Coprocessor Design for Health Monitoring System

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Abstract: The design of a 32-bit coprocessor for health monitoring system with a high performance and pipelining structure is presented in this paper. Here a proposed coprocessor is designed using a 32-bit MIPS instructions and 4-stage pipelined structure. Nowadays, a constant monitoring and recording of the body parameters of the patients correctly such as heart bit, blood sugar, blood pressure and temperature, etc. are very difficult task. Hence, to design the health monitoring system by using GSM modem is the purpose of the paper. To contact the doctors and to know about the health problems, this idea will help out the people who are out of reach. By using the sensors, real-time body parameters of a patient can be sensed and keeps an extra attention on the biomedical parameters of patient under test at home. The standard for mobile telephony that has been used in this project is a wireless technology. The foundation of the health monitoring system is very simple system in the area of telemedicine application.

Keywords: MIPS, coprocessor, GSM modem, sensors, telemedicine.

I. INTRODUCTION

Today the system processors required for various applications needs to be developed with a fast performance for communication purpose, with efficient low power and with multi-functionality. To achieve this, most of the system developers and SoC designers are used an efficient methodology which is based on microprocessor system. Since the last few years, an ARM processor plays an important role in the embedded system, due to some of its features. The central part of any system is the processor. Here, an FPGA based coprocessor is designed for the health monitoring system.

A health monitoring is very important research topic today. To improve the health care services by reducing the health expenses, and also supports for a home based health care services, a telemedicine system plays a vital role by taking the advantages of the telecommunication and medical information systems. A telemedicine is transformation of the medical data electronically from the remote areas to hospital centers. Up-to-date, without visiting to the physician, the health check-up or monitoring is not possible from the home, till an exponentially growing of mobile phone use in developing countries. Some developers designed a web based health monitoring system, where patients see the status of the health from anywhere as internet facility is available. Also some health societies used a paper based methodology, where vendors use the blood pressure and blood sugar sensors and recorded this status in the notebook manually. For ICU patients in the hospital, continuous monitoring of the health status of the patient can be done by the doctor. To do monitoring, legion amount of man power required, though some mistakes may be possible at the recording health values.

Therefore, to design a portable health monitoring system is the purpose of this paper. By using this system, a continuous monitoring of the body parameters of the patients such as, blood pressure, temperature, blood sugar and heartbeat, etc. is possible from anywhere and transfers this monitoring data to the doctors in terms of SMS using the GSM module. This system is also useful for rural areas, where distance is the major problem and where doctors or experts are not available. This designed system is based on the re-programmability, flexibility, stability and wireless technology, and the results obtained have to be expected.

II. PROPOSED SYSTEM

The proposed work of the project is to develop a real-time wireless monitoring system, which is designed using GSM network and transmitted the bio-signals of patients. The aim of this project is to design a coprocessor for health monitoring system for the patients at any time and any place using GSM module to provide wireless system to monitor the patient’s body parameters, such as heart bit, temperature, blood pressure, blood sugar, etc.

The figure 1 shows block diagram of the complete system. It shows how the concept is implemented as the real time application. This unit is connected to the patient’s body parts. For measuring the signals from the patient’s body, four sensors are used. After measuring, these analog signals are converted into digital forms and compared with the actual signals. If there is any difficulty/ problem occurs between the measured signals and the actual signals, then this situation is considered as an emergency and this health

DOI 10.17148/IJIREEICE.2016.4569

data values are saved and then transmitted to doctor's mobile phone through SMS. The processor plays a major role in controlling all the peripheral devices. In this, GSM modem transmits the sensed signals from the sensors which are controlled by the coprocessor to the Hospital unit.

