# GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES
## APPLICATION OF ECG IN HUMAN COMPUTER INTERACTION SYSTEM

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## ABSTRACT

This paper discusses the Design & Analysis of Monitoring of Electrocardiogram (ECG) and Electromyography(EMG)Signal.The electrocardiogram (ECG) and electromyography (EMG) is an important physiological signal that helps determine thestate of the heart rate measurement system& muscular system. Baseline wander is a commonly seen noise in ECG& EMG recordings and can be caused by respiration, changes in electrode impedance, and motion.It can mask important information from the ECG & EMG, and if it is not properly removed, crucial diagnosticinformation contained in the ECG & EMG will be lost or corrupted. extraction.By using high pass filter baseline wander (drift) removal will be done which blocks the drift and passes all main components of ECG though the filter. However, It requires the cut-off frequency of the high-pass filter be set higher than the lowest frequency in the ECG. Thereforementioned simple approach for baseline removal distorts and deforms the ECG & EMG signals.

*Keywords-* *Electrocardiogram (ECG), Surface Electromyography (EMG), Motor System, Matlab.*

## I. INTRODUCTION

Nowadays, the volume of Electrocardiogram (ECG) recorded inhospitals is as the peoplesuffering from heart diseases are increasing at an alarming rate. The ECG is one of the medical equipment that can measurethe heart rate, convert it into a signal and present the data on a piece of paper or on a monitor. An ECG is arecording of the electrical activity on the body surface generated by the heart. ECG measurement information iscollected by electrodes placed at designated locations on the body. It is the best way to measure and diagnose abnormal rhythms of the heart , particularly abnormal rhythms caused by damage to the conductive tissue that carries electrical signals, or abnormal rhythms caused by electrolyte imbalances.Chronic conditions are becoming first problem of public health in western countries. This situation is the result of changing demographic trends and population aging, changes in consumption patterns, rapidurbanization and social disintegration and the globalizationof health issues. The economic costs associated to the treatment of these patients are a burden that not only threatens the sustainability of health systems but alsoimposes challenges to the patients and their families. Our current healthcare structures, too focused in the healing of acute conditions, do not facilitate the management ofchronic patient. New emerging models of health care provision for chronic patientstake allthese components into account to achieve productiveinteractions between informed activated patients andproactive practice teams .Within the project, the chronic patient model will correspond toeither Chronic Pulmonary Obstructive Disease or Congestive Heart Failure or both.The focus will be set in the monitoring facilities of the different vital signs to ensure adequate follow-up at a distance. To this end, the URSAFE linked to a Portable Base Station (PBS) through UWB (Ultra Wide Band) techniques. Each sensor will include software for signal processing and alarm management; it has been agreed that a regular poll coming from the UWB associated to each sensors will regularlycheck if an alarm has been set at the sensor SW module. In case an alarm has been effectively raised, the UWB module then initiates the transmission scenario between the local monitoring network and the medical service center by using different transmission bridges that are the PBS and either indoor or outdoor dedicated networks.

## II. METHOD USED

The first step of the proposed methodis an adaptive notch filter, designed to form sub signals of the ECG which is shown in Figure 1 as a framework of proposed method.

The proposed method utilizes ICA to remove the baseline drift. Considering the noisy nature of the typical raw ECG signal, sub signals in low frequencies of the ECG are formed and these filtered signals are then formed by an adaptive notch filter, and then used as the input to the ICA algorithm. The ICA requires multichannel signals to process as its input, in order to use ICA to remove baseline wander, one needs to build multichannel signals ECG. In order to address this issue in the proposed method, a systematic process was created in addition, as shown in Figure 1, theindependent component formed by the ICA as the output, which is originally labeled as the baseline wander, needs to be further adjusted to form a better estimate of the baseline wander. This is due to the fact that, while one of the components resembles the baseline drift, it is unlikely that any of the original components detected by the ICA is"purely" the baseline wander. The specific steps shown inFigure 1 are further described below:

(a) Form sub-signals of ECG using an adaptive notch filter:The adaptive notch filter is designed and customized to form the sub signal. Due to its flexibility as well as itsrelatively superior performance the adaptivenotch filter is using. As mentioned above, applying the ICA algorithm on a sub-signal of the ECG has the advantage of reducing the errors coming frommulti-channel signals in estimating the baseline wander.

(b)Construct multi-channel signals: applying ICA requires that the signals are multi-channel ones. However, in many ECG processing applications only the single-channel ECG signal is available and/or processed. The proposed method applies the methodology toconstruct multi-channel signals by delaying the single-channel signal. In our study, the multi-channel signals are constructed using sixty signals, which are delayed 10 sample points (83 ms) of the original signal in succession.

(c) Adjust the baseline wanders extracted by ICA:

The baseline wander extracted by ICA is an approximation of the true baseline wander because

(1)There will be some errors in the resulting component due to the fact that the estimation process   may be non-optimal.

