. The received data is processed and stored in the system and transmitted to the user's PC/Mobile/Tab through Wi-Fi and then to the doctor. The system operates though AC adaptor/USB. The main advantage is that the system is battery equipped and allows the unit to stay-ON even when power fails up to 10 hours.

II. BLOCK DIAGRAM

As the system works on battery power, it is ensured that power consumption is minimized to the maximum extent possible.
The Battery powers PMIC which can be controlled to ON/OFF/SLEEP by Push-button switch. ECG amplifier IC is used for acquiring the ECG and respiration signal from the body of the patient. Glucometer and Thermometer are the ready standard devices from the market which has Bluetooth option for transmitting the measured data to the system. At the same time the system receives the data through Bluetooth. DDR3 SDRAM is used for storing the ECG, respiration, temperature and glucose level and transmitting these data to the Mobile/Tab/PC through WiFi in a faster rate. The system uses Audio-codec instead of Buzzer for the fault indication which gives the clear audio signals for the respective faults. Audio-codec converts the digital data in to audio signal. Since the Audio-codec itself cannot drive the speaker, it is amplified using Audio-amplifier.

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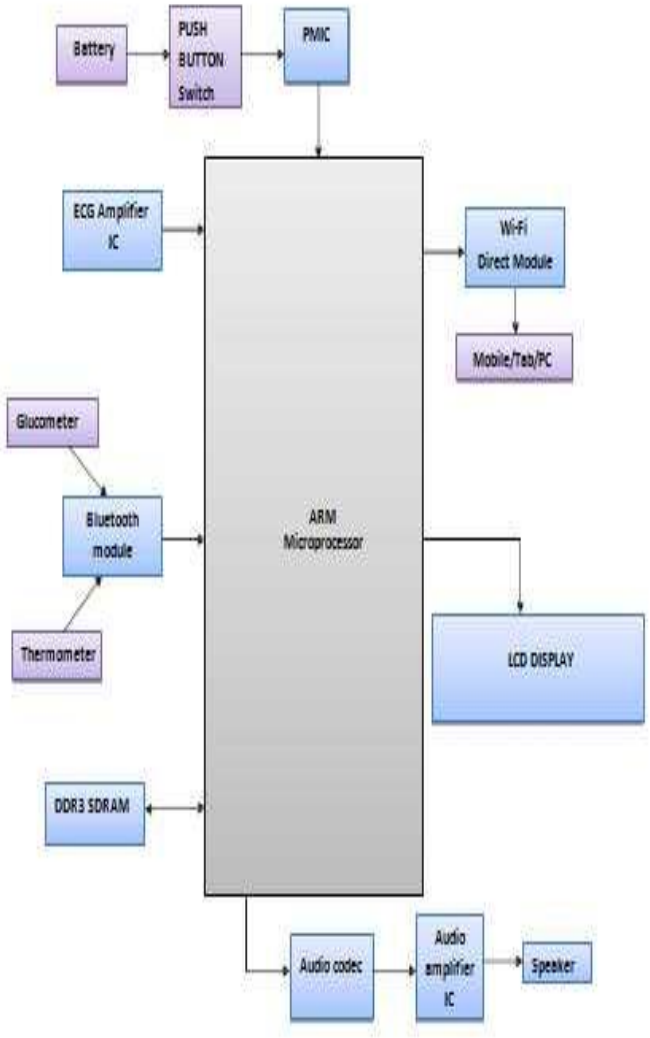

Figure 2: Block diagram

LCD display is used for fault indication. It also used for displaying ECG signals, respiration rate, temperature and glucose level. The block-diagram is shown in the figure. The pictorial representation of the VSM system after the mechanical casing is visible as shown in Figure 3.

