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RESEARCH ARTICLE

DESIGN OF CALORIMETER BASED ON ARM AND ZIGBEE.

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Manuscript Info

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Abstract

Calorimeter is a device used for measuring consumption of heat based on physical or chemical process. Design of calorimeter based on ARM LPC2148 is proposed. The device is capable of measuring and plotting real time measurement of calories at remote place. The GUI is design to show real time data. 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.

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Introduction:-

Wireless Communication has created a new world of possibilities today. A huge technological change has evolved over the years and people do not even imagine the world without wireless technology. One of such wireless technology that has developed very rapidly in the recent years is Zigbee. Zigbee is mostly used for short range communications. Data acquisition and monitoring using sensors and signal processing has become an integral part of day to day life. With the advancement in technology modern data acquisition and signal processing systems are now embedded into a single module using microcontroller. Embedded systems had played a very important role in industrial control and data acquisition system. Due to its wide applications embedded system has become a hotspot in for today's technological world. Due to the development of embedded system a new change can be observed in the life of traditional measurement and control system. [1]

A calorimeter is an object that is used for measuring calories, or the process of measuring the heat of a chemical reaction or heat capacity. The most common type of calorimeters are titration, differential scanning, accelerated rate and isothermal micro type calorimeters. A simple calorimeter contains only a thermometer that is attached to a metal container filled with water and suspended above the combustion chamber. The name calorimeter was made up by Antoine Lavoisier. In 1780, Antonine Lavoisier a French noblemen used guinea pigs in the experiments of his device to measure the heat produced. From his experiments he concluded that the heat coming out from the guinea pig's respiration melted the snow around the calorimeter, that is similar to a candle burning in combustion. For many years the way to measure and charge heat is based on living area. The block shares one valve. It is unfit for the development of current economic age and the abuse is more and more obvious. A calorimeter is a very important equipment that is used for user's consumption of heat. Using calorimeter to measure and charge heat is more scientific and facilities the users. But, the main disadvantage of traditional calorimeter is that the measured calories are displayed on the same place where it is measured. But, due to the rapidly increasing technology there is a need that the device should be able to display the measured calories at remote locations as well. Thus, this paper proposes a calorimeter based on ARM and Zigbee that not calculates calorie but also displays it on remote location. In [3] a zigbee based wireless sensor network is proposed. In this at receiver side a Zigbee is connected to PC that acts as a base station and on the transmitter side various Zigbees along with temperature sensor and A to D converter are

connected at remote locations that transmit data to the base station Zigbee. In [4] Zigbee's low power consumption, built-in security method is proposed.

In this paper, we are describing an calorimeter based embedded system having temperature sensor, ARM-7 LPC2148 and XBEE allowing remote device to monitor data with the help of GUI. The embedded device can play important element for building networked manufacturing systems that shows a very promising prospect for industrial applications.

System Architecture:-

The block diagram of calorimeter using ARM 7 processor, temperature sensor and Zigbee as shown in fig 1. As shown in the figure a temperature sensor is used to measure the heat in other way. Total amount of calorie can be calculated by subtracting the initial temperature from the final temperature and then multiplying by the amount of water used.

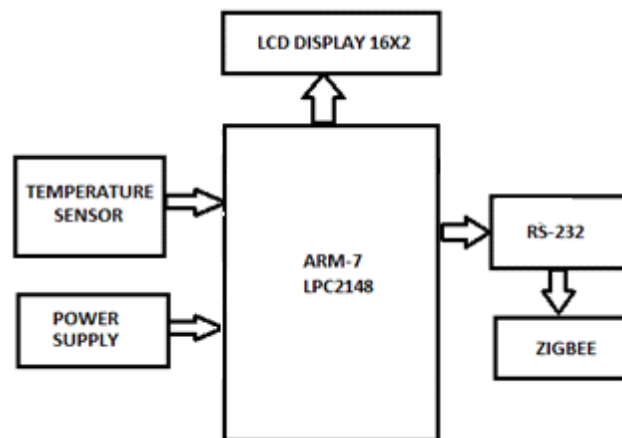


Fig. 1.1:- Block Diagram of transmitter section.

The input in terms of heat temperature can be measure by temperature sensor which gives analog output these calculations are done by the ARM processor. After the exact calories are calculated it can be displayed on LCD display or can be sent to a remote location through Zigbee. The

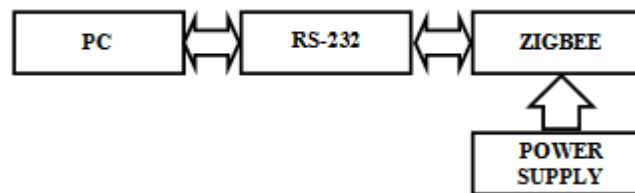


Fig.1.2:- Block diagram of receiver section.

Above figure shows the block diagram of receiver section of calorimeter. As shown in the figure the Zigbee receiver receives the signal that are transmitted by the Zigbee transmitter at the transmitter end. These received signals are then transmitted to PC via a USB to serial converter and the actual calories burnt are displayed on the GUI screen. Fig 1.3 shows the corresponding program flow chart.

