

# INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY

WINGS TO YOUR THOUGHTS.....

## AN APPROACH TO ECG MONITORING USING LAB VIEW

Chetan Chauhan<sup>1</sup>, Bhavi Bhatia<sup>2</sup>

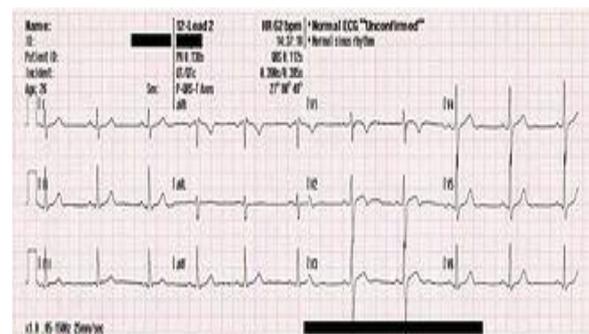
EIED Department  
Thapar University  
Patiala

**Abstract:** Due to detection of various cardiac diseases, ECG has been become the matter of intense research in the past years. So in this regard further research is required to effective diagnose and treatment of disease. An improved, knowledge driven, patient data monitoring diagnosis system is developed to acquire, store and process the data using GUI (Graphical User Interface) on Lab View platform. The GUI displays, communicates and processes crucial biomedical parameters such as Heart rate, beat to beat ratio, QRS, and QT intervals etc. after acquiring the ECG from the patient's body sensors. If there is any abnormality arises in the patients like irregular rhythm heart line, etc. then it will be detected by the system automatically and we can easily give the effective diagnose and treatment at that time. The developed system uses Lab View (Laboratory Virtual Instrument Engineering Workbench) 7.1 platform. The developed system is user friendly and provides the result in real time.

### 1. INTRODUCTION

Electro cardio graphy from Greek : kardia, meaning heart) is a transthoracic (across the thorax or chest) interpretation of the electrical activity of the heart over a period of time, as detected by electrodes attached to the surface of the skin and recorded by a device external to the body [1].The recording produced by this non-invasive procedure is termed an electrocardiogram (also ECG or EKG).

An ECG is used to measure the rate and regularity of heartbeats, as well as the size and position of the chambers, the presence of any damage to the heart, and the effects of drugs or devices used to regulate the heart, such as a pacemaker. Most ECGs are performed for diagnostic or research purposes on human hearts, but may also be performed on animals, usually for diagnosis of heart abnormalities or research. An ECG is a way to measure and diagnose abnormal rhythms of the heart [2] ,particularly abnormal rhythms caused by damage to the conductive tissue that carries electrical signals, or abnormal rhythms caused by electrolyte imbalances [3]. In a myocardial infarction (MI), the ECG can identify if the heart muscle has been damaged in specific areas, though not all areas of the heart are covered [4]. The ECG cannot reliably measure the pumping ability of the heart, for which ultrasound-based or nuclear medicine tests are used. It is possible for a human or other animal to be in cardiac arrest, but still have a normal ECG signal (a condition known as pulse less electrical activity) [5].



**Figure1:** Twelve-lead EKG of a 26-year-old male

The ECG device detects and amplifies the tiny electrical changes on the skin that are caused when the heart muscle depolarizes during each heartbeat. At rest, each heart muscle cell has a negative charge, called the membrane potential, across its cell membrane. Decreasing this negative charge towards zero, via the influx of the positive cations,  $\text{Na}^+$  and  $\text{Ca}^{++}$ , is called depolarization, which activates the mechanisms in the cell that cause it to contract. During each heartbeat, a healthy heart will have an orderly progression of a wave of depolarisation that is triggered by the cells in the sinoatrial node, spreads out through the atrium, and passes through the atrioventricular node and then spreads all over the ventricles. This is detected as tiny rises and falls in the voltage between two electrodes placed either side of the heart which is displayed as a wavy line either on a screen or on paper. This display indicates the overall rhythm of

# INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY

*WINGS TO YOUR THOUGHTS.....*

the heart and weaknesses in different parts of the heart muscle.

