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Real Time Patient Monitoring System Using LabVIEW

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Abstract: The objective of this paper is to present a Real Time Patient Monitoring System using LabVIEW, which enables continuous monitoring of a patient and helps the doctors to make better diagnosis. The system acquires, analyses and processes certain physiological parameters of a patient such as body temperature, Electrocardiogram and pulse rate. NI LabVIEW is used to take the current body temperature from the temperature sensor and ECG signals and heart rate from the ECG sensor attached to the DAQ (Data Acquisition – NI USB 6211) Signal Accessory. An alert file can also be created when any parameter exceeds the limit beyond a set point and can transfer the alert in the form of messages via Bluetooth. It can be used to perform routine tests as well for continuous monitoring of a hospitalized patient. LabVIEW is a user friendly platform which supports GUI interface for experiments and analysis of various physiological parameters which is essential for the patient's wellness. Electronic records can be made which is useful for future references.

Keywords: Bluetooth, Data Acquisition, ECG, LabVIEW, Pulse Rate.

I. INTRODUCTION

In recent years, computer based systems have become an inevitable part of every healthcare environment. Remote patient tele-monitoring system using LabVIEW enabled computer enables doctors to monitor the vital bio-signals such as body temperature, Electrocardiogram and heart rate of patients using the real time waveform and data monitoring function of LabVIEW installed on computer. The need for real time notification of vital signs of patient to the doctor is of prime importance, thus the need of active database system arises, and that is grouped with patient monitoring device. For instance, the emergency cases need immediate surgical intervention and intensive monitoring, hence operation theatre and ICU bed have to be prepared according to the emergency for which one needs to monitor the vital parameters of the patient and do a quick diagnosis for choosing treatment procedure. In order to minimize the time utilized for procedure preparation, it would be convenient if patient's clinical data reaches the doctors well in advance; this is where telemetry comes to play, so they are well prepared on the arrival of patient.

The vital parameters can be processed in ambulance which is implemented using LabVIEW with greater accuracy and at cheaper price. Then transmitting them dynamically to a mobile phone from where it can be transmitted to a doctor through internet and also alerting in charge about abnormal parameters by sending alert on in his/her mobile. Also, the medical world today faces two basic problems when it comes to patient monitoring, firstly the need of healthcare providers present bedside the patient and secondly the patient is restricted to bed and wired to large machines. In order to achieve better quality patient care, the above cited problems have to be solved. As the bioinstrumentation, computers and telecommunications technologies are advancing, it has become feasible to design a home based vital sign tele-monitoring system to acquire record, display and transmit the physiological signal from the human body to any location. This can help in saving time spent at hospitals and helps in better diagnosis. Integrated health records can be created by saving the parameter values to a spreadsheet. This provides an excellent provision for future reference and helps the doctors to analyse the pattern of variations in conditions of patients at regular intervals.

II. SYSTEM CONFIGURATION

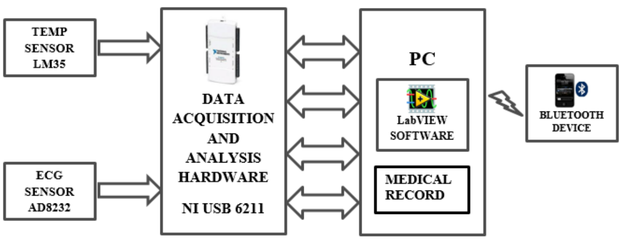

Fig. 1 Block Diagram of Real Time Patient Monitoring System

In the system, temperature sensor LM35 and ECG sensor AD8232 are used to take the signals from the body of the patient. The data acqusition module NI USB 6211 takes the current body temperature and ECG signal into the computer installed with LabVIEW. The signals are analysed and processed by various tools in the LabVIEW platform, which further displays the body temperature, ECG parameters and pulse rate of the subject.

The processed parameters are sent to a mobile phone using Bluetooth services, which can be sent to medical care professional for further analysis. The physiological

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parameters can be saved to a spreadsheet to form an integrated health record which may be refered to at a later point of time to analyse the patient's condition.

III. ACQUISITION AND PROCESSING OF PHYSIOLOGICAL PARAMETERS

The parameters of a patient are continuously monitored using sensors. The data acquisition system provides an interface to acquire the readings and process it on the LabVIEW platform.