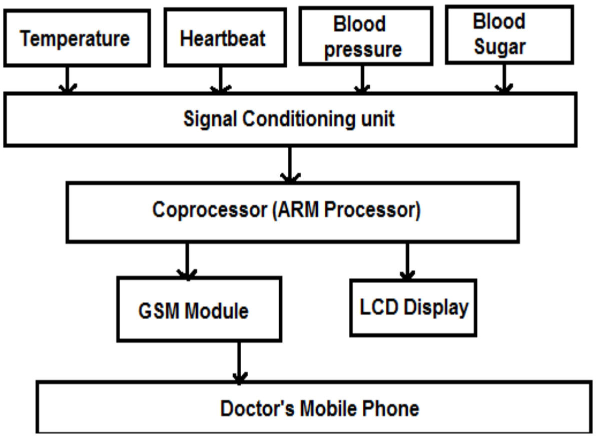

Figure 1: Block diagram of proposed System

When the health data SMS reached at the hospital unit, the health status of the patient is seen by doctor. In this way, the doctor can keep an attention on all the patients by sitting one place, instead of moving observations of all patients. A conversation has to be done by the doctor through SMS.

Sensors used:

1) Heart beat sensor:
The heart beat sensor works on the light modulation principle by blood flow through finger each pulse, which consists of a bright LED and light detector. When a finger is placed on it, it gives digital heartbeat output. After processing by processor, the beat per minute (BPM) rate is obtained as output.

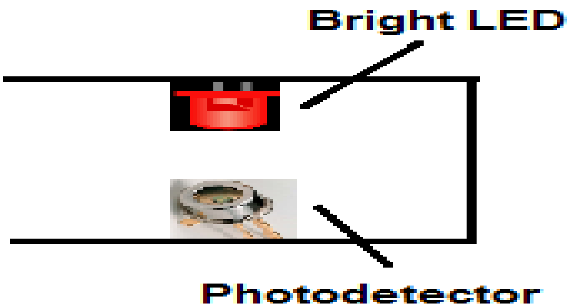

Figure 2: Heart Beat Sensor

2) Temperature Sensor (LM35):

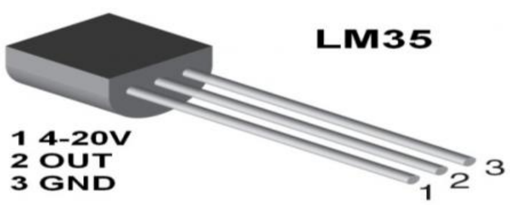

Figure 3: IC LM 35

It is a precision integration-circuit temperature sensor. The voltage output of the LM35 is linearly proportional to the Celsius temperature, which gives analog output. The scale factor of LM 35 for output voltage is a +10.0 mV/°C linear.

3) Blood pressure Sensor:
A blood pressure sensor is used to measure arterial pressure. Blood pressure is, nothing but, the blood's force pushing up against the blood vessel walls. The heart pumps blood through the arteries to rest of the body, in each heartbeat. The operation of blood pressure sensor is based on the oscillo-metric method.

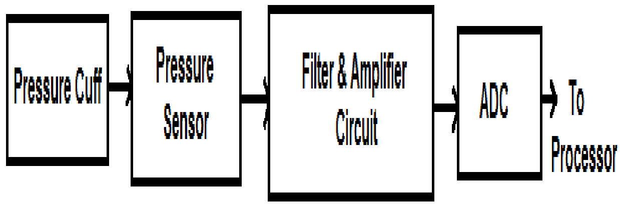

Figure 4: Blood Pressure Sensor

4) Respiratory Sensor:
The frequency of breaths taken within a certain amount of time is called a respiration rate. This rate can vary depending on the requirement of the oxygen. The correlation of the respiratory rate is with the blood's gas composition. This means that the breathing rate can be increased by increasing the carbon oxide concentration, which is derived from an infection.

LCD Display:

The LCD (Liquid Crystal Display) is used to display the output of the health monitoring application. To display the output of four sensors which are interfaced with the processor, the LCD plays a major role. It is also useful for system debugging, to rectify the system failure problem.

GSM Modem:

A GSM (Global System for Mobile Communications) is the world's most popular standard for mobile telephony systems. A SIM300 with a Tri-band GSM engine is used which works on frequencies, such as EGSM 900 MHz, DCS 1800 MHz and PCS1900MHz. It also provides provide RF antenna interfacing with antenna connector and antenna pad. For application like data transfer, GSM module is developed with AT-commands integrated with the TCP/IP protocol.

