A Low Cost Remotely Analysis of ECG Signal based on LabVIEW

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ABSTRACT
Electrocardiography (ECG) is a popular technique that is widely used to detect cardiac problems. One of the difficulties in developed countries is the lack of the number of specialists in heart diseases compared with the number of patients. Another problem is the high cost of ECG devices and medical services. This work helps to minimises the effects of these problems by development of a low cost ECG that can register and analyse the ECG signal of the patient. The ECG graph and the analysed data are sent to a remote expert for diagnosis by utilising diverse of communication technologies. In this work, the Internet is used as a low price and widely available technology. The history of the patient records is also stored in a cloud server. So the solution *is* characterized by being cheap, easy to use, and efficient for remote usage**.**

Keywords
ECG Analysis, Arduino, LabVIEW &IOT

1. INTRODUCTION
Cardiovascular diseases (CVDs) are the number one cause of death globally [1]. More people die yearly from CVDs than from any other cause. 17.9 million People died from CVDs in 2016, which is 31% of all global deaths. Of these deaths, 85% are due to stroke and heart attack. Developing countries account for more than three quarters of cardiovascular disease deaths. Out of the 17 million premature deaths (under the age of 70) due to non communicable diseases in 2015, 82% are in developing countries, and 37% are caused by CVDs. Most cardiovascular diseases can be prevented by treating behavioral risk factors such as smoking, injurious diet and corpulence, physical stillness and harmful use of alcohol [1]. Developing countries suffer from the lack of medical services and their high cost. In Egypt, the death from heart disease is five times other countries by 500 cases per 100 thousand Egyptians. CVD's account for 46% of total deaths in Egypt [1],[2]. CVDs are a frontier public health concern with significant social and economic implications in terms of healthcare needs, lost productivity and premature death [1]. The disease burden caused by CVDs in particular, is further fuelled by adoption of unhealthy lifestyles and eating habits. In fact, the incidence of CVD is fast shifting to the youth; a trend that's specifically prevalent in the capital city of Cairo and underserved urban communities where the lack of the number of specialists in heart diseases comparison with the number of patients [1]. In recent years several communication technologies such as Internet and mobile communication are widely used and their costs are continuously decreased. The advancement of electronic technology decreases the price of sensors and circuits. So, this work exploits these factors to develop a simple and low cost ECG. LabVIEW software is used to detect the ECG signal, reduces noise and extracts the ECG features [3]. The Internet is used as a tool to upload these data to a cloud for a further analysis and diagnosis by an expert [4]. Electrocardiogram (ECG) records electrical activity of the heart. During each heartbeat, a healthy heart has an orderly advancement of depolarization that starts with pacemaker cells in the senatorial node, spreads out through the atrium, passes through the atrioventricular node down into the pack of His and into the Purkinje fibers, spreading down and to the left throughout the ventricles [5] . This organized pattern of depolarization gives rise to the distinctive ECG tracing. For the trained clinician, an ECG transmits a large amount of information about the structure of the heart and the task of its electrical conduction system. Between other things, an ECG can be used to estimate the regularity of heartbeats [6], the size, and position of the heart chambers, the presence of any harm to the heart's muscle cells or conduction system, the effects of cardiac realty, and the function of implanted pacemakers. It is widely applied in the medical field, due to its noninvasiveness and its capability of detecting cardiac diseases. ECG is normally recorded in hospitals or clinical centers in which the patient needs to stay for hours or days. Portable or ECG telemetry devices have enabled patients to monitor their ECG. A normal ECG signal is shown in fig.1 [3] [7].Table (I) presents various components of the ECG signal and their function indications.
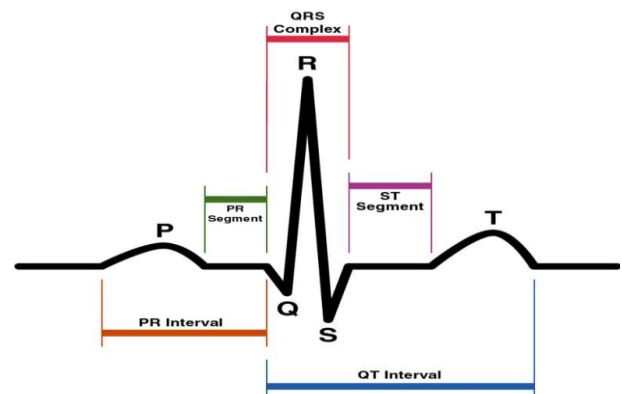

