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ECG TELE-MONITORING USING LABVIEW

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Abstract: **Patient tele-monitoring is remotely monitoring the vital parameters of patient and providing them to the doctor at remote location. The parameters such as ECG, Heart rate etc are obtained and thus ensuring mobility of both patient and the doctor. Patient telemonitoring involves processing, analyzing and extracting necessary features from the biomedical signals easily and conveniently and the signals obtained are displayed on a graphical user interface, which are provided dynamically to a web page in real time to be viewed by an authorized doctor. If anyone of the vital parameters go out of normal range than an alert signal is generated by the system. All the objectives are fulfilled on LabVIEW platform.**

Keywords: **LabVIEW, Patient monitoring system, Telemonitoring, Electrocardiogram (ECG), Heart rate, Webpage, Web server.**

1. INTRODUCTION

There are three directions that influence the development of medical instruments and establish an early position in a very competitive market: producing safe, high quality devices for patient care and reduced development time and low cost system. Therefore for increasing the patient care efficacy there arises a need to improve the patient monitoring devices and make them more mobile.

The medical world faces two basic problems when it comes to patient monitoring, firstly, the need of healthcare provider's 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 are to be solved.

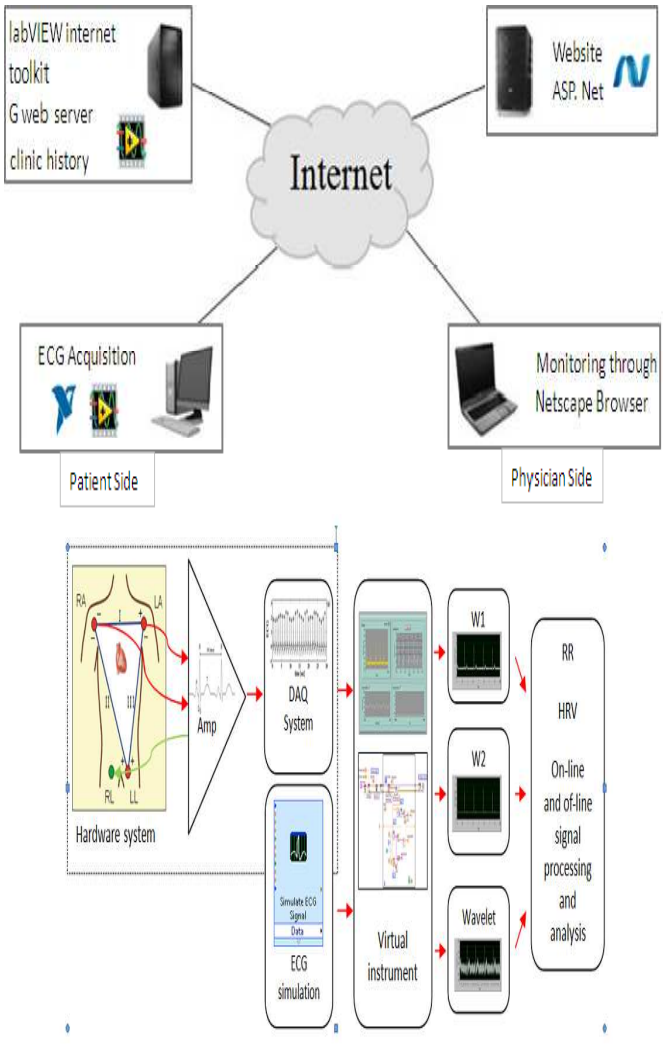
As the bioinstrumentation, computer and telecommunications technologies are advancing it has become feasible to design a home based vital sign tele-monitoring to acquire record, display and transmit the physiological signal of the human body to any location.

The importance of patient monitoring system (PMS) in medical treatment is very high, hence medical manufacturers are introducing centralized PMS. In centralized PMS all patient monitors are connected with a single server based PMS. The TCP/IP protocol suite based architecture systems are capable to upgrade PMS's firmware and software through dedicated TCP/IP protocol suite via open communication network.

The computer based signal acquisition, processing and analysis system using LabVIEW is used as a filtering and peak detection tool in ECG. The computer based patient education can help improve patient's awareness and understanding of his or her disease, thus the efficacy of treatment can be increased.

2. SYSTEM REPRESENTATION:

The figures shows the real time vital parameter transmitting system with both hardware and software components. The electronic component covers two aspects. The first ensures the acquisition and transmission of the signal using acquisition card DAQmx, the second receives the signals on the server side using LabVIEW application.