III. OBJECTIVE OF PROJECT

To design a Coprocessor for Health Monitoring System for the patients using GSM modem for monitoring the body parameters such as heart bit, temperature, blood pressure, blood sugar, etc. is the main objective.

A coprocessor is designed using an RISC processor using a pipelined architecture. For designing a coprocessor, a 32 bit MIPS instructions set would be used. A coprocessor

ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 4, Issue 5, May 2016

works in the 4-stages as i) Fetch, ii) Decode, iii) Execute, iv) Memory Read/ Write Back. Hence, this coprocessor contains a unit of fetch instruction, unit of decode instructions unit, the arithmetic and logic unit (ALU) instructions, a register file for operands holding, and the memory that stores instructions and data.

A coprocessor is a multiplexer based design, which implemented with a single data path cycle and random logic decoder based on FPGA. A coprocessor consists blocks such as data path, Arithmetic & Logic unit (ALU), a controller unit and the memory block.

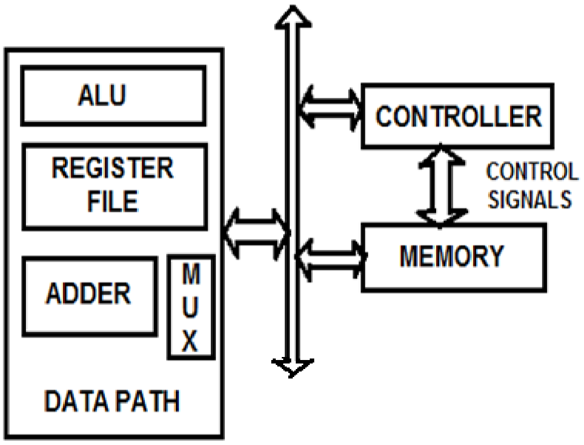

Figure 5: Block diagram of coprocessor design

Data Path:

In coprocessor design, data path designed with a single cycle fetch-decode-execute. It is the heart of the processor. The design of the data path block based on general discipline as (1) determination of the required formats and classes of instructions in the ISA, (2) for each instruction class or format, the data path components and interconnections design required, and (3) composed the segments from the second stage to yield a data path.

The data path consists of ALU, multiplexer, register file, etc., which are used for performing the various data processing operations. A main part of the processor is a data path, used to regulate the interaction between the data path and the data itself.

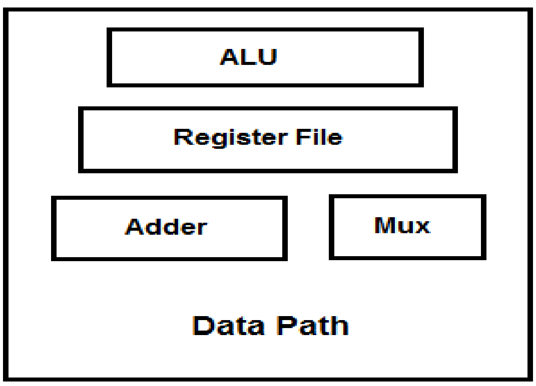

Figure 6: Block diagram of Data path

Controller:

A controller unit is the hardware which tells the data path what to do regarding various operations. It is very important part in the processor, which controls the various operations performed by the data path and also memory. It generates the control signals required for the execution of memory instructions, which are pure combinational logic signals.

Memory:

In the coprocessor design, the memory is used as a device for storing the information at high-speed, which is used by the processor for further processing. Memory blocks are used for implementing instruction and data memories for an embedded processor using FPGA. The memory is generally implemented using a few blocks of Static RAM. Here, a memory module is 32-bit wide.

IV. HARDWARE TESTS AND RESULTS

1. Simulation Results of Coprocessor:

1) The simulation waveform diagram of the data path & controller is shown below. According to the Controller & ROM instructions, the below output waveform is obtained.

