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A Survey on Wearable ECG Monitoring System using Wireless Transmission of Data

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Abstract: Wearable electrocardiograph (ECG) monitoring systems today use electrodes that require skin preparation in advance, and require pastes or gels to make electrical contact to the skin [2]. To avoid these pastes or gels we use sensors. The developed acquisition system is used for remote monitoring of patients' heart rate. This system allows the physician able to understand patient's scenario on the monitor by wireless module. Here low cost, low power consumption and flexible network topology ZigBee wireless module is used to sense the remote patient data. All sensor data are transferred within a group of Zigbee wireless module [2].

Keywords: Wearable ECG, ZigBee, Photodiode, Heart rate, Wireless transmission.

I. INTRODUCTION

India has seen a rapid transition in its disease burden (number of cases/lakh) over the past couple of decades. India is undergoing an epidemiological transition and is on the threshold of an epidemic of cardiovascular disease. Demographic projections suggest a major increase in cardiovascular disease mortality as life expectancy increases and the age structure of the growing population changes. Overall, cardiovascular diseases (CVDs) accounted for around one-fourth of all deaths in India in 2008. Our main focus is to avoid high risk of injury or even death because of stroke especially for people who are not in reach of proper medical facilities. Such people have to be monitored continuously and provided with immediate medical aid and attention in case of emergency. A solution to this problem is development of wearable ECG monitoring system.

Electrocardiogram (ECG) signals show the electrical activity of the heart. The patient can be continuously monitored in his home-situation doing daily activities. We use sensors which are placed on the patient's body to record the raw data and the data is filtered then displayed graphically using MATLAB software. This data is transmitted using wireless transmission to the doctor who examines the ECG signals and guides the patient if there is any emergency medical aid required and also monitors and keeps a track of all the patient's data periodically. The wireless transmission is done using ZigBee technique which is an efficient way of transferring data. Using hyper link terminal in the PC the data from each sensor is perceived. And the received data of a patient at home is transmitted to the doctor using Zig Bee.

II. DESIGN FACTORS

There are three main factors to be satisfied and enhanced: High Throughput, Ultra-Wear ability and Low Power [2].

A. High Throughput

To achieve high network throughput, which is necessary for a low realtime monitoring system?

B. Ultra-Wear ability

Wear ability is the most crucial issue in designing a wireless ECG monitoring system. However, to the best of our knowledge, none of the existing miniature sensing systems can be considered truly wearable in the strict sense, not just because they are still bulky but also because conventional ECG sensors can cause skin irritation.

C. Low Power

Low power consumption is another highly important design factor. Low power consumption contributes not only to prolonged lifetime, but also to system miniaturization, because the size of a battery occupies most of the system volume.

III. LITERATURE SURVEY

Using a microchip wireless based wearable physiological parameters monitoring system, the patient is wirelessly monitored at his home. The device detects the heart rate, temperature. These signals are sending to a receiver unit. The receiver unit is connecting to the computer. This system is operated with the help of battery power. A patient has to be monitored continuously using wireless sensors networks. This system has been designed with a host computer, wireless sensors, and temperature sensor [4].

A perspective study on patient monitoring systems based on wireless sensor network, its development and future challenges is about the recent works addressing the Patient Monitoring Systems based on Wireless Sensor Networks. Wireless Sensor Network consists of a number of sensor nodes. Each sensor node includes a radio transceiver along with an antenna, a micro controller, an interfacing electronic circuit and a battery as the energy source [5].

In Wearable Wellness Monitoring Using ECG and Accelerometer Data paper, the hardware allows data to be transmitted wirelessly from on-body sensors to a handheld device using Bluetooth. Data is then transmitted to a back-end server for analysis using either a wireless internet connection, if available, or a cellular phone service [9].

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IV. SYSTEM DESIGN

To satisfy the constraints and to overcome some of the design problems mentioned in the papers on which literature survey is done, we can follow some of the design modifications mentioned in this paper. Design includes Sensors, Data sampling, Wireless transmission and base station. The data is collected from the heart of the patient's body from the sensors. Data sampling, manipulation and analysing a subset of data points in order to identify patterns and trends in the larger data set is done using MATLAB software. For wireless transmission, ZigBee technique is used.

A. Heart Rate

Heart rate measurement is one of the very important parameters of the human cardiovascular system. The heart rate of a healthy adult at rest is around 72 beats per minute (bpm). Babies have a much higher heart rate at around 120 bpm, while older children have heart rates at around 90 bpm. Athletes normally have lower heart rates than less active people. The heart rate rises gradually during exercises and returns slowly to the rest value after exercise. The rate when the pulse returns to normal is an indication of the fitness of the person. Lower than normal heart rates are usually an indication of a condition known as Brady cardiac, while higher than normal heart rates are known as tachycardia. Heartbeat is sensed by using a high intensity type LED and photodiode.

The change in volume caused by the pressure pulse is detected by illuminating the fingertip's skin with the light from an LED using a photodiode sensor. With each heartbeat, a surge of blood is forced through the vascular system, expanding the capillaries in the finger, and changing the amount of light returning to the photo detector. Very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. To measure the valid pulse, pre-processing of the raw signal has to be done. A suitable operational amplifier is needed to amplify the heartbeat signal, due to its very low amplitude compare to the surrounding noise. A super bright LED is suggested in the circuit as it can also perform well as a light sensor. A photodiode is preferred whose resistance changes in response to the amount of light shining on it [1].

B. MATLAB Software Details

MATLAB is the best software which could be used to obtain the required ECG signals from the data obtained by placing the sensors on the human body. By obtaining the voltage variations with respect to time, we plot the graph using MATLAB software with Y-axis displaying Voltage and X-axis displaying the time. A suitable MATLAB code is written which obtains the graph with inputs voltage and time.

C. Wireless Transmission

Various wireless network technologies have been used in health monitoring system; however, this is a better technique. Wireless Sensor Networks (WSNs) [1] are used for communication in health monitoring system, the entire wireless system should be able to re-route and change network architecture when patient move to any position immediately. The system is based on ZigBee wireless standard. Zig Bee is famous for low cost, low power consumption and flexible network topology.

D. Signal Reception

The raw ECG signals are filtered and the data is perceived using hyper link terminal in the PC. And the received data of a patient at home is transmitted to the doctor using Zig Bee.

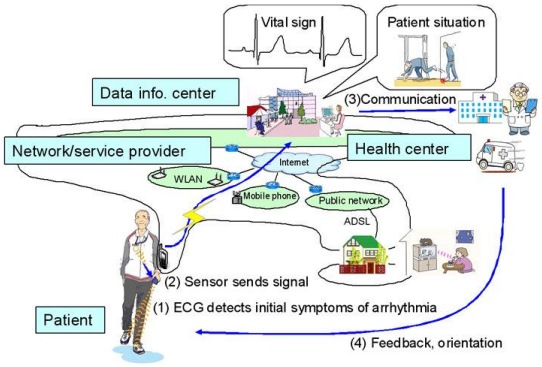

Fig1: Functioning of wearable ECG monitoring system

V. CONCLUSION

Various samples are compared with the other techniques of heart rate monitoring and compared with this wearable ECG monitoring system. The performance is as better as other heart rate monitors used in hospitals. With this device more number of patients can also be monitored with some changes in the software. In this paper, better design techniques to be implemented to measure the ECG signals are shown. The main advantage is that the device is wearable and can be easily operated by the patient anywhere he wants. Thus the basic aim to detect the emergency conditions is satisfied.

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