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3. BRIEF DESCRIPTION AND METHODOLOGY

Laboratory Virtual Instruments Engineering Workbench (LabVIEW) software is used as the integrating platform for acquiring, processing and transmitting the physiological data as it is an excellent graphical programming environment to develop sophisticated measurement, test and control systems. LabVIEW is a program development application much like C or BASIC. However LabVIEW is different from those applications in one more important respect. Other programming systems use text-based languages to create lines of code, while LabVIEW uses a graphical programming language, G, to create programs in block diagram form. LabVIEW like C or BASIC is a general purpose programming system with extensive libraries of functions and subroutines for any programming task. LabVIEW also includes execution to see how data passes through the program and single step through the program to make debugging and program development easier.

3.1 ECG Recording: The low noise ECG signal is acquired by National Instruments Laboratory VI suite using a 3-lead or a 4-lead system. The acquired signal is further processed by LabVIEW which is having signal processing module.

3.2 Heart Rate Determination: Heart rate is determined by the number of heart beats per unit of time expressed as beats per minute(BPM). The measurement of heart rate is mainly based on the QRS complexes.

3.3 ECG Detection Algorithm Available For Telemetry Applications

From this various detection algorithms are available. Some of them are listed below

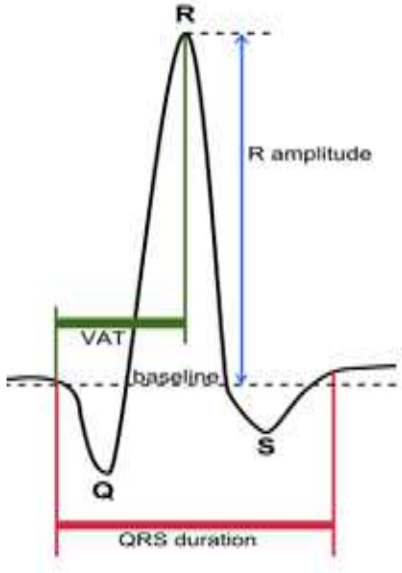
- Turning point algorithm
- Aztec algorithm
- Fan algorithm
- QRS Detection algorithm

For the storage of the wave, to save the memory space the redundancy is eliminated but with some constraints.

3.4 QRS Detection Algorithm

For this detection algorithm we design aband pass filter from a special class of digital filter which requires only coefficient. It is very difficult to design digital band pass filter directly so we design a cascaded connection of low pass and high pass filter. It attenuates the low frequency characteristics of P and T waves and baseline drifts and high frequency.

Some of the important features of ECG



ECG Parameters

Feature	Description	Duration
RR interval	The interval between an R wave and the next R wave: Normal resting heart rate is between 60 and 100 bpm.	0.6 to 1.2s
P wave	During normal atrial depolarization, the main electrical vector is directed from the SA node towards the AV node, and spreads from the right atrium to the left atrium. This turns into the P wave on the ECG.	80 ms
PR interval	The PR interval is measured from the beginning of the P wave to the beginning of the QRS complex. The PR interval reflects the time the electrical impulse takes to travel from the sinus node through the AV node and entering the ventricles. The PR interval is, therefore, a good estimate of AV node function.	120 to 200 ms
PR segment	The PR segment connects the P wave and the QRS complex. The impulse vector is from the AV node to the bundle of His to the bundle branches and then to the Purkinje fibers. This electrical activity does not produce a contraction directly and is merely traveling down towards the ventricles, and this shows up flat on the ECG. The PR interval is more clinically relevant.	50 to 120 ms
QRS complex	The QRS complex reflects the rapid depolarization of the right and left ventricles. They have a large muscle mass compared to the atria, so the QRS complex usually has much larger amplitude than the P-wave.	80 to 120 ms
J-point	The point at which the QRS complex finishes and the ST segment begins, it is used to measure the degree of ST elevation or depression present.	N/A
ST segment	The ST segment connects the QRS complex and the T wave. The ST segment represents the period when the ventricles are depolarized. It is isoelectric.	80 to 120 ms
T wave	The T wave represents the repolarization (or recovery) of the ventricles. The interval from the beginning of the QRS complex to the apex of the T wave is referred to as the absolute refractory period. The last half of the T wave is referred to as the relative refractory period (or vulnerable period).	160 ms
ST interval	The ST interval is measured from the J point to the end of the T wave.	320 ms
QT interval	The QT interval is measured from the beginning of the QRS complex to the end of the T wave. A prolonged QT interval is a risk factor for ventricular tachyarrhythmias and sudden death. It varies with heart rate and for clinical relevance requires a correction for this, giving the QTc.	Up to 420 ms in heart rate of 60 bpm
U wave	The U wave is hypothesized to be caused by the repolarization of the interventricular septum. They normally have a low amplitude, and even more often completely absent. They always follow the T wave and also follow the same direction in amplitude. If they are too prominent, suspect hypokalemia, hypercalcemia or hyperthyroidism usually.	
J wave	The J wave elevated J-point or Osborn wave appears as a late delta wave following the QRS or as a small secondary R wave. It is considered pathognomonic of hypothermia or hypocalcaemia.	