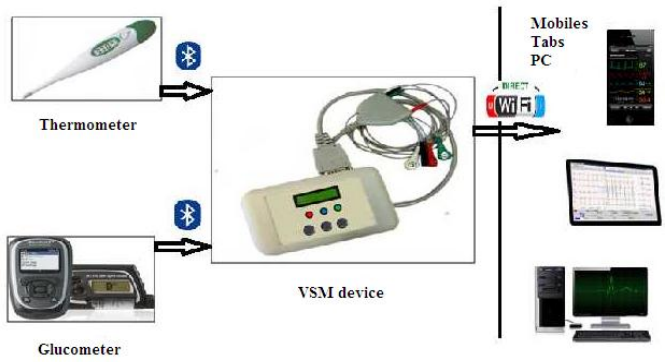

Figure 3: Vital Signs Monitoring System

III. System Description

The whole system is powered through a tps65217c Power Management IC and tps630252 Buck-Boost converter. These two ICs powers the AM3352 Microprocessor and all other modules such as ECG, DDR3 SDRAM, BLE-WiFi, Audio Codec, LCD. The power to PMIC and Buck-Boost converter is through Battery. PMIC can also work through AC adaptor and USB. The ECG and respiration rate is captured by 3 electrodes using ADS1292R ECG amplifier IC. It is a 2-channel, simultaneous sampling, 24-bit, delta-sigma ADC with built-in programmable gain amplifier. The respiration and ECG signals are measured through Right arm(RA) and Left arm(LA) leads. The two leads can be wired into channel 1 for respiration and channel 2 for ECG signals. Right leg (RL) is used as a reference point. It has a in-built EMI filter on channels 1 and 2. The -3dB filter bandwidth is approximately 3 MHz. The 1st order IIR filter is used to remove the DC component from acquired data using the transfer function:

$H(z)=Y(z)/X(z)$

$=(z-1)/(z-a)$

ECG has a in-built 24-bit ADC. The signals captured by the electrodes from the body of the patient are amplified using a in-built PGA. The maximum frequency of ECG signal is up to 160 Hz. The converted data is transmitted to the processor through SPI interface. These data are stored in DDR3 temporarily. Along with these data the temperature and glucose level data is transmitted to the Mobile/Tab/PC using BLE-WiFi.

IV. HARDWARE Description

The system comprises two parts of transmission. First is transmission of temperature and glucose level to the system using Standard Thermometer and Glucometer. Second is transmission of ECG, respiration, temperature and glucose level to the Mobile/Tab/PC.

Features supported in this System:

- ECG cable with 3 electrodes support
- ECG Leads: Lead I, Lead II, Lead III, Lead aVR, Lead aVL, Lead aVF and respiration channel.
- Modes of operation: Live ECG and Respiration
- It acquires data up to 8 kHz
- Lead off detection is based on current
- Power is based on USB and PC application connectivity
- ADS1292R registers are accessed via an easy to use GUI
- Built-in time domain, FFT, histogram and ECG or Respiration related analysis on the PC application
- Live ECG which also includes heart rate calculation
- Firmware upgrade option is based on USB
- AM3352 firmware debugging using XDS100v2 emulator

A. VSM Hardware Introduction

- System is based on AM3352
- ADS1292R is suitable for six leads of ECG: Lead I, Lead II, Lead III, Lead aVR, Lead aVL and Lead aVF
- ADS1292R is suitable for one lead of ECG (Lead I) and respiration channel
- It consumes less power
- Data rate ranges from 125 sps to 8k sps
- It has On-chip oscillator and reference
- It has On-chip RLD amplifier
- SPI interface with the host
- 2GB DDR3 SDRAM support
- Bluetooth-WiFi module
- Audio-codec

B. PC application

The AM3352 firmware and PC application are designed to automatically detect the installed part. Before installing software, verify that the PC meets the minimum requirements such as Pentium III/ Celeron 866 MHz or equivalent processor, minimum 256 MB of RAM, Windows 7 operating system, 1280 x 1024 or greater display screen resolution. After installing the software, the analysis tab consists of various analysis routines and displays which includes Scope, Histogram, FFT, ECG/Resp Display. The ECG/Resp data is acquired by clicking ACQUIRE button.

C. Live ECG/Resp Display Tab

Live ECG/Respiration Display tab shows the Live ECG and respiration data as shown in Figure 4. This tab shows the respiration rate, heart rate and lead-off information.

