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DESIGNING OF ELECTRONIC CARDIAC EVENTS RECORDER

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Abstract:

Cardiac disease is the single leading cause of global mortality and is projected to remain so. Cardiac arrhythmia is a very common type of cardiac diseases and may indicate an increased risk of stroke or sudden cardiac death. ECG is the most widely adopted clinical tool to diagnose and assess the risk of arrhythmia. ECGs measure and display the electrical activity of the heart from the body surface. During patient's hospital visits, however, arrhythmias may not be detected on standard resting ECG machines, since the conditions may not be present at that moment in time. In this paper we design a reflective photo sensor, which picks up the biosignals that is fixed to a earphone which is used in our day to day life.

Keywords: Reflective photosensor, Micro-controller, USB, Mobile.

I. Introduction

In the present world people who are affected by cardiac diseases are equal to those who have diabetes. Cardiac diseases have become one of the most common diseases in the world. People who are above 35 years must undergo regular heart check up. One of the existing systems is ECG, which requires electrodes to be placed on the patients body, this causes skin irritation and it also requires external power. In order to provide long-term and convenient cardiac monitoring, significant technical challenges in terms of power, cost, size, weight, functionality and packaging need to be overcome. In the proposed system, a non- invasive cardiac monitor using a reflective photo sensor is designed. This photo sensor works on the principle of reflection. The photo sensor consists of a photo transistor and an Infrared LED. It is implemented in the earphone or headset, which will be comfortable for the patients who are using it. The amount of light emitted from IR LED is passed through the skin and the light reflected back from the subcutaneous blood vessels is detected by the photo transistor, during the cardiac cycle there

will be volumetric changes in the blood vessels, which in turn causes subsequent changes in the amount of reflected light indicate the timing of cardiovascular events. . The output of the sensor is given to a filter circuit for eliminating the noise signals and to separate the ac components. The control and processing unit is done by a digital signal controller (DSC), which has inbuilt A-D converter. The digital signals are then transmitted to a mobile phone using USB port, and to a laptop with the help of a radio transceiver.

II. System Design

A. Sensor Construction

We design a probe for heartphones to resemble commercially popular intra-concha earphones.This is a rational design choice since such earphones are unobstrusive and have undergone extensive design to be comfortable to people. The earing sensor is a miniaturised, unobstrusive device design to measure the pulsation of blood flow. The reflective photosensor consists of infrared LED that is integrated with the photo transistor in a small resin package. The amount of light emitted from IR LED is passed through the skin and the light reflected back from the subcutaneous blood vessels is detected by the photo transistor, during the cardiac cycle there will be volumetric changes in the blood vessels, which in turn causes subsequent changes in the amount of reflected light indicate the timing of cardiovascular events.

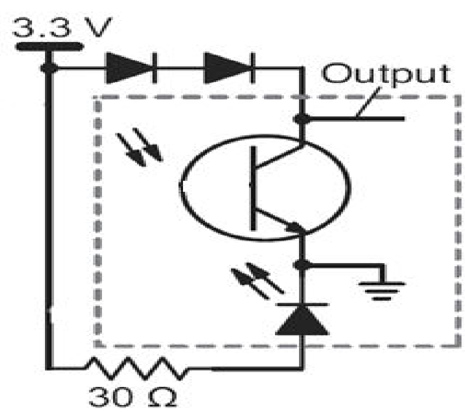

Fig-1: Sensor circuit- Schematic diagram of reflective photosensor.

B. Description of the circuit

In fig 1: The two diodes in series are used to convert the changes in collector current to logarithmic voltage change in order to achieve a wide dynamic range of measurements. To obtain measurements the sensor earphones are inside into the ear and positioned in such a way that the reflective photosensor is against the inner side of the tragus (Flap in front of the external opening of the ear). The resulting output is passed through a four stage active bandpass filter to separate the ac components of the signal, reduce electrical noise and motion artifacts. A digital signal controller (DSC) was selected as a control unit because of its capability for performing complex analysis and signal processing on board. The analog signals are sampled at 400 Hz through an A-D converter with 12-bit resolution on the DSC.

C. System Architecture

Fig 2 shows the system architecture of the proposed system, the resulting output of the sensor is passed through high gain active bandpass filter then the output signals are sampled at 400 Hz via an A-D with 12-bit resolution on the DSC. The DSC acts as the control center that can be programmed on-board through an In-Circuit Serial Programming (ICSP) interface. The analog waveform, each new detected beat interval and average heart rate over the last 30 beats are then sent to a mobile device via serial communication for visualization or further processing.