Figure (1) a normal ECG signal

Table (1) ECG signal components

P wave	represents the depolarization of the atria
PR Interval	It is a period that begins with the beginning of the p_ wave and ends at beginning the complex. It Is the period of the transmission of the impulse of the atrium to ventricle.
QRS Complex	represents the depolarization of the ventricles
ST Segment	Through which I know whether it is ischemia and infarction or not through a point called (J point).
J point	Is the junction between the end of QRS and the beginning of ST segment?
T wave	represents the repolarization of the ventricles
QT Interval	Electrically represents the entire ventricle. It represents the time taken for ventricular depolarization and depolarization. The Qt interval is the time from the start of the Q wave to the end of the T wave.

2. PROPOSED ECG SYSTEMS

Figure (2) shows the proposed ECG system block diagram. In the following, the function of each block will be explained. ECG electrodes sense the electric activity of the heart and transfer this activity to the ECG Arduino shield that's used for capturing, filtering, and amplifying the ECG signal [8]. Arduino board is used to transfer the ECG signal to a laptop. LabVIEW software is used to analyses the ECG signal to extract its numerical features. Internet is used to send the ECG signal with its associated features to an expert for diagnosis. The ECG signal records are stored on the cloud to be used by an expert to track the history of the case.
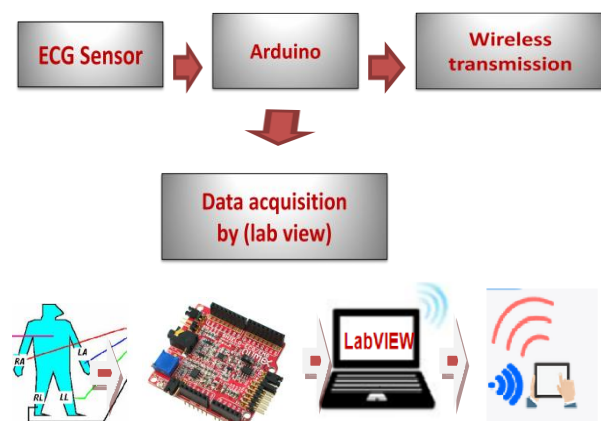

Figure (2) Proposed System

2.1 Labview ECG signal analysis

The ECG signal is analysed in several steps as shown in figure (3). First, 30 seconds captured ECG signal data is saved in an excel file. This excel file is converted to TDMS format [3] to be appropriate for analyses in the LabVIEW environment. Two digital filters are used to adapt the ECG