(2)In the ICA analysis there may be more than one maximum in the estimation function and, therefore, the true baseline wander may not be located accurately,

(3) The constructed multi-channel signals cannot convey all information about the baseline wander and, as such, the proposed process mayalleviate the issues associated with the non-optimalconstruction of multi-channel signals.
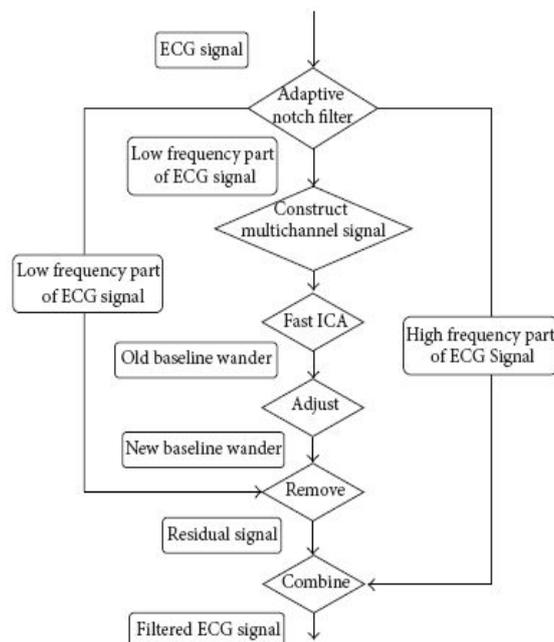


**Figure 1: Flowchart diagram of proposed method.**

## III.  INDEPENDENT COMPONENT ANALYSIS(ICA)

Independent component analysis (ICA) is a statistical and computational technique for revealing hidden factors that underlie sets of random variables, measurements, or signals. ICA defines a generative model for the observed multivariate data, which is typically given as a large database of samples. In the model, the data variables are assumed to be linear mixtures of some unknown latent variables, and the mixing system is also unknown. The latentvariables are assumed non gaussian and mutuallyindependent and they are called the independent components or sourcesof the observed data. ICA is superficially related to principal component analysis and factor analysis. The data analyzed by ICA could originate from many different kinds of application fields, including digital images document databases, economic indicators and psychometric measurements. In many cases, the measurements are given as a set of parallel signals or time series; the term blind source separation is used to characterize this problem. ICA is a much more powerful technique.Typical examples are mixtures of simultaneous speech signals that have been picked up by several microphones, brain waves recorded by multiple sensors, interfering radioarriving at a mobile phone, or parallel time series obtained from some industrial process.

## IV. MEDICAL REQUIREMENT CONSTRAINT

The present document focuses on the definition of the signal processing needs for the development of tele-monitoring applications. This task shall include in complementary way, both medical requirements as well as technical feasibility. The following sections adopt a medical point of view and provide basis for drawing the technical system specifications. It has particularly led to some adaptation of the initial system architecture and has orientated the signal processing application SW. The updated medical aspects of the context ; it will help to define a first stage for the signal processing activity specifications. The sensors of interest and the associated biomedical data in the scope of this study are the baseline-selected devices. But as we will further underline, the most demanding signal from both medical and technical points of view is the ECG. First we will highlight the "medical" objectives of an automated monitoring, that is to say what kind of events have to be analyzed, detected, and recognized. Then with the clarified medical objectives in the scope of URSAFE we will present the steps followed for the signal processing activity study. This part will finally help support the technical specification of the software modules dedicated to biomedical data monitoring.

## V. MEDICAL SUPPORT PROVIDED THROUGH

**The Use of wearable & Continuous**
**Monitoring Devices**

The efficiency of the whole URSAFE concept from medical cost reduction as well as patient way of life improvement has been proved in deliverable D1. Particularly focusing on the signal processing activities, we have to detail some fields of application of the system. This section recalls in which situations this system could be required to satisfy the two initial objectives of the project: hospitalization costs reduction and patient quality of life by avoiding visits to the hospital.

## VI. CASE STUDY

**Case 1**
After a by-pass heart operation, the patient comes at home after some days and earlier than she/he would have been back without the use of the U-R-Safe platform. The continuous monitoring at home allows during the initial dates the rhythm of the evolution to be continuously monitored. A nurse comes from time to time to the home of the person to assure her/him. When the person does not feel comfortable a first contact is established with the voice processing system. A series of simple but critical questions is set by the machine and answered by the person. This information is transmitted to the Hospital or other Medical Service and the Medical doctor in charge of the case decides either to send the emergency or to settle the case by phone. After some days of home follow-up the person can quit her/his home and drive a normal life: visit family, shopping, travelling. The whole system is following her/him: the communication is conducted outdoors via the GPRS system. To avoid excess transmission of data, automatic transmission is triggered on events or manually when the person feels less comfortable. The same procedure based on voice processing is also followed in the outdoors case. By doing so for the first several weeks after the operation the person is better followed up (continuously) with lower cost (the hospital bed cost for 2-3 days versus monitoring for several days – presently precursor services come with costs of the less than 2 Euro per day, that even for weeks of monitoring is considerably lower than the cost of a hospital bed for 2-3 days).

