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DESIGN OF CALORIMETER BASED ON ARM AND ZIGBEE

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ABSTRACT

The design of ARM based wireless Calorimeter is proposed. Calorimeter is a device used to measure amount of heat based on physical or chemical process. The calorimeter is design using ARM LPC2148 microcontroller which is low power and small size. The device is capable of measuring and plotting real time measurement of calories at remote place. The system uses a 32 bit RISC processor which is high speed and having on chip 10 bit analog to digital converter. The proposed design uses temperature sensor, ARM -7 and Zigbee. The wireless data acquisition can be done by using Zigbee. MATLAB software is used for creating GUI and showing real time plots at remote site.

Keywords: ARM, LM35, LPC2148, ZIGBEE.

I. INTRODUCTION

In real-time control systems and online supervision systems data acquisition plays a very important role. Many a times any important data is required to be stored for future use. In traditional approach of data acquisition system, the integrated circuits including ADC and multiplexers are used to apply data to different sensors in the circuit. The generation of control signals, data reading and selection of the channel in the multiplexer is done by software, that will affect the acquisition time and accuracy of the data acquisition system. Therefore the system cannot carry out highly efficient data acquisition and the real-time performance also gates slow. In order to avoid this here we are using wireless communication technology in our project. [1]

Wireless communication systems are playing a very important role in today's technological world. Now a days efforts are being given to make all the wired systems to wireless. The most evolving technology for Internet devices is Embedded Web Server Technology. It is used in many areas such as in industrial measuring instruments, in Electronics and telecommunication devices and in a lots of consumer electronics devices. The need that industrial parameters should be controlled via network has become a trend with the advancement of internet technology and communication equipments. Here, in this paper we have proposed a wireless calorie meter based on ARM LPC 2148. Although a variety of wireless technologies are available but here we are using zigbee in our project for wireless communication. Zigbee is a wireless communication protocol that is used for Personal Area Network (PAN).

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Zigbee is 802.15.4 IEEE standard that is much simpler and efficient than other available wireless devices. [2]

Embedded system is a type of control system whose hardware or software can be expanded or reduced according to the requirement. Embedded system has are very reliable and advantageous. Due to its advantages like high speed of operation, good data handling capacity, real time data handling, and multitasking it is mostly preferred. Wireless calorimeter based on ARM is thus designed using Embedded Systems.

This system measures heat at a particular location and transmits this value to a remote location using Zigbee. The system is extremely low cost, has good quality of communication network and some dependable operating conditions. [3]

II. DESIGN METHODOLOGY

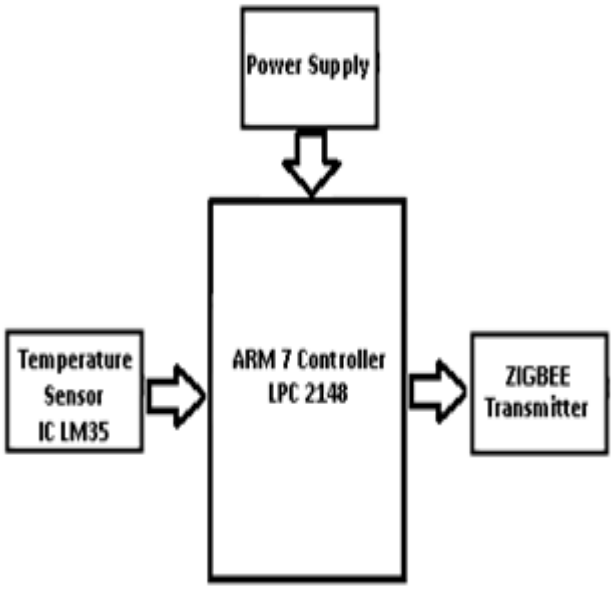

Fig: 1.1 Block Diagram of transmitter section

2.1 Transmitter Section

Fig. 1.1 shows the transmitter section of ARM based wireless calorimeter. As shown in the figure it consists of a power supply, temperature sensor IC LM35 and a Zigbee transmitter to transmit the digital data wirelessly.

Here the temperature sensor IC LM35 measures the temperature and then its output which is in analog form is applied to the ARM controller. The ARM controller then converts this analog value into digital value using the internal A to D converter and sends this digital value with the help of Zigbee wirelessly.