A. Body Temperature

The normal body temperature of a person varies depending on gender, recent activity, food and fluid consumption, and time of day. Normal body temperature can range from 97.8 degrees F (or Fahrenheit, equivalent to 36.5 degrees C, or Celsius) to 99 degrees F (37.2 degrees C) for a healthy adult. Body temperature may be abnormal due to fever (high temperature) or hypothermia (low temperature). A fever is indicated when body temperature rises about one degree or more over the normal temperature of 98.6 degrees Fahrenheit. Hypothermia is defined as a drop in body temperature below 95 degrees Fahrenheit.

The LM35 series are precision integrated-circuit 1 calibrated Directly in Celsius (Centigrade) with an output voltage linearly- proportional to the Centigrade temperature. The 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. The low-output impedance, linear output, and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. The LM35 device is rated to operate over a −55°C to 150°C temperature range. The output voltage to temperature conversion is based on the relation:

$$1℃ = 0.1 \text{ mV}$$

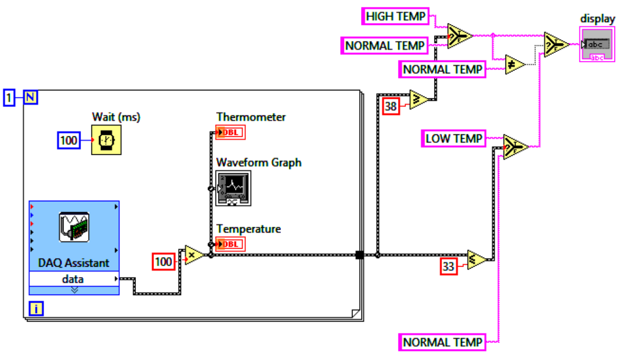

Fig. 2 Sub VI to Measure Temperature

The temperature sensor output is connected to PC using a DAQ NI USB 6211. In this system, we simply connect it to a computer where LabVIEW platform is installed with a USB cable. The output voltage is converted to corresponding temperature readings using numeric palettes in LabVIEW. The obtained temperature is compared with a normal temperature range to generate a warning.

B. Electrocardiogram and Heart Rate

Electrocardiogram is the most effective and efficient tool in diagnosis and monitoring of patients with cardiac disorders. It provides enormous amount of clinical information regarding the electrical activity of heart. As the heart pushes blood through the arteries, the arteries expand and contract with the flow of the blood. Taking a pulse not only measures the heart rate, but also can indicate the heart rhythm and strength of the pulse. The normal heart rate for healthy adults ranges from 60 to 100 beats per minute. The pulse rate may fluctuate and increase with exercise, illness, injury, and emotions. The raw ECG signals are obtained using ECG sensor AD8232 via electrodes, from which ECG parameters and heart rate can be obtained.

The AD8232 is an integrated signal conditioning block for ECG and other bio-potential measurement applications. It is designed to extract, amplify, and filter small bio-potential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. For recording and measuring these electrical signals, electrodes are placed on the skin of patient. Locations specified for picking up the signals through electrode are between muscles on the upper arms and lower legs based on Einthoven triangle. The waveform so obtained after connecting electrodes is acquired using DAQ assistant and processed using various elements of LabVIEW. The result helps the specialist in observing the condition of heart and diagnosis the problem associated with the various heart activity of the subject.