Usually, more than two electrodes are used, and they can be combined into a number of pairs (For example: left arm (LA), right arm (RA) and left leg (LL) electrodes form the three pairs LA+RA, LA+LL, and RA+LL). The output from each pair is known as a **lead**. Each lead looks at the heart from a different angle. Different types of ECGs can be referred to by the number of leads that are recorded, for example 3-lead, 5-lead or 12-lead ECGs (sometimes simply "a 12-lead"). A 12-lead ECG is one in which 12 different electrical signals are recorded at approximately the same time and will often be used as a one-off recording of an ECG, traditionally printed out as a paper copy. Three- and 5-lead ECGs tend to be monitored continuously and viewed only on the screen of an appropriate monitoring device, for example during an operation or whilst being transported in an ambulance. There may or may not be any permanent record of a 3- or 5-lead ECG, depending on the equipment used.

## 2. TYPES OF ECG MACHINES

Electrocardiography (ECG or EKG) machines are available in a variety of different types that offer different features, from the most basic hand-held devices to fully featured machines for use in cardiac centers. All ECG machines work in basically the same way and are used to perform electrocardiogram tests looking for heart rate abnormalities. The main difference between the types is found in the amount of information they gather, the information they display and record, their portability, and their usability features. So depending upon these differences they may be classified into three types.

### 1) 3-lead ECG

To obtain accurate 3-lead ECG data using the MP150 data acquisition system, set all of the hardware and software parameters as stated below. These have proven to be optimal for ECG testing, although many of the settings can be customized to account for individual testing preferences.

### 2) 6-lead ECG

To obtain a 6-lead ECG you need to calculate three augmented leads in addition to Leads I, II, and III. These three new leads are typically noted as aVR, aVL, and aVF, and are functions of Leads I, II, and III. They can be derived through calculation expression channels.

In order to acquire 6-lead ECG information, you will need to calculate the three augmented leads, also termed the Goldberger leads. These leads are derived from advanced vector-cardiography based on the three standard leads (Leads I, II, and III). No additional electrodes or leads are required to obtain the augmented leads as they are functions of the three standard leads and can be calculated online or post-acquisition with the following formulas:

$$VR = (\text{Lead I} + \text{Lead II}) / 2$$

$$VL = (\text{Lead I} - \text{Lead III}) / 2$$

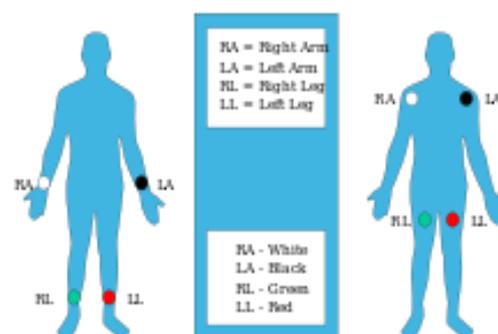
$$VF = (\text{Lead II} + \text{Lead III}) / 2$$

### 3) 12-lead ECG

To obtain a 12-lead ECG you need to calculate six precordial (chest) leads in addition to Leads I, II, and III and the three augmented leads. In some remote cases 6-lead ECG does not give enough information about the electrical activity of the heart. It is possible to add six more leads for a total of 12 leads, hence the title 12-Lead ECG [6],[7]. The six new leads, called precordial leads, or chest leads, are arranged across the chest in a horizontal plane and record electrical flows moving anteriorly and posteriorly. To create the six precordial leads, each chest electrode is positive, and the whole body is used as the common ground. The six positive electrodes, creating the precordial leads V1 through V6 are positioned as shown in the diagram above and rotated through consecutive recording segments to provide 12-lead ECG data

## 3. PLACEMENT OF ELECTRODES

Ten electrodes are used for a 12-lead ECG. The electrodes usually consist of a conducting gel, embedded in the middle of a self-adhesive pad onto which cables clip. Sometimes the gel also forms the adhesive [8]. They are labelled and placed on the patient's body as follows [9-10].



# INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY

*WINGS TO YOUR THOUGHTS.....*

**Figure 2**

Proper placement of the limb electrodes, color-coded as recommended by the American Heart Association (a different colour scheme is used in Europe): The limb electrodes can be far down on the limbs or close to the hips/shoulders, but they must be even (left vs right). [11] When exercise stress tests are performed, limb leads may be placed on the trunk to avoid artefacts' while ambulatory (arm leads moved subclavicularly and leg leads medial to and above the iliac crest).