Methodology:-

The designing methodology is described as follows:

The hardware design includes the power supply section, Temperature sensor, ARM processor, LCD and the Zigbee transmitter.

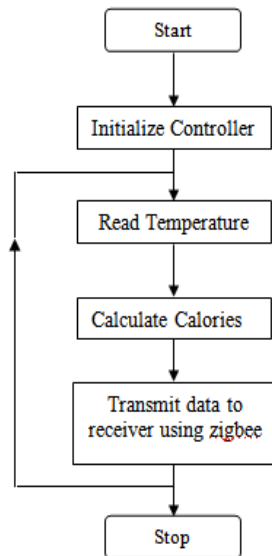


Fig.1.3:- Flow-chart of program.

Power Supply Circuit:-

Two types of power supply are required in this circuit.

- **+5v:** For temperature sensor, LCD and zigbee transmitter.
- **+3.3v:** For ARM 7 processor.

In our project we have designed 5 v power supply using transformer, bridge rectifier, regulator IC 7805 and filter. The IC 7805 produces a constant output voltage of 5v and this 5 v output supply is then given to IC 1117. IC 1117 is a 3.3 v voltage regulator IC whose input may be any voltage greater than 3.3v and produces output 3.3v which is then applied to the ARM7 processor.

Hardware Description:-

Arm 7 Processor:-

Conventional 8 and 16 bit processors have some limitations when compared with 32bit processor. Also the 32 bit processors are fast as compared to 8 and 16 bit processors. Thus, in our research we are using a 32 bit ARM processor that is fast enough than other processors. The architecture of ARM processor is based on Reduced Instruction Set Computer (RISC) principles. In an RISC architecture the instruction set and the decoding mechanism are much simpler than a Complex Instruction Set Computer (CISC) principles. Due to this simplified architecture a good instruction throughput and impressive real-time interrupt response is achieved from a small and cost-effective processor core. The Philips LPC2148 that we are using is based on 16/32 bit ARM7 TDMI core with real time simulation supporting. When these features of ARM 7 processor is combined with RTOS the timing constraint can be obtained for data acquisition and transmission with a high level of accuracy and precision.

Here in this project the parameter to be monitored is sensed through the sensor and this sensed data is then fed to ARM7 processor. Traditionally, in most of the embedded devices there are two blocks: a Controller and a DSP Processor that is used to process the signals. But, since the development of ARM processors, these two are replaced by a single processor. This is actually responsible for all the processes happening inside the ARM 7 processor. These systems will monitor & control all the peripheral devices that are connected in the system. Thus, this unit can be termed as a heart for the whole system. In short, it can be concluded that the thing depends on the software that is embedded in the ARM. Here the codes are written in Embedded C and are developed and tested in Kiel micro-vision [7]

Temperature Sensor:-

A temperature sensor IC is used to measure the amount of heat. Here in our project we are using IC LM35 for this purpose. IC LM 35 works on +5v power supply. It has three terminals namely input, ground and output. The output

terminal of IC LM produces an analog output. This analog output is precisely proportional to the temperature being measured and this output is then given to the processor. IC LM35 does not require any external calibration

Zigbee:-

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. The Zigbee technology is much more simpler and less expensive 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.

Software Description:-

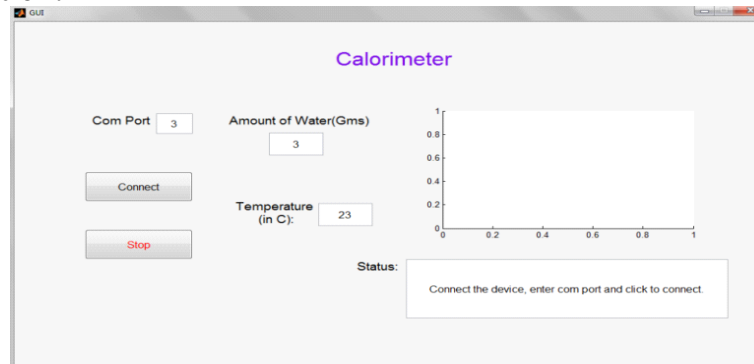


Fig. 1.4:- GUI of Calorimeter.

Fig 1.4 shows GUI designed in MATLAB to measure the amount of calories burned. As shown in the figure the field "Temperature in degree Celsius" shows the current temperature measured by the temperature sensor. Amount of water in Grams whose calories are to be measured and the Com Port which is receiving the sensors data had to be entered manually. Now, by taking the value of initial temperature and the final temperature calories are calculated and displayed. All the temperature readings measured and the calories burnt are finally stored in the form of an excel sheet.

Conclusion:-

The system is capable of measuring remote data wirelessly using Zigbee. The amount of calories can be monitor in real time basis and the data can be saved. The system is flexible and low power as it works on ARM processor. The design of system which makes easy of monitoring the amount of heat by use of the system.

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