ISSN 2395-1621

Adaptive Multisensor using FPGA for Biomedical Application

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ABSTRACT

The main objective behind this project is to build the multisensory system which can deal with a multiple sensors. This is done by interfacing sensors with the FPGA. This will save time for testing a particular sample. Nearly three sensors are interface in a system. This project idea of using multiple sensors can not only be useful for biomedical applications but also for other applications other than for medical use i.e. the sensors can be changed and different type of sensors can be used instead of biomedical sensors. But this project mainly is particularly based on sensors for the biomedical use.

Keywords : **FPGA, LCD, Sensors, 8 channels ADC**

ARTICLE INFO

Article History

Received :13th March 2016

Received in revised form :

15th March 2016

Accepted : 18th March 2016

Published online :

21st March 2016

I. INTRODUCTION

Today, our daily life increasingly relies on sensing technologies. Sensor-enabled devices are everywhere and used in a wide range of applications, from environmental monitoring and building security to personal biomedical uses, such as molecular detection and health monitoring. Even though sensing technologies continue to evolve for many years and greatly increase the quality of life, there is still plenty of room for improvement. Here, the applications in biomedical area are discussed exclusively. Current commercial sensing devices for health monitoring are power-hungry, and hence inconvenient for daily use. For reducing overall system power consumption, we can do either low power design for each circuit block or by power-saving operation. The other way is to endow this system with energy harvesting capability, which means this system can scavenge power from various ambient energy sources.In many real-life applications, such as treating patients with severe disease, it is necessary to monitor several biomedical signals simultaneously. Consequently, physicians have to handle different kinds of monitoring systems in parallel and hence waste much precious time and increase the probability of medical mistake. In view of these problems, it can be concluded that an ideal health monitoring system should possess several necessary merits: multiple sensing ability, powerful signal processing.Some of the health monitoring system which is available in the market only consists of the one sensor to sense a particular parameter, along with it they are bulky, power consuming and consumes more time. Along with that the some systems does not provide the facility of self powering technique.Therefore a health monitoring system should consist of various sensors such as pH sensor, vibrating sensor, temperature sensor etc. in a single system in order for the convenient used for the biomedical purpose. Due to this many sensing operation can be carried out using one system. The main motive to develop such a system is to show that a multiple sensors can be used at a single time for the biomedical application. With the help of this project various other sensors can be used together instead of using separately.

II. RELATED WORK

Requirement:
Day-by-day different types of diseases are getting are infecting the word. People facing different diseases need to be treated in different way. In order to know which type disease a person is infecting from there are various test to be taken. While doing this test number of systems are used which consist of different type of sensor. Systems used usually have only one sensor, this takes lots of time for testing. Also these systems use more power i.e. power consumption is more in these systems.

Therefore a multisensory system should be implemented so that number of sensors can be used in one system along with self-power technique and less power consumption. This will save time for changing different system for different sensor, as well as number of samples tested in one day will be increased.

Objective of the project:

The main objective behind this project is to build the multisensory system which can deal with a multiple sensors. This is done by interfacing sensors with the FPGA. This will save time for testing a particular sample. Nearly three sensors are interface in a system.

This project idea of using multiple sensors can not only be useful for biomedical applications but also for other applications other than for medical use i.e. the sensors can be changed and different type of sensors can be used instead of biomedical sensors. But this project mainly is particularly based on sensors for the biomedical use.

III.LITERATURE SURVEY

The Lauwers, J. Suls, W. Gumbrecht, D. Maes, G. Gielen, and W.Sansen, "A CMOS multiparameter biochemical microsensor with temperature control and signal interfacing," IEEE J. Solid-State Circuits, vol. 36, no. 12, pp. 2030–2038, Dec. 2001.