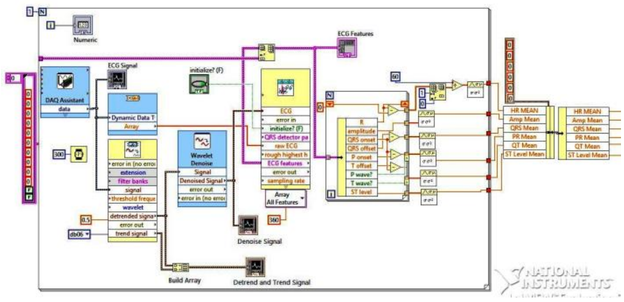

Fig. 3 Sub VI to process ECG signals

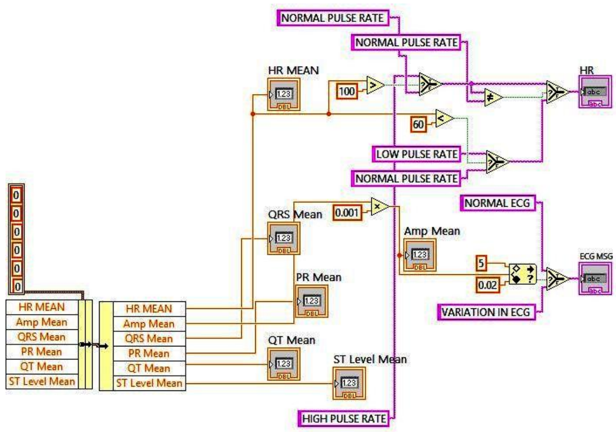

Fig. 4 Sub VI to compare ECG signal values

By using LabVIEW Wavelet Detrend VI and Wavelet Denoise Express VI of Advanced Signal Processing tool

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Kit the baseline wandering and wideband noise in the acquired ECG signal data can be removed. The Discrete Wavelet Transform is used to represent the signal and various ECG parameters are generated. The processed signal is compared with the normal ECG signal available in the biomedical toolkit of LabVIEW. Whenever any variation occurs, a warning signal can be generated which can be transmitted to a mobile phone using Bluetooth along with pulse rate and other body parameters.

IV. BLUETOOTH SERVICES FOR ALERT FILE GENERATION

Bluetooth technology provides flexible, low-power communication among Bluetooth devices over a radio frequency. In LabVIEW, VIs running on separate computers or on Mobile devices can use Bluetooth capabilities to communicate. Bluetooth is a wireless technology that uses a radio frequency of 2.4 GHz to allow devices to communicate. The range of a Bluetooth connection is between 30 and 40 feet, depending on the device and environmental conditions.

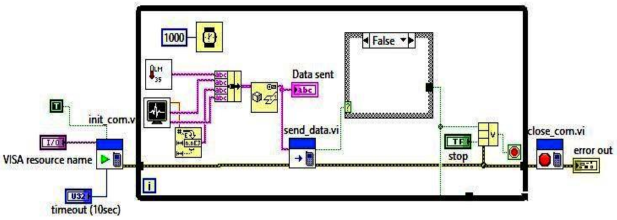

Fig. 5 Final VI to transmit message via Bluetooth

The LabVIEW Bluetooth VIs and functions use RFCOMM, which is a connection protocol the Winsock interface exposes. RFCOMM is simple transfer protocol that emulates serial communication. The RFCOMM interface defines Bluetooth servers and clients. Creating Bluetooth server and client applications in LabVIEW is similar to creating server and client applications for TCP communication.

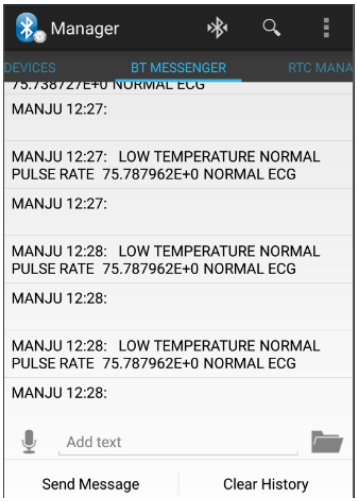

Fig. 6 Message received on mobile phone

A Bluetooth server uses the Service Discovery Protocol (SDP) to broadcast the availability of the services the server contains and listens for inbound connections. A client creates an outbound RFCOMM connection to a server. Once the client and server connect to each other, they exchange data until the client or server terminates the connection or until the connection is lost. The android application, Bluetooth SPP (Serial Port Protocol) Manager is installed on the mobile phone. Whenever any parameter varies from its normal conditions, the warning signal is sent to the mobile phone via Bluetooth and received on the BT messenger. The values of different body parameters at different instants can be saved in a spreadsheet for future reference using Write to Measurement File palette.

V. CONCLUSION

In this paper, LabVIEW graphical programming platform provides an efficient environment to process and keep track of various physiological parameters of a patient like body temperature, ECG and heart rate in real time. Any variation in the parameters from the normal value results in generation of a warning message which is sent to a mobile phone via Bluetooth. The values of the parameters at any time can be saved to an excel file for future references.

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