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ECG TRANSMISSION THROUGH RF

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ABSTRACT

An ECG signal is an important physiological signal being monitored by medical personnel to check the heart condition of a patient. ECG monitors, currently in use are bulky, wired and non portable requiring a series of wires run from patients' bed to the nurses' desk, regarded to be manual. Current trend of monitoring of bio-medical signals is toward more integration of data acquisition devices (such as ECG machines) with presentation devices (such as PCs, cellular phones) through the wireless means for on-line monitoring purposes. In this paper design and implementation of an ECG data telemetry system is presented which takes ECG signals from a simulator and sends it through a wireless connection to a nearby computer. Radio frequency transmitters are used and the received signal is interfaced to the computer through NI-Card. The ECG signal is displayed after passing it through a series of filters developed in the software tool of LabView. Through experiments frequency and attenuation responses are given to show to indicate that the proposed telecommunication system is robust and reliable.

ملخص البحث

تعتبرإشارة ال (اي سي جي) التي يتم مراقبتها من قبل الموظف الطبي إشارة فسيولوجية مهمة لفحص حالة مرضى القلب. مرشد ال (اي سي جي)، المستخدم في الوقت الحاضر حجمه كبير، وله توصيلات سلكية عديدة، ولايمكن تغير مكانه بسهولة، كما يتطلب عدة توصيلات بين سرير المريض، ومكتب الممرضة، بالإضافة إلى أن السيطرة عليه تتم يدويا. الاتجاه الحالي يميل أكثر إلى الحصول على الإشارات الطبية البيولوجية باستخدام أجهزة ال (اي سي جي) والمربوطة مع الادوات المساعدة مثل الحاسوب والموبايل بدون الحاجة إلى التوصيلات السلكية لغرض متابعة حالة المريض. تم في هذه الاطروحة تصميم، وتطبيق نظام ال (اي سي جي) والذي يأخذ الإشارات من المحاكي، ويرسلها إلى الحاسوب القريب بدون الحاجة الى التوصيلات السلكية. تم استخدام جهاز إرسال التردد الراديوي كما أن الاشارة المستلمة تذهب إلى الحاسوب خلال كارت (ان آي). إشارة ال (أي سي جي) تعرض على الشاشة بعد مرورها خلال مجموعة من المرشحات التي تم تطويرها في أدوات السوفت وير المسمّى "الاب فيو". تم خلال التجارب قياس التردد، وكثافة الاشعاع الالكترومغناطيسي للتاكيد على ان هذا النظام المقترح هو قوي وموثوق به.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Mechatronics Engineering.

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Sheroz Khan
Supervisor

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Innovation Centre

The dissertation was submitted to the Kulliyah of Engineering and is accepted as a partial fulfilment of the requirements for the degree of Master of Science in Manufacturing Engineering.

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Ahmad Faris Ismail
Dean, Kulliyyah of Engineering

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Kushsairy bin Abdul Kadir

Signature..... Date . …….

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DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

ECG DATA TRAMSMISSION THROUGH RF

Affirmed by Kushsairy bin Abdul Kadir

…….. ……..
Signature Date

In dedication to my parent,
beloved wife and children

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LIST OF ABBREVIATIONS

E.C.G.	Electrocardiogram
E.E.G.	Electroencephalogram
E.M.G.	Electromyogram
I.C.P.	Intercranial Pressure
W.M.T.S.	Wireless Telemetry Medical Band
I.S.M.	Industrial, Scientific and Medical Band
R.F.	Radio Frequency
R.T.U.	Remote Terminal Unit
N.I-D.A.Q	National Instrument Data Acquisition Card
C.MR.R.	Common Mode Rejection Ratio
A.M.	Amplitude Modulation
F.M.	Frequency Modulation
P.M.	Phase Modulation
A.D.C.	Analog Digital Converter
P.X.I.	PCI eXtensions for Instrumentation bus
G.U.I.	Graphical User Interface

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

An electrocardiogram (ECG) is a recording of the electrical activity captured on the body surface generated by the heart. Skin electrodes are placed at designated locations on the body collect ECG measurement information. An ECG signal is characterized by six peaks and valleys, labeled with successive letters of alphabets P, Q, R, S, T and U. An ECG signal is used by medical personal to determine the conditions of the human heart. This is done using ECG monitors. ECG monitors are used to look after varying heart conditions in order to get an insight into existing problems or to help predict impeding problems.