signal. The first filter is a low pass filter which is responsible for removing both the high frequency muscle artefact and the external interference. The second filter is a band pass filter which is used to remove disturbances caused by respiration and displacement of electrodes [9]. Finally, the ECG features such as the QRS complex, P wave, T wave, and ST segment are extracted. These features can be displayed or saved for later retrieving.
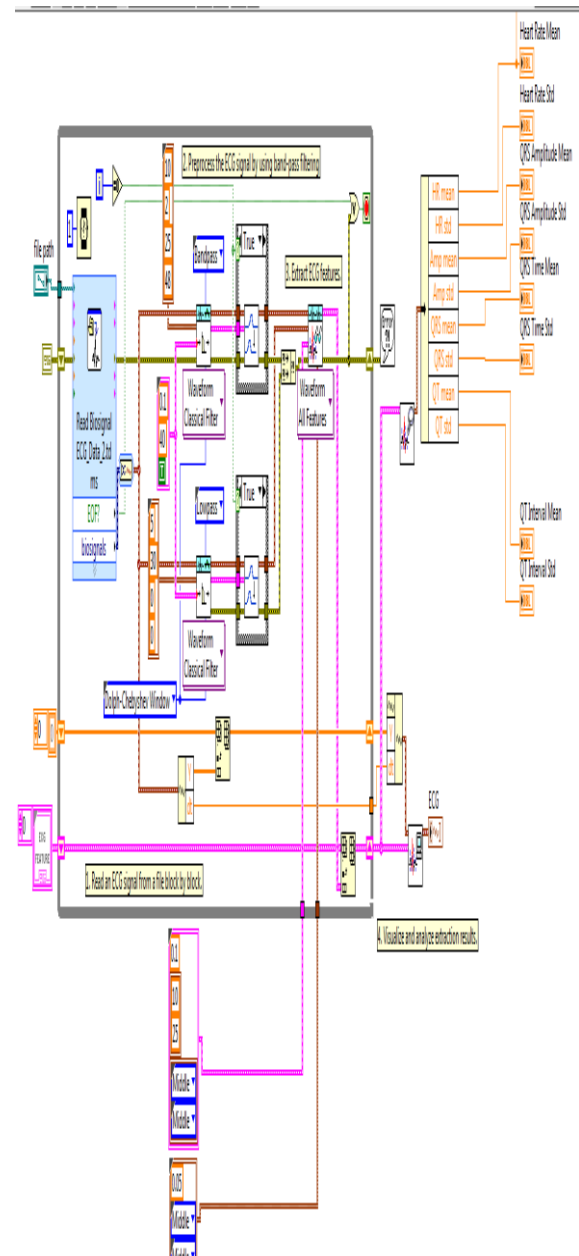
Figure (3) LabVIEW ECG signal analysis

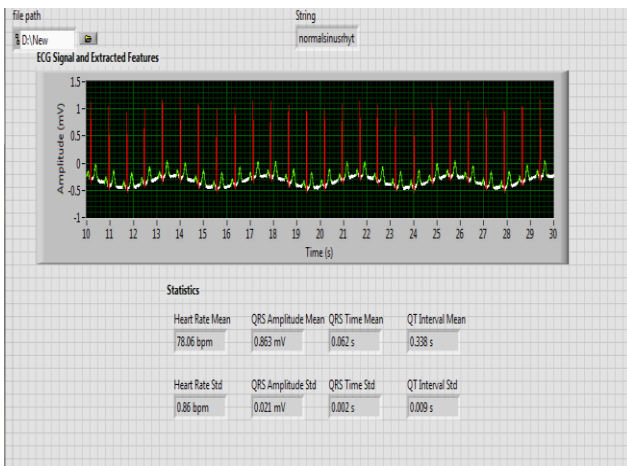## 2.2 Performance test and practical work

The performance test for the proposed work is divided into two main PARTS. Firstly, a predetermined data for different cases[10] is incorporated to the LabVIEW program at which data analysis is carried out. The analysis results of normal heart beat and quick heart beat s cases are show in figures (4) & (5) respectively. Typical ECG signatures are shown in table.2 and the heartbeats of Healthy Adults usually range from 60 to 100 PPM of for when the person is in a state of

REST [3] . The equation to calculate heart rate is given by [11] **Heart Rate = (1/RR Interval in sec.) * 60**

Table (2) Typical ECG signatures for clinical use [12].