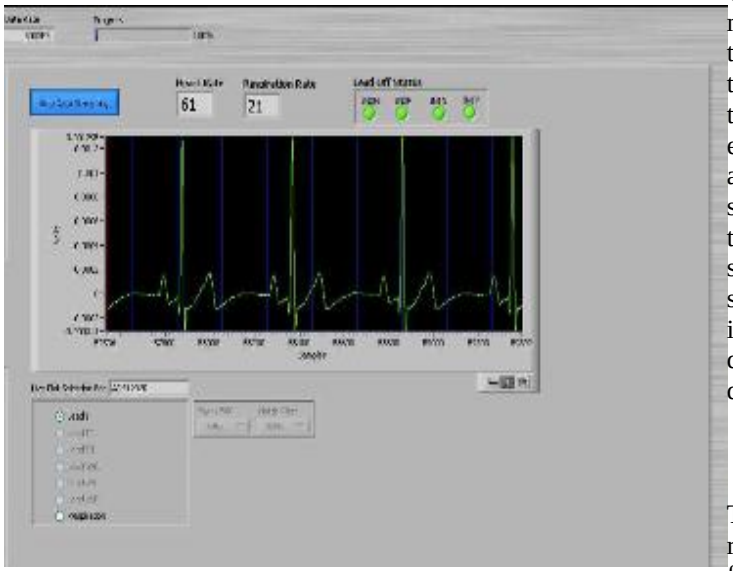

Figure 4: Live ECG for ADS1292R

Clicking on **Start Data Streaming** starts the Live ECG or respiration display as shown in the Figure 5. It can be stopped by clicking on **Stop Data Streaming**.

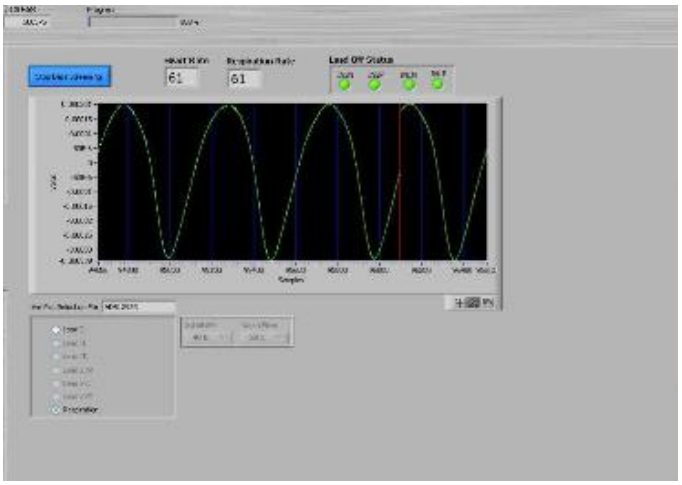

Figure 5: Live Respiration channel

The signals are captured by the electrodes and amplified using a PGA. The ECG amplifier has an in-built 24-bit ADC which converts the acquired analog signal in to digital signal and transmitted to processor using SPI interface.

IV. CONCLUSION

In our work, we thought of utilizing the technological advancement in communication for the benefit of heart patients. The ECG and respiration data from the system can be transmitted to Mobile/Tab/PC using Wi-Fi. In addition other parameters of the body like temperature and glucose level can also be monitored. The most important advantage of this system is excellent flexibility. The main part of this system is wirelessly monitoring using Wi-Fi network. Previous monitoring system uses Bluetooth as data transmission technology, hence patient has restriction about distance from the system. In our case as we are using Wi-Fi technology as transmission technology, the restriction from 10 meters is extended up to 50-100 meters. The system has several advantages like utilization of 2GB DDR3 SDRAM for fast storing and transmitting data which transmits double data than the previous systems and consumes less power. The old system just uses Buzzer for fault indication, but this paper shows the utilization of Audio-codec where the fault can be indicated through audio signals. This system also uses LCD display for fault indication and displaying the biopotential data.

V. FUTURE ENHANCEMENT

The system is developed in such a way that the vital signs are received by the Mobile/Tab/Pc through the VSM system. In future this can be enhanced to send these data to the doctor or hospital through internet or GSM from the Mobile/Tab/PC where the data is received.

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