An ECG machine must be able to deal with extremely weak signals ranging from 0.5mV to 50mV, combined with a DC component of up to ± 300mV resulting from electrodes skin interface and a common mode component of up to 1.5V resulting from potential between electrodes and ground. The bandwidth of the signal is in the range of 0.5Hz to 100Hz. Typically an ECG machine has 12 or 3 electrodes to be connected to the patient body. The types of electrode used are pre-gelled electrodes or suction cup type electrodes. The electrode is placed on the plane of body and signals are the result of various combinations of electrodes. An ECG machine acquires the signal and displays it on screen. If a medical personnel needs to analyze ECG pattern it is printed out using a thermal paper. Some of the newest ECG machines have storage capability and so a signal can be transferred to a PC via a serial cable or while

some other machines have provision to manually download the ECG data using USB port.

Research has been carried out over many years on the development of technique for the radio frequency (RF) telemetry to eliminate the need of wired and human intervention in sending an ECG signal from a patient ECG machine to a PC. It is with this aim the project is undertaken to provide a solution of transmitting the ECG signal via a wireless link. The advantages of this solution are many, for example; it can reduce the size of the machine, and also once connected to the PC there are many possibility that can be done for analysis and manipulation of ECG signal such as display the signal over an internet.

1.2 PROBLEM STATEMENT

ECG signals are vital parameter that being used by medical personnel to diagnose hearts conditions of a patient. The current practice of acquiring and monitoring the signal are more or less wired and manual. Most ECG machines in hospital use a thermal paper to record ECG pattern for the purpose of analysis by medical personnel. The latest ECG machine has memory capability but the transfer of ECG data is done via a serial cable, some of these monitors have USB ports and one has to download the data to a nearby computer. Another disadvantage of current ECG systems used in hospital is that its display is on the CRT of the ECG machine. These machines are bulky and fixed to the wall or to a monitoring station thus make the machine non-portable. For a standard practice where patients with heart conditions are monitored every 1 to 2 hours for unusual heart rhythms using ECG monitor, nurses need to go from patient to patient dragging the station with them.

Therefore, This work will concentrate on acquiring ECG signal from a patient and to transmit the signal automatically to a PC using a wireless link. The medical personnel can then monitor the ECG signal and patient vital sign can be logged onto a central workstation and saved for the purpose of analysis. With elimination of cables and wire and also reduction of size of the ECG machine patients with less severe condition need not to be bedridden with the portable ECG machine.

1.3 PROPOSE APPROACHES

This thesis aims at building an ECG system that can transmit the ECG data from the local terminal to a remote PC via wireless link. This is achieved by using a RF transmission to transmit the data to the centrally monitoring terminal. Generally the system can be broken into three main phases:

- ECG signal acquisition and conditioning
- Data transmission and Receiving
- Displaying the ECG signal at a remote terminal

Firstly a signal is generated from an ECG simulator that will simulate signal of a patient, the signal generated by the simulator is in the range of 40mV. This is the range of ECG signal generated at the surface of human body. Then, the signal is acquired and amplified to the required level using an instrumentation amplifier for transmission. The signal is then modulated using frequency modulation technique before being transmitted using a RF transmitter. The acquisition and transmitting side of the ECG system is going to be battery operated. The signal is then received by RF receiver and demodulated first before it is sent to a National Instrument Data Acquisition Card (NI-DAQ) in the PC.

Then the signal is converted from analog to digital form using built in ADC. Lastly LabVIEW software is used to process the signal and then display the signal on the screen using virtual instrument of the LabVIEW. The virtual instrument will display the filtered and unfiltered signal for comparison purposes.

1.4 OBJECTIVE OF THE THESIS

The main objective of this thesis is to design and implement ECG data transmission through RF and display the signal on a PC at a central workstation. The second objective of the thesis is to acquire the signal at the central workstation and condition the signal to get a good representative of ECG terminal on the graphical user interface. This is to overcome the current ECG data transmission system where the nurse need to go from one patient to one patient to record the ECG signal on thermal paper, by a wire using a serial cable or by manual download using USB port.