**Table1**

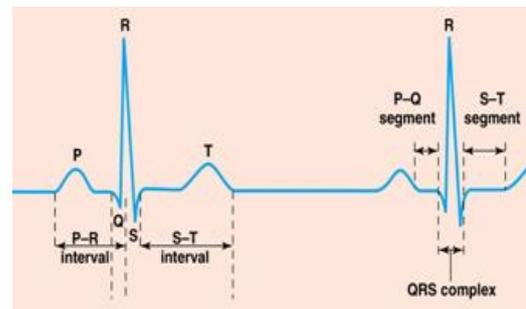
Electrodelabel (in the USA)	Electrode placement
RA	On the right arm, avoiding thick muscle.
LA	In the same location where RA was placed, but on the left arm.
RL	On the right leg, lateral calf muscle.
LL	In the same location where RL was placed, but on the left leg.
V <sub>1</sub>	In the fourth intercostal space (between ribs 4 and 5) just to the right of the sternum (breastbone).
V <sub>2</sub>	In the fourth intercostal space (between ribs 4 and 5) just to the left of the sternum.
V <sub>3</sub>	Between leads V <sub>2</sub> and V <sub>4</sub> .
V <sub>4</sub>	In the fifth intercostal space (between ribs 5 and 6) in the mid-clavicular line.
V <sub>5</sub>	Horizontally even with V <sub>4</sub> , in the left anterior axillary line.
V <sub>6</sub>	Horizontally even with V <sub>4</sub> and V <sub>5</sub> in the maxillary line.

## 4. ECG PARAMETERS AND THEIR IMPORTANCE IN DIAGNOSIS

The standard full ECG is a 12-lead, which uses six electrodes on the chest and one on each limb for a total of 10 electrodes. The configuration of the electrodes produces 12 leads by the way signals are transmitted between them. The electrodes themselves are sometimes called leads, but this is not technically accurate because a lead is actually composed of a group of electrodes.

Each lead transmits information to the main machine, which produces a graph depicting the

signals. This graph can be interpreted to determine whether a patient has any cardiac abnormalities, such as those produced by a myocardial infarction — a heart attack. Some types of ECG machines come with interpretation built into the device, which makes them easier to use. A patient's most recent ECG results can be compared with his or her previous ECG results to track cardiac changes.



**Figure 3: Standard ECG waveform**

1) P wave: Depolarization of both atria;

- Relationship between P and QRS helps distinguish various cardiac
- Shape and duration of P may indicate atrial enlargement

2) PR interval: from onset of P wave to onset of QRS

- Normal duration = 0.12-2.0 sec (120-200 ms) (3-4 horizontal boxes)
- Represents atria to ventricular conduction time (through His bundle)
- Prolonged PR interval may indicate a 1st degree heart block

3) QRS complex: Ventricular depolarization

- Larger than P wave because of greater muscle mass of ventricles
- Normal duration = 0.08-0.12 seconds
- Its duration, amplitude, and morphology are useful in diagnosing cardiac arrhythmias, ventricular hypertrophy, MI, electrolyte derangement, etc.
- Q wave greater than 1/3 the height of the R wave, greater than 0.04 sec are abnormal and may represent MI

4) ST segment: Connects the QRS complex and T wave

- Duration of 0.08-0.12 sec (80-120 msec)

# INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY

*WINGS TO YOUR THOUGHTS.....*

5) T wave:

- Represents repolarization or recovery of ventricles
- Interval from beginning of QRS to apex of T is referred to as the absolute refractory period

6) QT Interval

- Measured from beginning of QRS to the end of the T wave
- Normal QT is usually about 0.40 sec
- QT interval varies based on heart rate

## 5. LAB VIEW: An Overview

Lab VIEW (short for Laboratory Virtual Instrument Engineering Workbench) is a system-design platform and development environment for a visual programming language from National Instruments., Lab VIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms including Microsoft Windows, various versions of UNIX, Linux, and Mac OS X. The latest version of Lab VIEW is Lab VIEW 2012, released in August 2012.

The analysis and processing of bio-signals and biomedical images can provide useful information for recognizing, visualizing, and understanding biomedical characteristics in human bodies and in animal bodies. The Lab VIEW Biomedical Toolkit includes tools that you can use to acquire, pre-process, extract, and analyze bio signals and biomedical images.

By using the Biomedical Toolkit with National Instruments DAQ hardware, you can set up a system for learning signal processing techniques in bioinstrumentation. You can use different signal processing methods in research and academic projects related to biomedical engineering and other biomedical fields.

