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Development of Wireless Electrocardiogram Detection System for Personal Health Monitoring

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Abstract—
In this paper we discuss the system designed for detection of ECG data using ARM7 LPC2148 and we also plot its graph with the help of IEEE 802.15.4 Zigbee module. Here first the data is acquired using ARM7 which is further sent wirelessly using ZigBee for further processing to nearby local health care systems where we can plot the ECG graph with the use of GUI created in MATLAB. The complete hardware structure of the system and the real time operating system process are introduced here. This system would be beneficial in bio-medical application where patients monitoring are on priority. The data transmitted is in real time which can be easily plotted using GUI which process all the data obtained.
Keywords—ARM7 LPC2148, Wireless, ECG data acquisition, ZigBee

I. INTRODUCTION

Now a days we are into the technological era where everything are on the go which are somehow affecting our lifestyles making us prone chronic cardiovascular diseases. And it is found to be increasing day by day in comparison to the diseases caused due to infection. Hence which has laid the foundation for many biomedical applications. Biomedical applications requires high precision, accuracy and faster
response rate in order to give proper treatment to the patients. Wireless monitoring devices can make the biomedical system more convenient. Wireless technology can be implemented inside biomedical areas where there are several electrical devices are connected through long cables. So this project is an implementation of Electrocardiograph (ECG) data acquisition and plotting wirelessly manner. Normally in traditional methods we require a doctor to physically monitor the patient's health and then diagnose it. And many times we find that for plotting the ECG the patient has to move to the certain facilities where we have such monitoring system pre-installed or we need to transfer data from the acquisition data systems to the plotters. But in this system we can wirelessly transmits data to the local heath care stations and on the same time we can plot the ECG graph which is very useful in case of emergency conditions.

II. SYSTEM DESIGN ARCHITECTURE

The complete system block diagram is as shown in the figure 1.The hardware system consists of an ECG data acquisition module, the ARM7 processor, data transmission module. The ECG signals are acquired using ECG electrodes. Practically generally 12 leads are imposed to the patient's
body to get ECG signals. For prototype here two biomedical ECG electrodes are used to acquire an ECG signal. These signals are amplified and filtered before they are processed by the ARM7 processor. ARM microprocessor after processing these signals transmits into the air through UART0. Through UART0 we have interface ZigBee module which transmits data to local heath stations. At the receiver end these signals are received using another Zigbee module which is connected to PC, Laptops or palmtops via USB.

The requirements for this project are basically divided into two parts,

1. Hardware requirements
   - Power supply unit
   - ARM7 microcontroller
   - ECG module
   - ZigBee module
   - USB-Serial convertors

2. Software requirements
   - Keil µVision4
   - Flash Magic
   - USB-Serial Driver
   - MATLAB 7.9 or higher

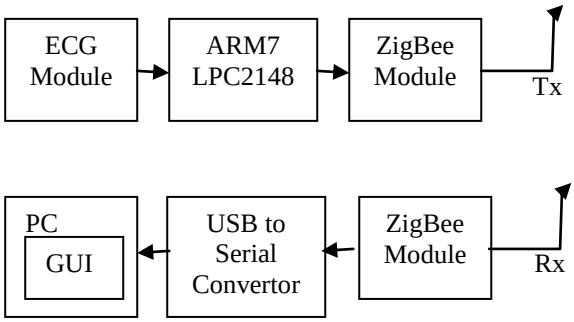

Figure 1: System Block diagram

The signal detected by the ECG module is very low frequency so it is needed to amplify the signal first then it is given to ARM7 processor but microcontroller process digital data so the signal is needed to convert into digital form that is achieved with the help of ADC. Here in ARM7 LPC2148 we have in-built two ADC's out of which we are using one for converting analog signals to the digital data. The signal flow is shown in figure 2,

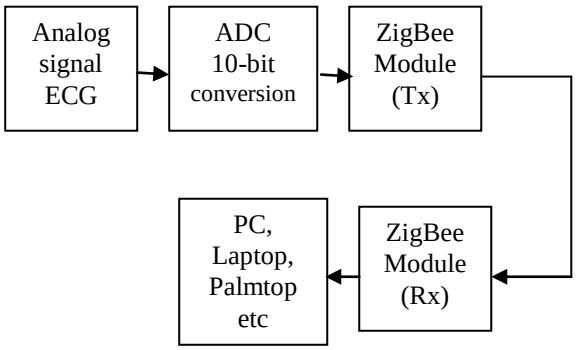

Figure 2: Signal flow

III. TRANSMITTER SECTION

A. ECG module

ECG is a test that measures the electrical activity of the heart. ECG test is proven worldwide to be the most accurate method to determine patient's heart condition [2]. ECG is an interpretation of the electrical activity of the heart over a time period, as detected by the electrodes attached to the outer surface of the skin and recorded by the external device and then plotted on the paper. The output of the ECG recorder is a graph with time on X-axis and voltage on Y-axis.

In a prototype structure two electrodes are used to acquire ECG signal. These signals are of very low output voltage and hence needs to amplify for further processing. These signals after filtering are processed through ADC. The maximum filtered output voltage must not exceed 3.3V which is a CMOS voltage of the processor.

B. ARM7 processor

Microcontroller is very practical and successfully utilized, the conventional 8 and 16bit Microcontroller has its deficiencies when compared with 32bit.The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core. The proposed design uses Philips LPC2148 which is based on 32 bitARM7 TDMI core supporting real time simulation.When ARM processor combined with RTOS with timing constraint can be realized for the data acquisition and transmission of data with high precision.