Clinical signature Typical values (unit) Nominal limits (unit)	Clinical signature Typical values (unit) Nominal limits (unit)	Clinical signature Typical values (unit) Nominal limits (unit)
P width	110 ms	±20 ms
T width	180 ms	±40 ms
PR interval	120 ms	±20 ms
QRS width	100 ms	±20 ms
QT interval	400 ms	±40 ms
P amplitude	0.15 mV	±005 mV
T amplitude	0.3 mV	±0.2 mV
QRS amplitude	1.2 mV	±0.5 mV

Figure (4) Predetermined Normal heart beat

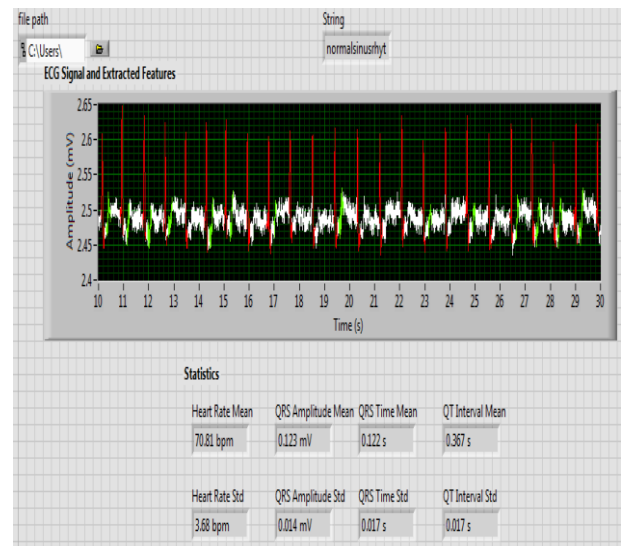**Figure (5) A Predetermined quick heartbeat**

Secondly, ECG signal recordings are taken directly from real persons. These recording are analysed by LabView program. These recordings with their associated analysis results are shown in figures (6) & (7) for normal heartbeat case and figs (8) & (9) for a quick heartbeat.
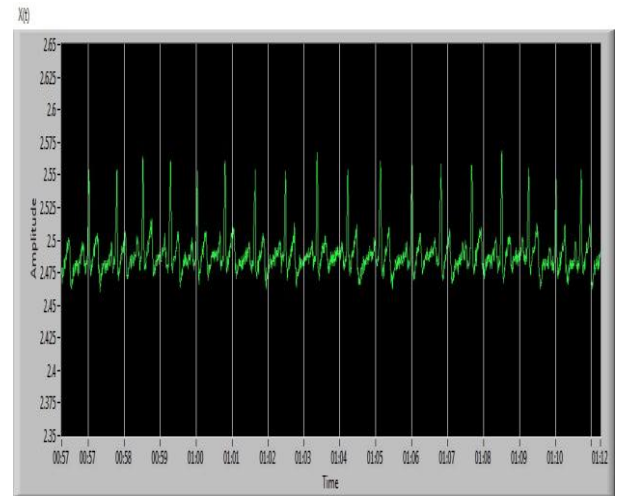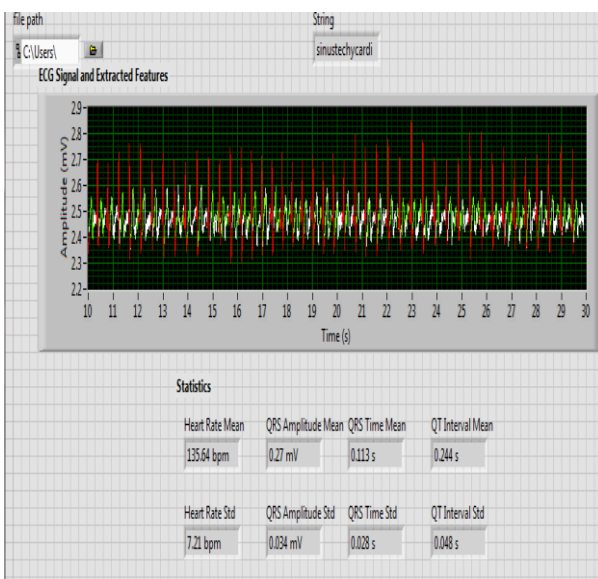