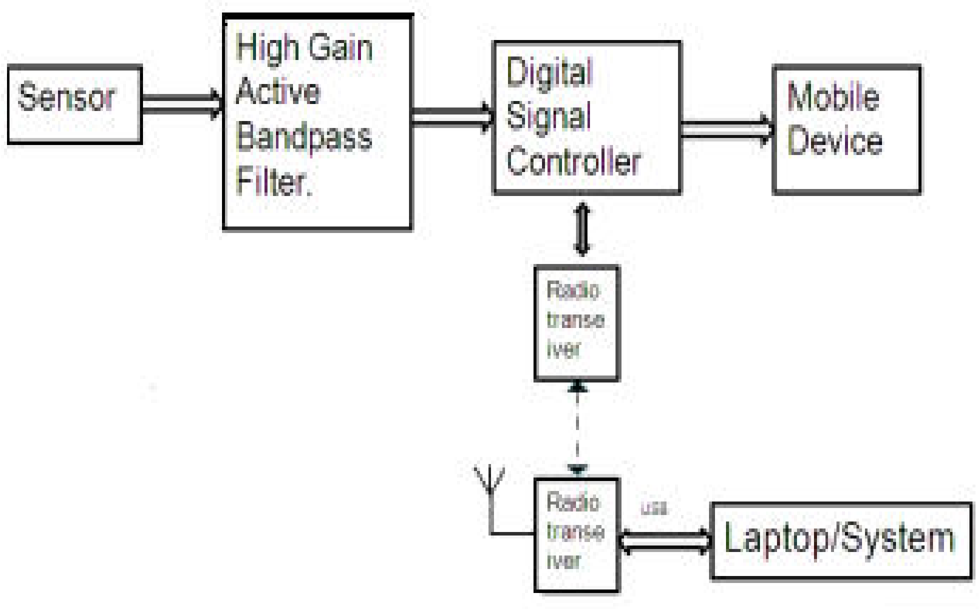

Fig-2: Overview of the system architecture.

Alternatively, the system can also communicate wirelessly with a laptop using a pair of wireless 2.4 GHz radio transceivers modules. When the control unit is connected to mobile device, power is drawn directly from the device itself. A step-up/step-down charge pump produces a fixed, regulated output of 3.3 V for the DSC and peripheral components. Otherwise, the control unit operates on a single lithium polymer battery with a nominal voltage of 3.7 V that can be recharged on-board from a USB port. The entire control/processing module is fits into a compact mobile connector housing thus eliminating the need for a bulky external unit.

D. Noise Cancellation

For any device to be truly wearable, it has to be able to tolerate motion artifacts generated when the user is on the move. While the

E. USB Interface

ECG signals are analogue in nature and will have to be digitized using a microcontroller interface before being sent to the phone for display. The microcontroller has an in-built analog to digital converter (ADC). A program stored in the processors memory samples the ECG signals and stores them in the processor's registers, before being sent to the system's USB and mobile phone.

F. Mobile Application

The application allows the users to visualize their heart rate in real time by reading data from the DSC through the serial port. In addition, it keeps the record of the highest and lowest reading for that session. Users also have the option of viewing the raw cardiac waveform and graphing their heart rate overtime.

Fig-3: Prototype of earphone system with reflective photosensor.

III Results

A. Display Unit

The resulting signals are intended to be sent from the interface to the mobile phone via a USB cable connected to the phone's USB port, and displayed on the phone's screen. The ECG signals will also have displayed on the system running windows XP.

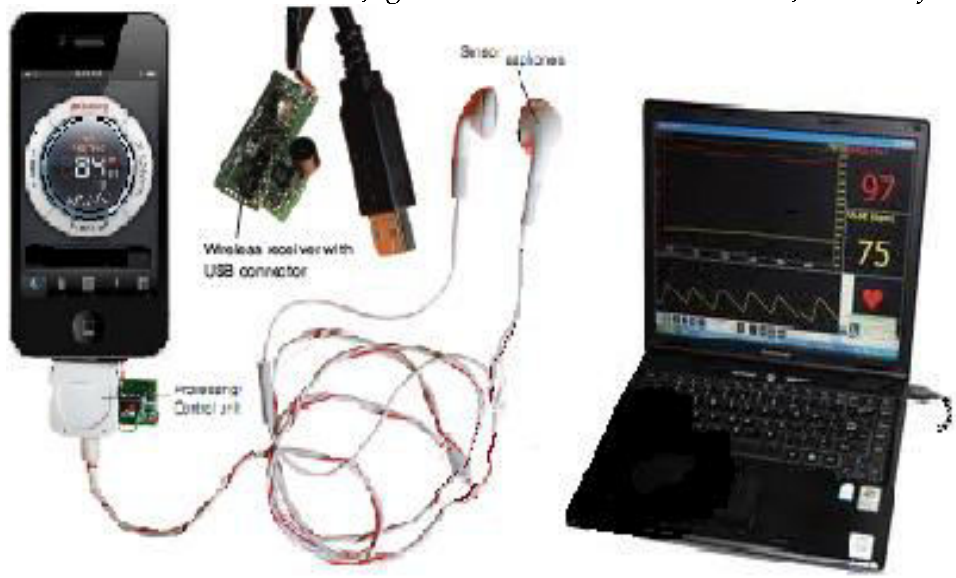

Fig-4: Overall system prototype.

B. Conclusion

Intelligent design of sensor attachment and the use of advance signal processing methods required for the development of wearable biosensors capable of providing accurate measurements during daily activities. Wearable devices that are compact, robust and comfortable will enable widespread use in extending the care and support of emergency operators.

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