The signals from ECG module are processed by the processor. The filtered ECG signals are applied to the on-chip peripheral ADC0. This ADC0 is configured as a 10-bit output data which gives high precision compared to the 8-bit microprocessors. This digital data is transmitted through UART0. UART0 transmits the data 8-bit at a time. ZigBee module transmits the data at the rate of 256 characters per second. The output results on Keil µVision4 software is as shown in the figure 3.

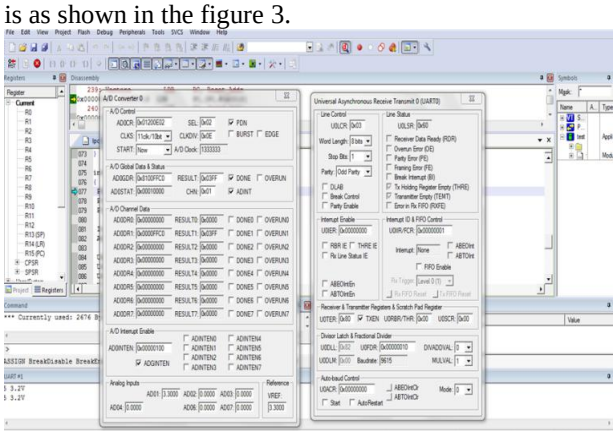

Figure 3: ECG voltage transmitted through UART0of LPC2148

The actual hardware implanted is shown in figure 4 where it consists of LPC2148 along with the ECG module and Zigbee module. This system can directly plot ECG graph via sending data wirelessly.

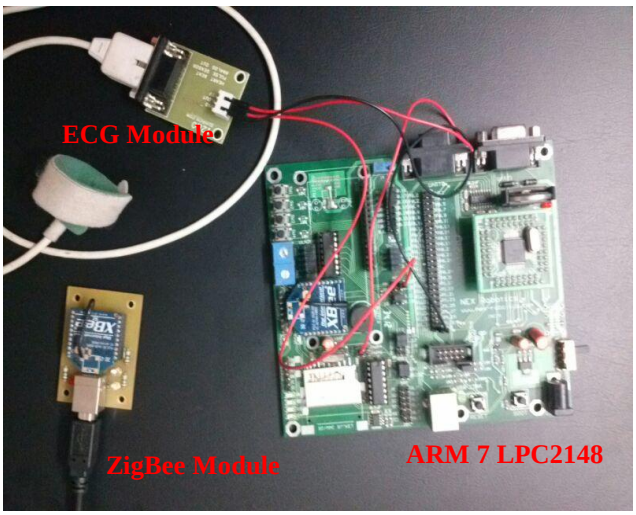

Figure 4: Actual Hardware

IV. MEMORY EXPANSION MODULE

The monitoring system needs to save the processed data so as to made access availability even after transmission of the signals. Comparisons can be made between online and offline ECG signals of a patient. The proposed design can be implemented using Serial Peripheral Interface (SPI) protocol supported by the LPC2148 ARM7 processor.

V. RECEIVER SECTION

A. IEEE 802.15.4 ZigBEE module

The IEEE 802.15.4 ZigBee simple protocol specification is suitable to the body sensor network in a near-body application that provides the communication between the acquisition auxiliaries. The ZigBee module is interface with the microntroler as shown in figure 5

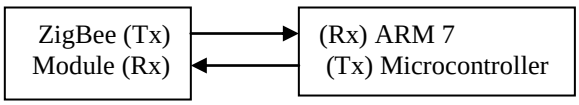

Figure 5: Interfacing ZigBee Module with Microcontroller.

B. GUI

A simple GUI is created under MATLAB which process data transmitted from the microcontroller. From this GUI we can plot the graph for ECG which is as shown in figure 6 for which we can select the proper port and then we can press Start tab to obtain the ECG plot.

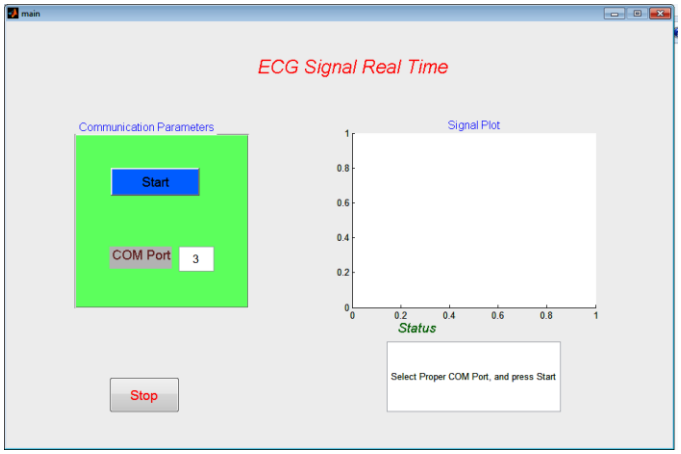

Figure 6: ECG signal plot on GUI of MATLAB

VI. SOFTWARE DESIGN

The program and logic is written under the Keil µVision4 which after successful implementation we proceed for the the generation of the Hex output file. Hex output file is then dumped into the IC using Flash magic software which is connected to PC using USB to serial convertor.

VII. CONCLUSION

The design describes the complete system architecture and successfully completed ECG data acquisition. This proposed design made the node from local heath stations to ECG machine wireless so as to monitor the patients remotely. Memory card interfacing using SPI protocol providing data backup is successfully implemented. Also GUI provides more user-friendly approach of the design which is also displayed successfully.

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