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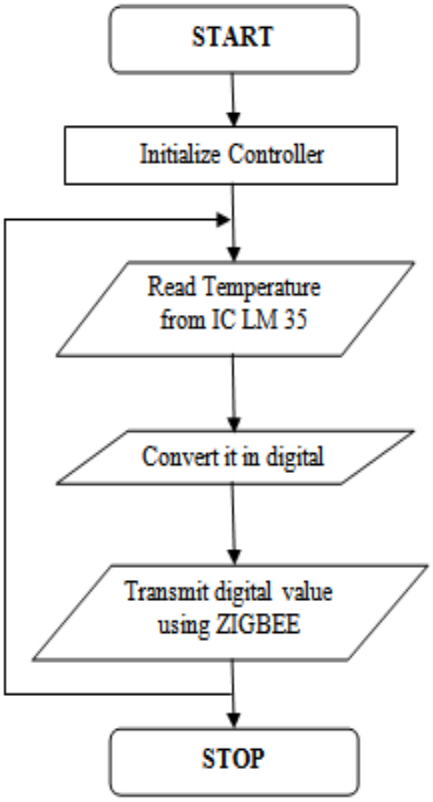

Fig.1.2: Flow-chart of transmitter section

2.2 Receiver Section

Fig. 1.3 shows the block diagram of receiver section. As shown in fig. it consists of three blocks ZIGBEE receiver, RS 232, and PC. The Zigbee receiver receives the signals that are sent by the Zigbee transmitter. These signals are then transmitted to the PC via. RS 232. Upon receiving the signal the PC will calculate the calories and display it on GUI according to the equation given below:

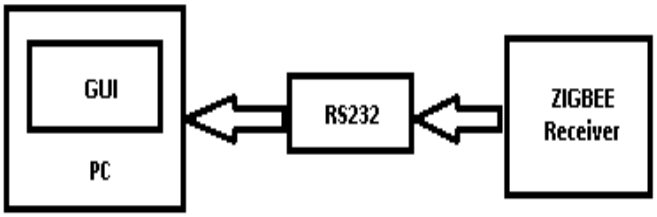

Fig.1.3: Block diagram of receiver section

Total Calories = (Final Temperature – Initial Temperature) × Amount of water in Grams _ (1.1)

Here the GUI is designed in MATLAB.

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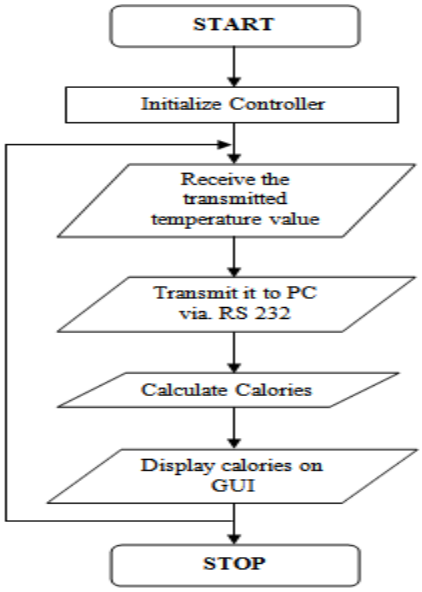

Fig.1.4: Flow-chart of receiver section

III. HARDWARE DESCRIPTION

The hardware required for this is as follows:

3.1 Arm 7 Processor

32bit processors have many advantages as compared to conventional 8 and 16 bit processors. Also the 8 bit and 16 bit processors are slow as compared to the 32 bit processor. Therefore, we are using a 32 bit processor in the research that is very fast than 8 and 16 bit processors. The ARM processor works on the principle of Reduced Instruction Set Computer (RISC). In RISC processors the instruction set is very less and simpler but the hardware is very complex and difficult to understand than Complex Instruction Set Computer (CISC) processors. Due to the simplified instruction set a good throughput and a good real time interrupt response is obtained from a small and cheap processor. The processor which are we using is Philips LPC 2148. It is a 32/16 bit TDMI core processor that supports real time simulation. If these features of ARM 7 are used with RTOS the timing constraint with a high level of accuracy and precision may be achieved for data acquisition and transmission [4]

Fig.1.5: ARM processor LPC 2148

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3.2 Temperature Sensor

IC LM 35 is a very precise sensor that is mostly used for temperature measurement. It consists of three terminal Vcc, Output and ground.

