ECG Data Reconstruction using LabVIEW Simulink

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Abstract- This paper describes LabVIEW simulink for serial communication and ECG signal reconstruction. In fact, various programming languages are available to meet the requirements of serial communication and reconstruction of data. However, LabVIEW, altering from habitual programming languages, is interested in this paper. LabVIEW is a programming environment in which programs can be easily created using graphical icons. The aim of this paper is to support readers with a fundamental understanding of serial communication and reconstruction of ECG signal in LabVIEW. After reconstructing of ECG signal using LabVIEW simulink, it is intended to transmit and receive this ECG signal by using wireless module such as ZigBee and RF module. However, reconstruction of ECG signal is only discussed in this paper.

Keywords – Electrocardiogram, LabVIEW

I. INTRODUCTION

Data acquisition and signal construction play an important role in medical health care. Several technologies have already been introduced for serial communication and signal construction (e.g, Matlab and C#). However, LabVIEW is interested in this paper because it alters from habitual programming languages similar to Java, C, or C++, in that program can be done through text. In [1], the author discusses the approach of real-time system development using the data acquisition tool of LabVIEW. The author uses NI USB6008 DAQ device for data acquisition and temperature signal analysis. In [5], the author discusses the usefulness of multifunction data acquisition card (DAQ) for acquisition, monitoring and control. Without DAQ card, the system cost is effectively reduced. By writing easy LabVIEW code using VISA resource, the communication through external hardware is very easy.

A. LabVIEW

LabVIEW (Laboratory Virtual Instrument Engineering Workbench), visual programming language from National Instruments, is a system-design platform and development environment. LabVIEW is commonly used for data acquisition, instrument control, and industrial automation. The programming language used in LabVIEW is graphical language which is also known as dataflow programming language.

LabVIEW programs are called virtual instruments (VIs). Each VI consists of:

• Front Panel: serves as the user interface.
• Block Diagram: contains the graphical source code that defines the functionality of the VI.
• Icon and connector panel.
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B. Characteristics of an ECG signal

Although preprocessing and post processing of an ECG signal are not interested in this paper, basic characteristics of ECG signals are taken into account to check whether it is an ECG signal or not in receiving session. ECG data source is PHYSIONET Bank record.

An electrocardiogram (ECG) is a recording of the electrical activity on the body surface generated by the heart. The PQRST waveform represents one complete ECG cycle. P wave occurs when SA (sinoatrial) node fires and the impulse spreads across atria and triggers atrial contraction. QRS complex occurs when the impulse spreads to ventricles and triggers ventricular contraction. T wave represents the return to resting state by the ventricles.
Duration of P wave is not more than 0.11 seconds and amplitude is not more than 3mm in height and gently rounded, not pointed or notched. The PR interval is measured from the beginning of the P wave to the beginning of the QRS complex. The normal duration for this is 0.12-0.20 seconds. A prolonged interval, beyond normal limits (0.12-0.20 sec.), is considered to be abnormal. An abnormally short P-R interval is cause for alarm as it is often seen in association with hypertension and paroxysms of tachycardia. The normal duration of QRS complex interval is 0.05 to 0.10 seconds. A measurement of 0.12 seconds or more indicates abnormal intraventricular conduction and often indicates a block of one of the bundle branches or a ventricular arrhythmia. The S-T segment follows the QRS complex. It normally gently curves into the T wave. The normal shape of the T wave is slightly rounded and slightly asymmetrical. The sharply pointed symmetrical T waves should make one suspicious of myocardial infarction [7].

The heart rate (beats per minute) can be readily computed from the inter beat(R-R) interval. The normal human heart rate ranges from 60–100 bpm. Bradycardia refers to a slow heart rate, defined as below 60 bpm. Tachycardia refers to a fast heart rate, defined as above 100 bpm at rest. When the heart is not beating in a regular pattern, this is referred to as an arrhythmia. These abnormalities of heart rate sometimes, but not always, indicate disease [6]. Therefore, ECG signal interpretation is very important to human.

II. SYSTEM IMPLEMENTATION

Preprocessing of ECG signal is not interested in this paper. Only sampled ECG data are taken from database. Data source is PHYSIONET Bank record and sampling frequency for the recorded ECG signal is 100Hz. Figure 5 shows recorded data source and figure 6 shows original ECG data construction in Matlab.
These data are transmitted through virtual port connection to serial port of LabVIEW. Total number of sampled points is one thousand. Therefore, a while loop is used in LabVIEW to receive one sampled point at a time. A while loop means that keeping the program to run continuously, except when it is terminated by a user. If the number of loop iteration is greater than the total number of sampled points, read buffer is blank (nothing will appear in read buffer). This is the end of receiving and the switch button can be pressed. The flowchart for serial communication and data construction in LabVIEW is shown below.

**Figure 6. Original ECG signal**

**Figure 7. Flowchart for serial communication and data reconstruction in LabVIEW**
III. Simulation Results

There are two sessions in tests and results; sending side and receiving side in LabVIEW. In simulink, virtual port connection is used to connect each comport. In this paper, Microsoft visual studio software is used to send sampled data points to LabVIEW. For giving connection between these, virtual serial port emulator (VSPE) is used.

In LabVIEW, serial port must be configured if the user want to receive data through it. The process of configuring serial port contains parameter setting and resource name selecting. Four parameters are baud rate, data bits, parity bit and stop bit and default baud rate is 9600 bps. A while loop is used in LabVIEW to receive one sampled point at a time. In front panel, receiving data can be checked in read buffer during the processing time. After receiving all transmitted data, nothing will display in read buffer. Therefore, one user can know that whether receiving is successfully completed or not.
IV. CONCLUSION

Receiving sampled ECG data from serial port and reconstruction of them in LabVIEW have been successfully done in this paper. In this paper, receiving data can only be checked in read buffer during the processing time and only one sampled point can be received at a time. One simple way to be easier in checking data is that all received data is displayed in read buffer at the same time even after receiving is completed. As future work, this signal will be transmitted and received by using wireless module and microcontroller.

REFERENCE