- Mass production, high yields, and low manufacturing costs are concepts readily associated with electronics integrated on a single piece of silicon. Other considerations such as low power, high speed, etc., are also motivations for silicon integration.
- Apart from these factors, small dimensions and portability are of great value in the field of medical healthcare. Analysis of blood gases in intensive-care units is common practice nowadays.
- For this analysis, many samples can be required every day, consuming a lot of blood, time, and resources. Continuous monitoring of blood gases is therefore a major improvement for critical-care patients and reduces the amount of blood samples needed.
- For many other applications, as for example, in bioreactors, the possibility to perform continuous measurements is also advantageous.
- This paper presents the implementation of a complete micro sensor system for the continuous monitoring of ions, dissolved gases, and bimolecular. Even more functionality has been integrated on chip, such as a conduct metric sensor, an on-chip absolute temperature control, and a one-bit EPROM for medical security reasons.

T. C. D. Huang, S. Sorgenfrei, P. Gong, R. Levicky, and K. L. Shepard, "A 0.18-micron CMOS array sensor for integrated time-resolved fluorescence detection," IEEE J. Solid-State Circuits, vol. 44, no. 5, pp. 1644–1654, May 2009.

- Fluorescence techniques find wide application in life sciences and are ideally suited for biomolecular detection both in vivo and in vitro. Targets molecules of interest, difficult to detect otherwise, are labeled with fluorophores.
- When optically excited, these fluorescent labels emit light at a longer wavelength than the excitation source. The difference in peak wavelengths between excitation and emission is referred to as the Stokes shift, typically 50 nm–100 nm.
- Precise optical filtering (of typically more than 160 dB) must be employed in almost all fluorescence applications for background rejection, filtering out the excitation light.
- Sensitive photo detection approaches, including cooled CCD imagers and photomultiplier tubes (PMTs), then measure the fluorescent signal.
- This paper describes the design of an active, integrated CMOS sensor array for fluorescence applications which enables time-gated, time-resolved fluorescence spectroscopy. The 64-by-64 array is sensitive to photon densities as low as photons/cm_ with 64-point averaging and, through a differential pixel design, has a measured impulse response of better than 800 ps.
- Applications include both active microarrays and high-frame-rate imagers for fluorescence lifetime imaging microscopy.

Y.-J. Huang, T.-W. Lin, T.-H. Tzeng, C.-W. Huang, P.-W. Yen, C.-T. Lin, and S.-S. Lu, "A self-powered CMOS reconfigurable multi-sensor SoC for biomedical applications," in 2013 IEEE Symp. VLSI Circuits Dig., Jun. 2014, pp. 248–249.

- A highly adaptive multi-sensor SoC comprising four integrated on-chip sensors and a smart wireless acquisition system is realized in standard CMOS process for the first time.
- To intelligently process different types (C, R, I, and V) of sensor signals, a linear (R-square is 0.999) and reconfigurable sensor readout is proposed based on switched-capacitor circuit technology.
- In addition, a dual-input energy harvesting interface with conversion efficiency of 73% is also integrated to pick up light energy and RF power, which potentiates long-term use without battery replacement.
- The entire SoC occupies die area of 11.25 mm2 and consumes only 942.9 µW. Experimental results show that four physiological parameters

(temperature, glucose and protein concentration, and pH value) can be simultaneously monitored using this chip.

- This system can be seen as a universal sensor platform.

IV. PROPOSED SYSTEM

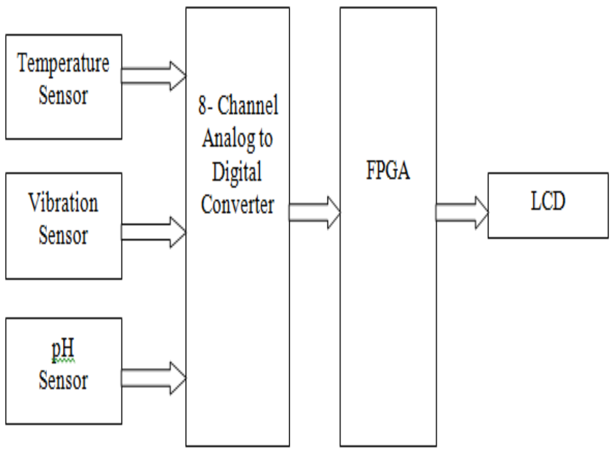

Fig 1. Block diagram for adaptive multisensor using FPGA for biomedical application

The description for the system block diagram is given in various different points. Each block is described in detailed and its datasheet are attached at the end.