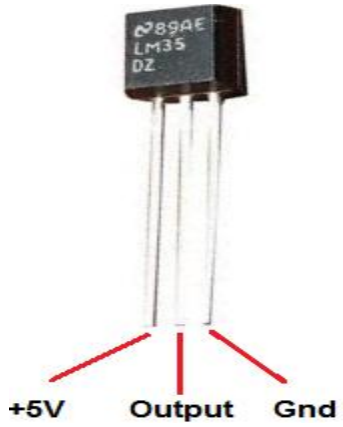

Fig.1.6: LM 35

The operating temperature range of IC LM 35 is -55 to +150 ^{o}C. Here the output voltage changes by a step of 10mv for 1^{o}C change in temperature. From figure 1.4 we can see that LM 35 has no input terminal. Thus, it can take input or senses from its body and produces the précised output proportional to the temperature being measured. In IC LM 35 there is no need for external calibration. [5]

3.3 Zigbee Transreceiver

Zigbee is an IEEE 802.15.4 based 'Wireless Networking Technology' communication protocol that is used to create Personal Area Network (PAN). The zigbee technology was developed by Zigbee Alliance. [6]

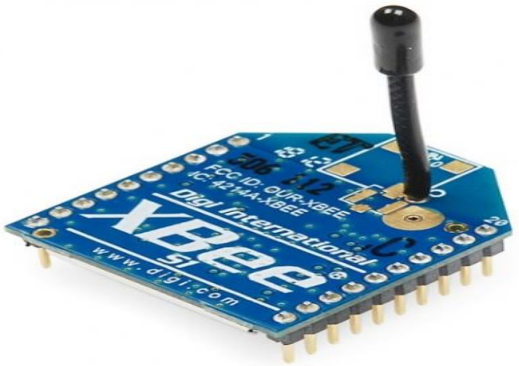

Fig.1.7: Zigbee Module

The Zigbee technology is much more simpler and less expensive than than other wireless devices such as Blue-tooth or Wi-Fi. Zigbee is typically used in devices that have lower data rate and requires long battery life. It is a low-cost, low-power device. But, due to its lower power consumption its distance is limited to 10-20 meters. The transmission distance can be increased by using a mesh network. [7]

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III. RESULTS

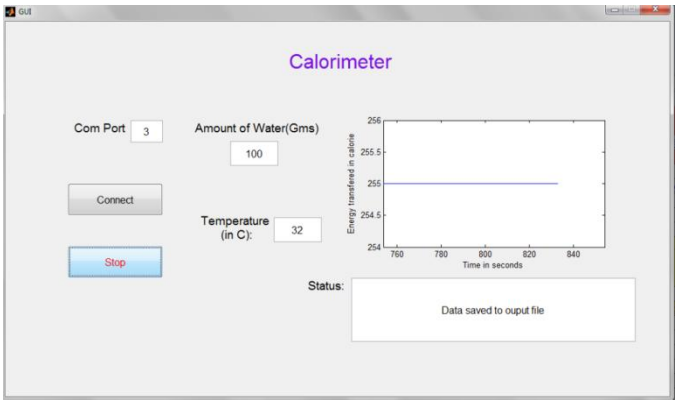

Fig. 1.8: GUI of Calorimeter designed in MATLAB

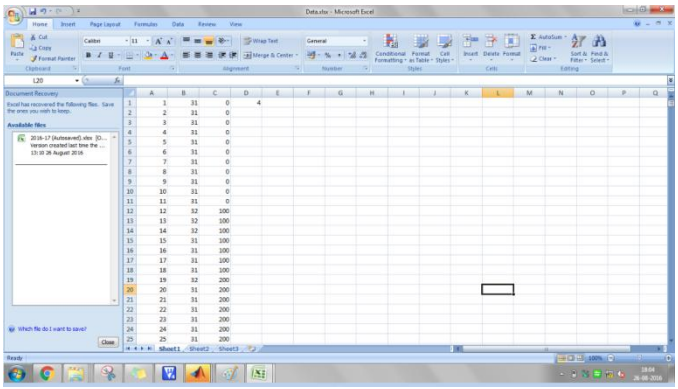

Fig. 1.9: Database recorded in Excel file

Fig. 1.9 shows the GUI for wireless calorie meter measurement. As, shown in the figure the GUI consists of following fields: Com Port, Amount of water, Temperature in ^{O}C, status, and calorimeter graph. Here the field "com port" displays the com port to which the Zigbee receiver is interfaced. "Amount of water" shows the weight of water in grams and "Temperature in ^{O}C Celsius" indicates the final temperature of the water. After measuring the initial temperature of the water the calories are calculated using equation 1.1 and then a graph between the amounts of calories burnt with to time is plotted. Finally, a database of all these values is created in an excel file (as shown in figure 1.60) and saved for future reference.

IV. CONCLUSION

In this research we tried to implement a wireless calorimeter based on ARM and Zigbee. The output results shows that the designed system works up to the mark as expected and has a good accuracy and less conversion and transmission time.

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