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Pathological variations in ECG

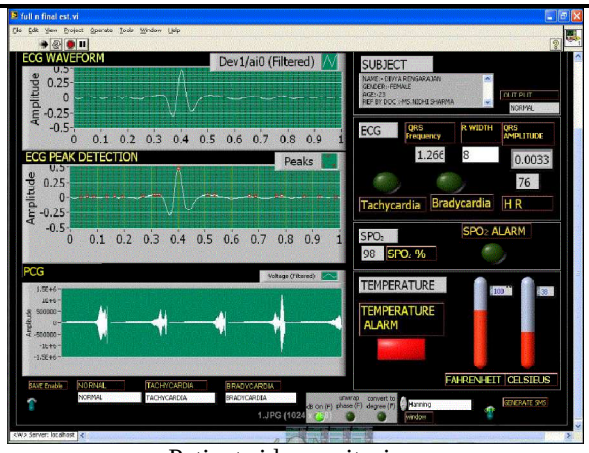
Shortened QT interval	Hyperkalaemia, some drugs, certain genetic abnormalities, hyperkalaemia
Prolonged QT interval	Hypocalcaemia, some drugs, certain genetic abnormalities
Flattened or inverted T waves	Coronary ischemia, hypokalaemia, left ventricular hypertrophy, digoxin effect, some drugs
Hyper acute T waves	Possibly the first manifestation of acute myocardial infarction, where T waves become more prominent, symmetrical, and pointed
Peaked T wave, QRS wide, prolonged PR, QT short	Hyperkalemia, treat with calcium chloride, glucose and insulin or dialysis
Prominent U waves	Hypokalemia

4. REAL TIME TELE MONITORING USING LABVIEW

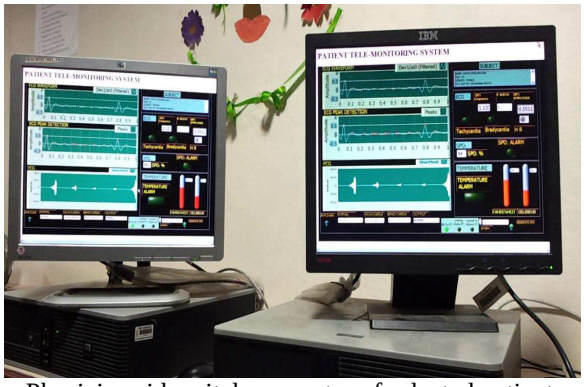
LabVIEW has been used to build Computer Graphics Interface (CGI) programs and URL's to send and receive data using the Telnet protocol, to store and retrieve files from FTP servers and to publish VI's on the web server. LabVIEW have internet toolkit including the G web server which is an HTTP/1.0- compatible server used to run applications on the web. Servers and CGI applications intercommunicate through environmental variables and standard inputs and outputs. The G web server is used to publish image of front panel on the web. Using this static or animated front panel images can b loaded. The G web server can generate images in JPEG or PNG image format. In some cases while assessing the health condition of a patient, need to go back to previous data occurs. Each session is saved in TDMS file now and then uploaded at the end of session to the server which allows the physician to retrieve the desired session. Using report generation toolkit present in LabVIEW a real time patient record containing basic patient and clinical information like heart rate, and ECG waveform is generated. Also whenever an alert file is generated by the LabVIEW, it will automatically send mail using Email notification application.

5. RESULT AND DISCUSSION

This system can be used to transmit the patient vital parameter information in real time to remote location and can be viewed by the care giver. Also a printable Patient report can be generated any time as per the need. As this is medical application, reliability is needed in the first place. A reliable TCP protocol was used in this application which was implemented in LabVIEW.



Patient side monitoring



Physician side, vital parameter of selected patient

6. CONCLUSION

Tele-monitoring application allows doctor to view his patient's remotely and dynamically in a web page in real time and does not need to have any special requirement on his PC, all he needs is an internet access. For the patient side, it is a home based LabVIEW application embedded in home PC during signal acquisition.

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