Figure (6) Normal heartbeat

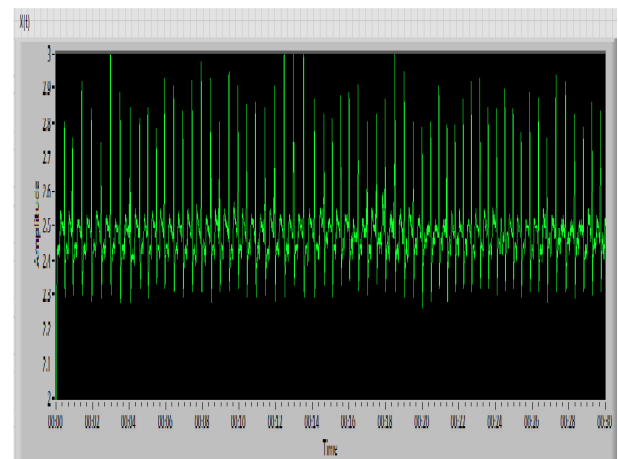**Figure (7) Normal heartbeat Analysis**
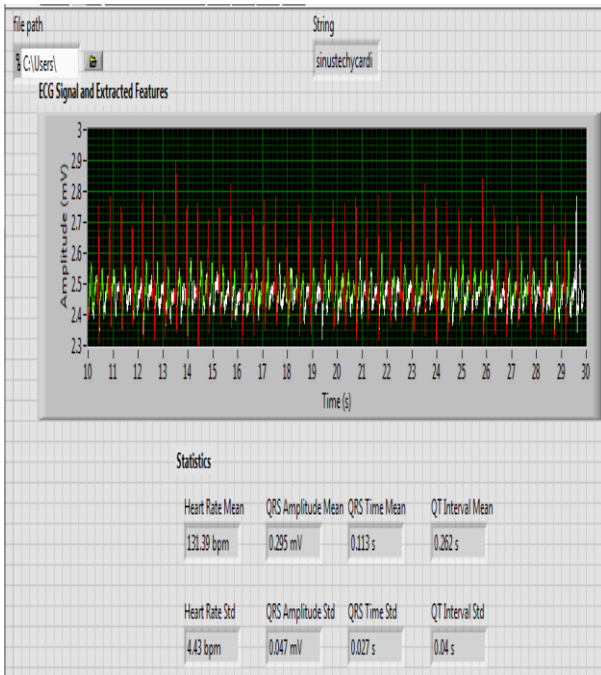

Figure (8) Quick heartbeats

Figure (9) Quick heartbeats Analysis

3. INTERNET DATA UPLOAD

Patient ECG recordings and the signal analysis results are uploaded to a cloud server. The patient doctor can access these data for diagnosis purpose [13],[14] . A web site has been built and its home page[15] is shown in figure.10 where several options are available. From patient option, either registering a new patient or presenting records of a registered patient is selected.

Figure 10 Website Home Pages

New patient page is shown in figure. 11 where the patient data is entered (Name, Address, Phone, Birthday, User name, Password).

Figure 11 New patients Page

Recorded Patients page is shown in figure. 12 This Page displays a Table that lists all the patients in the system and their data (ID, Name, Address, Phone, Age, and Start Date of their registration).

ID	Name	Address Rate	Phone	age	Start Date	Results	Report	Edit
1	walaa	shobra	010	3	2018-03-09 16:39:14	Results	report	manage
5	ali hassan	cairo - nasr city	012	15	2018-04-04 17:44:11	Results	report	manage
6	mahmoud	shobra	010	32	2018-04-04 17:48:17	Results	report	manage
7	adsvasd	sdvbdsv	0102231453	0	2018-10-15 22:49:43	Results	report	manage
8	mahmoud	darder	01022102603	2015	2018-10-17 16:08:56	Results	report	manage
9	omer	gfhgvi	00137865	0	2019-07-24 06:15:37	Results	report	manage