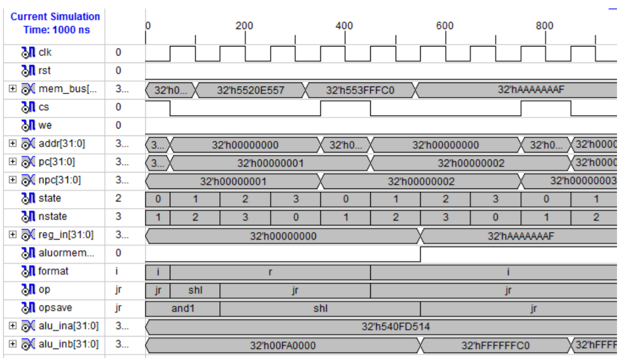

Figure 7: Simulation diagram of data path and controller unit

2) Following output waveform shows that the complete processor's simulation output. This performance is based upon the various instructions and pipelining structure.

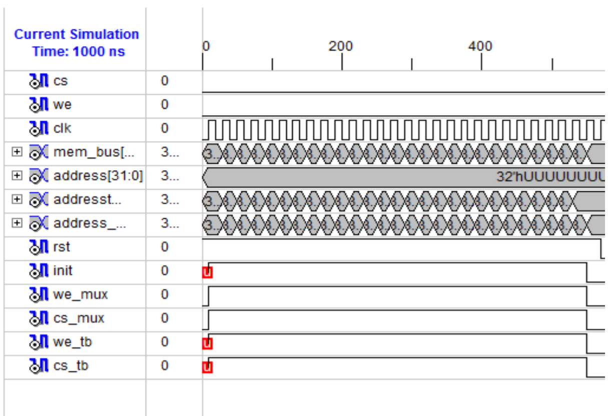

Figure 8: Simulation diagram of complete coprocessor

2. Test Results of Health Monitoring System:

Table 1: Result of Health Monitoring System

Sr. No	HB on sensor	Temp on Sensor	Blood Pressure	Respiration	HB Manually	Temp On Therm	Message Sent
1	**77**	**27**	**85-104**	**05**	**78**	**27**	**Temp = 27** **HB = 77** **BP = 85-104** **Resp. = 05**
2	**79**	**29**	**89-108**	**09**	**82**	**28**	**Temp = 29** **HB = 79** **BP = 89-108** **Resp. = 09**
3	**73**	**32**	**87-102**	**03**	**71**	**31**	**Temp = 32** **HB = 73** **BP = 87-102** **Resp. = 03**

V. ADVANTAGES OF THE SYSTEM

Some of the advantages of this system are as follows:

• This system is easy to use and also reliable for doctors working in the hospital. Thus, a continuous monitoring of the critical patient is possible.

• The working efficiency is increased to a great extent.

• By reducing the human error chances in recording the health parameters status, this system increase the accuracy of monitoring and recording, as this is a time to time updated system.

VI. APPLICATIONS THE SYSTEM

The health monitoring system is based on the wireless technology i.e. GSM Modem, provides the updates of the existing health monitoring systems. This system supports to a continuous health monitoring, which yields a better performance in curing a critical condition. The continuous monitoring is provided the vital signs of the patient for long time. This health monitoring system gives a long time capability of monitoring, which is useful for the doctors and staff in the hospitals, which reduces their workload at a great manner.

VII. CONCLUSION AND FUTURE WORK

Hence, a coprocessor designed with a single cycle pipelined structure and the synthesis and simulation of the coprocessor is done successfully in this paper. Here, we developed a wireless health monitoring system, monitors health data from the home and identify the real time health status of the patient. By using this system, we are able to transmit the health data sensed from the patient's body to the doctor's mobile phone by using wireless transmission technology, i.e. GSM Module. After receiving a SMS on mobile phone, the doctor can keep an attention on the patient's health status from anywhere. To take an immediate action, the sensors are calibrated properly for accurate precise parameter measurement, for providing an immediate treatment to the patient in emergency case.

Future work may include the development of the system with more number of sensors in a single system to provide flexibility. Also, a multi-cycle pipelining structured coprocessor will be designed for fast and better performance response.

ACKNOWLEDGMENT

This experimental work is supported by the NK Orchid College of Engineering & Technology, Solapur. We are very thankful to Department of Electronics & Telecommunication, NK Orchid, Solapur for the support.

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