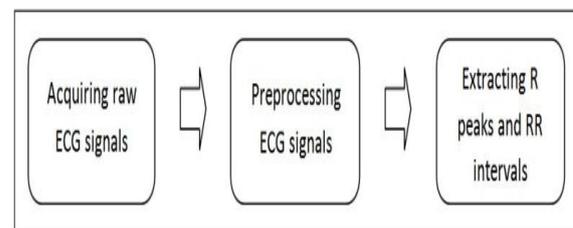
The following figure demonstrates the biomedical analysis process that uses the Biomedical Toolkit with NI DAQ hardware. The previous biomedical analysis process contains the following components:

- **Frontend**—Devices, such as transducers and electrodes that you directly attach or connect to the test subject. The frontend might include preamplifiers and isolation circuits to ensure the quality of the data acquisition.

- **NI DAQ Hardware**—Hardware that acquires data for analysis and processing. Different NI DAQ hardware devices provide different specifications for sampling rate, resolution of the A/D converter (ADC), etc. Refer to the data sheet of the hardware for detailed information.
- **Signal Processing in LabVIEW**—Includes the Biomedical VIs and other signal processing tools in LabVIEW. You can create customized VIs for processing biosignals and biomedical images and visualize the analysis results in LabVIEW.
- **Biomedical Workbench**—Ready-to-use applications for acquiring, pre-processing, extracting, and analyzing bio signals and biomedical images.
- **Actuator**—Devices that transform electrical signals into certain kinds of motion or into physical signals. You can use the analog or digital output channels of NI DAQ hardware to drive an actuator.

Generally the recorded ECG signal is often contaminated by noise, artefacts<sup>9</sup> that can be within the frequency band of interest and manifest with the similar characteristics as the ECG signal itself. In order to extract the useful information from noisy ECG signals, you need to process the raw ECG signals.

ECG signal processing can be roughly divided into two stages by functionality: pre-processing and feature extraction (as shown in fig). The pre processing stage removes or suppresses noise from the raw ECG signal and the feature extraction. Stage extracts the diagnostic information stage from the ECG signal [12].



**Figure 4:** Pre-processing of ECG signal

## 6. CONCLUSION

The work discussed here is to monitor the data of ECG using lab view. In it the system was implemented on Lab View 7.1. After collecting the ECG signal, it was pre processed to remove the

# INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY

*WINGS TO YOUR THOUGHTS.....*

noise and base line wandering and then extraction process takes place. The system detects any emergency condition automatically, if the patient develops any abnormality in his heart rate or irregularity in rhythm heart line and establishes direct connectivity between specialists and patient. This can be achieved by comparing the standard ECG signal with that of patient's. Further, for future scope this ECG signal can be collaborated with other signals such as temperature, pulse rate, etc. so as to acquire a detailed review about the patient's health.

**ASSOCIATED**

**PROBLEMS.**

**scst.org.uk**

**[11] ECG Based Biometrics Verification system using Lab view, Ankit Sharma, July 2009.**

## REFERENCES

- [1] "ECG- simplified Aswini Kumar M.D.". Life Hugger. Retrieved 2010-02-11.
- [2] Braunwald E. (Editor), **Heart Disease: A Textbook of Cardiovascular Medicine, Fifth Edition, p. 108, Philadelphia, W.B. Saunders Co., 1997. ISBN 0-7216-5666-8.**
- [3] Van Mieghem, C; Sabbe, M; Knockaert, D (2004). "The clinical value of the ECG in noncardiac conditions".
- [4] "2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care – Part 8: Stabilization of the Patient With Acute Coronary Syndromes". *Circulation* 112: IV-89 – IV-110. 2005.
- [5] Electro cardio gram explanation [image.nobleprize.org](http://image.nobleprize.org).
- [6] ECG lead placement- Normal Function of the Heart- Cardiology Teaching Package- Practice Learning – Division of Nursing- The University of Nottingham. [Nottingham.ac.uk](http://Nottingham.ac.uk). Retrieved 2009-08-15.
- [7] The standard 12 Lead ECG. [Library.med.utah.edu](http://Library.med.utah.edu). Retrieved 200-08-15.
- [8] "Einthoven's Triangle". [Library. Med. utah . edu](http://Library.Med.utah.edu). Retrieved 2009-08-15.
- [9] AHA Diagnostic ECG Electrode Placement. WelchAllyn
- [10] **RESTING 12-LEAD ECG ELECTRODE PLACEMENT AND**