Figure 12 Show Patient Web Pages

From the table you can access a certain patient historical records (Heart beat rates, ECG signal graph and the result of ECG signal analysis) as show Figure. 13
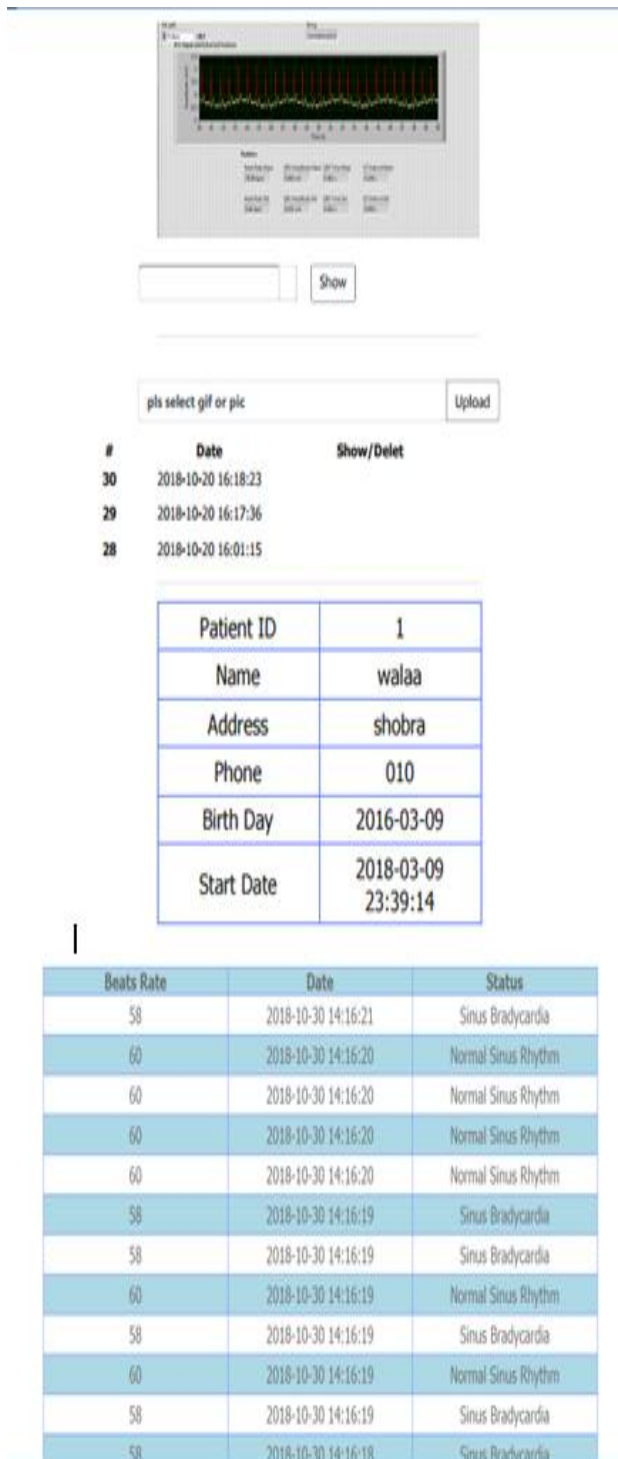
Figure 13 Records for a patient

4. CONCLUSIONS

In developing countries, the shortage of the number of skilled experts compared to population and the low economic income make a difficulty to provide health care services. The Cardiovascular diseases are the first cause of the globally death. The ECG is a vital and expensive tool for diagnosis and usually used in hospitals and clinical centers. Patients need to travel from remote location for this purpose. This work is an effort to tackle this problem by developing a low cost ECG system that can capture, analyze, and transfer ECG signal to a clinical expert remotely. The low cost is due to the use of a popular hardware which composed of an Arduino board and an ECG shield. LabVIEW software is used for ECG signal analysis. An Internet web site is constructed to upload, present, and store the ECG signal and its associated features. This helps in fast diagnosis especially for serious cases. The system can be adapted to use other popular communication technologies such as mobile communication. In the future, this system will be developed for preliminary automatic diagnosis.

5. REFERENCES

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