1.5 THESIS STRUCTURE

The document introduces the broader problem of health monitoring in Hospital. The thesis provide details of the design and implementation of a system that addresses the problem of section 1.1 and whose general solution is given in section 1.3. The purpose method is an alternative to the current ECG monitoring system that is implemented in the hospital. The chapters are classified as introduction, literature review, methodology, results and discussion and finally conclude with conclusion and recommendation.

Chapter 1 is the introduction, brief information about the whole work and objective of each section.

Chapter 2 is the literature review; it discusses some of the background ideas, such as on the function of human body and the understanding of biological signal, specifically the ECG signal, sensors and transducer for capturing the signal, and descriptions of other types of ECG system. It also discusses on the INTERNET technology in patient health care and comparison was also made on past and current research and development on the topic.

Chapter 3 is the methodology. It discusses the method followed to develop and implement the system along with the necessary requirement. It shows how the signal is acquired and the types of suitable sensors, amplifier and the filtering requirement to be integrated with the LabVIEW.

Chapter 4 delves into the implementation of the system. It shows simulation and experimental testing that have been done. The results obtained by this work are discussed in this chapter. It also shows how the system works.

Chapter 5 concludes by discussing on the significance of the finding and give recommendation for future work. This chapter shows how the system is properly working and how to improve it in the future.

CHAPTER TWO

LITERATURE REVIEW

2.1 BIOLOGICAL WAVEFORM

Biological waveforms are time-varying biopotentials, representing electrical activity corresponding to bodily functions, which can be measured on the body's surface. We can monitor a patient by acquiring and transmitting desired biological waveforms. Electrocardiogram (ECG) is one of the most commonly monitored biological waveforms.

2.2 ELECTROCARDIOGRAM (ECG)

The rhythmic behavior of heart can be monitored and used as a diagnostic tool to detect heart abnormalities by acquiring electrical activity on the body surface, across the heart, known as ECG. This electrical activity originates from electrical activation of muscles in heart, inherently indicating a sort of mechanical motion. The electric potentials generated by the heart appear throughout body and can be measured across its surface. Figure 2.1 displays a typical ECG waveform which, is characterized by five peaks and valleys labeled in with the successive letters P, Q, R, S, T and U [1]

The following table highlights ECG sections and what they indicate:

Table 2.1
Electrocardiogram Basic Characteristics

Section of Electrocardiogram	*Source*
P-Wave	Atrial Excitation
QRS-Complex	Atria repolarization + Ventricle depolarization
T- Wave	Ventricle repolarization
P-Q Interval	Excitation timing delay

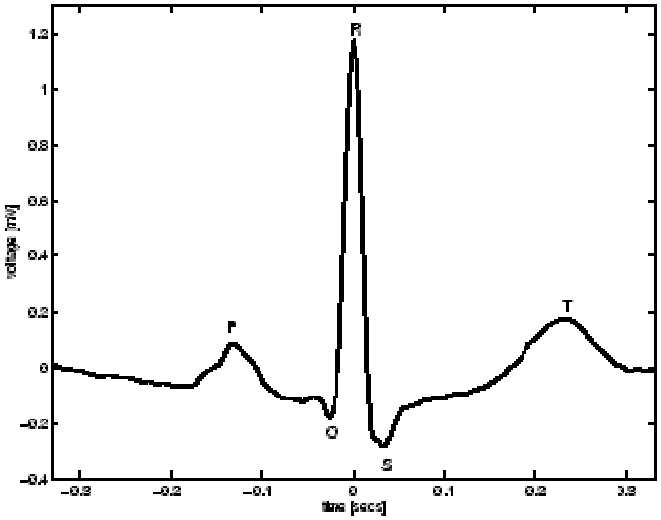

Figure 2.1: One Cycle of ECG signal

To perform a clinical ECG, it is important that one lead (also known as channel) be recorded in order to accurately describe the heart's electrical activity. There are two planes in which these leads may lie: the frontal plane (the plane of the body that is parallel to the ground when one is lying on one's back); and the transverse plane (the plane of the body that is parallel to the ground when one is standing erect). For three channels ECG, only the leads in the frontal plane are required. The frontal plane of an ECG consist of three basic leads, as can be seen in Figure 2.2. These leads are the