Sensors

The sensor is an object whose purpose is to detect an event or changes in its environment and then provide a corresponding output. Typically a sensor is a type of transducer, sensors may provide various types of output, but typically use electrical or optical signals. There are three different sensors used in this system namely temperature sensor, vibration sensor, pH sensor. Each sensor has a different used and are used for different purpose. Each sensors description is given below.

Temperature sensor

The LM35-series devices are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

Vibration sensor

A vibration sensor is a piezoelectric sensor that uses a piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain or force by converting them into an electrical charge. In short, this sensor buffers a piezoelectric transducer. As the transducer is displaced from the mechanical neutral axis, bending creates strain within the piezoelectric element and generates voltages. This sensor can detect even the small movement in the environment and generates an alarm so that the changes can be observed.

pH sensor

The pH of a solution indicates how acidic or basic (alkaline) it is. The pH term translates the values of the hydrogen ion concentration which ordinarily ranges between about 1 and 10 x -14 gram-equivalents per litre - into numbers between 0 and 14. On the pH scale a very acidic solution has a low pH value such as 0, 1, or 2 (which corresponds to a large concentration of hydrogen ions; 10 x 0, 10 x -1, or 10 x -2 gram-equivalents per litre) while a very basic solution has a high pH value, such as 12, 13, or 14 which corresponds to a small number of hydrogen ions (10 x -12, 10 x -13, or 10 x -14 gram-equivalents per litre).A neutral solution such as water has a pH of approximately.

In the glass-electrode method, the known pH of a reference solution is determined by using two electrodes, a glass electrode and a reference electrode, and measuring the voltage (difference in potential) generated between the two electrodes. The difference in pH between solutions inside and outside the thin glass membrane creates electromotive force in proportion to this difference in pH. This thin membrane is called the electrode membrane. Normally, when the temperature of the solution is 30 ℃, if the pH inside is different from that of outside by 1, it will create approximately 60 mV of electromotive force.

In other words, a glass electrode is devised to generate accurate electromotive force due to the difference in pH. And a reference electrode is devised not to cause electromotive force due to a difference in pH.

Channel ADC

The AD7739 is a high precision, high throughput analog front end. True 16-bit p-p resolution is achievable with a total conversion time of 250 μs (4 kHz channel switching), making it ideally suited to high resolution multiplexing applications. The part can be configured via a simple digital interface, which allows users to balance the noise performance against data throughput up to 15 kHz. The analog front end features eight single-ended or four fully differential input channels with unipolar or bipolar 625 mV, 1.25 V, and 2.5 V input ranges. It accepts a common-mode input voltage from 200 mV above AGND to AVDD − 300 mV. The differential reference input features no-reference detect capability. The ADC also supports per channel system calibration options. The digital serial interface can be configured for 3-wire operation and is compatible with microcontrollers and digital signal processors. All interface inputs are Schmitt triggered.

LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segment and other multi segment LCDs. The reasons being: LCDs are economical, easily programmable, have no limitation of displaying special & even custom character (unlike in seven segments), animations and so on.

V. ADVANTAGES AND APPLICATION

Advantages

1. The major advantage of this system is that the multiple sensors can be used at one time for performing the biomedical operations.
2. As this system has a adaptive nature the sensors can be changed as per the requirement
3. The sensors can give the accurate result.

Applications

The application for this system is that it can be used in the biomedical field for the purpose of detecting various samples. The detection consist of,

1. Vibration detection
2. Temperature detection
3. pH detection

VI. CONCLUSION

In this project we have implemented to build the multisensory system which can deal with a multiple sensors. This is done by interfacing sensors with the FPGA. This will save time for testing a particular sample. Nearly three sensors are interface in a system.

This project idea of using multiple sensors can not only be useful for biomedical applications but also for other applications other than for medical use i.e. the sensors can be changed and different type of sensors can be used instead of biomedical sensors. But this project mainly is particularly based on sensors for the biomedical use.

VII. FUTURE SCOPE

By viewing the ideas of this project, by considering various sensors a multiple sensor system can be created for different fields other than the biomedical field. Similarly the number of sensor that can be used can decide as per the one's choice.

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