**Case 2**
A diabetic person is in rural area. A satellite communication system is the means to establish the contact to the home of this person. In a normal case the personal base station is measuring diabetes. At a certain moment a case of hypoglycemia appears. Then the Satellite Communication is activated. According to the position of the home either a confident neighbour is invited to come or the emergency service (that can be in this case the rural medical doctor or helicopter help). Again information gained through the voice processing before collapse and glucose automatic measurements are fed to the Service center..Electromyography is a muscle examination method which tracks and interprets electrical activity that provides to muscle contractions. Surface electromyography (SEMG) is widely used as a diagnostic tool in estimation of muscle strength, calculation of muscle fatigue and ergonomics, sports physiology and rehabilitation. Obtaining and examining carefully EMG signals provide valuable information in determining and examining abnormalities in the muscle and motor system. In this research, a computer based, instrumentation system has been designed for EMG signals which are taken from the patient's arm muscle. The aim of the hardware is to provide, transfer to computer and view the EMG information of the patients received over the USB port. The essential hardware and software was created to perform the system. On the phase of obtaining the signal,EMG signals that were received from the surface

electrodes over the patient's arms have been subjected to various filtering and amplification processes to transport from the transmission channel to the environment that the signal will be displayed. The EMG signal was translated from analogueto digital and was transferred to the computer with USB. According to my research: (i)Facialexpression and human emotion analysis, (ii) Eye movement and gaze tracking, (iii) Speech recognition and synthesis ,(iv)Virtual reality interaction,(v) Driver assisted multimodal interface. Noisecan compromise the extraction of some fundamentals. Baseline wander in electrocardiogram (ECG) signals is one such example,which can be caused by factors such as respiration,variations in electrode impedance, and excessive body movements. Unless baseline wander is effectively removed, the accuracy of any feature extracted from the ECG, such astiming and duration of the ST-segment, is compromised.

This paper approaches this filtering task from a novelstandpoint by assuming that the ECG baseline wander comes from an independent and unknown source. The technique utilizes a hierarchical method including a blind source separation (BSS) step, in particular independent component analysis, to eliminate the effect of the baseline wander. Weexamine the specifics of the components causing the

baseline wander and the factors that affect the separation process. Experimental results reveal the superiority of the proposed algorithm in removing the baseline wander.

## VII. CONCLUSION

An ECG dataset of human volunteer undergoing lower body negative pressure (LBNP) as a surrogate of hemorrhagewas employed to verify the effectiveness of removingbaseline wander. This data set was created underInstitutional Review Board approval. The LBNP dataset consisted of a total of 91 subjects. Each subject had a single vector lead ECG recording collected at the sampling rate of 500Hz. The baseline wander in ECG signals demonstrated significant level of variations in the amplitude over the course of the LBNP experiment. During LBNP, subjects areexposed to increasing negative pressure to their lowerbodies. This causes a redistribution of blood volume to the lower extremities and abdomen causing a decrease in blood pressure and cardiac output and resulting in an increased respiratory rate. The results of the proposed method are compared with a reference method, called robust locally weighted regression , which is often treated as one of themost robust and commonly used methods to remove baseline drift. .
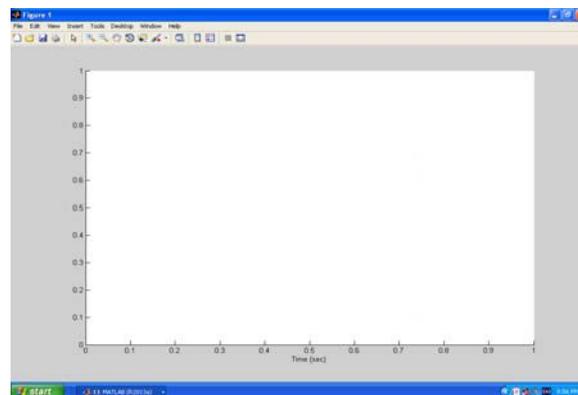
## VIII.   ECG ANALYSIS RESULT
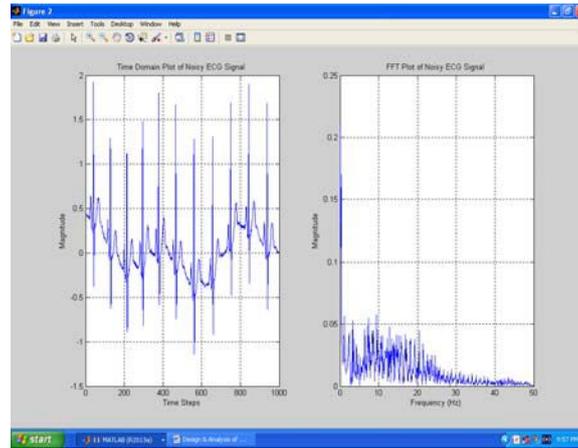


**Figure 2: Schematic diagram of proposed method**

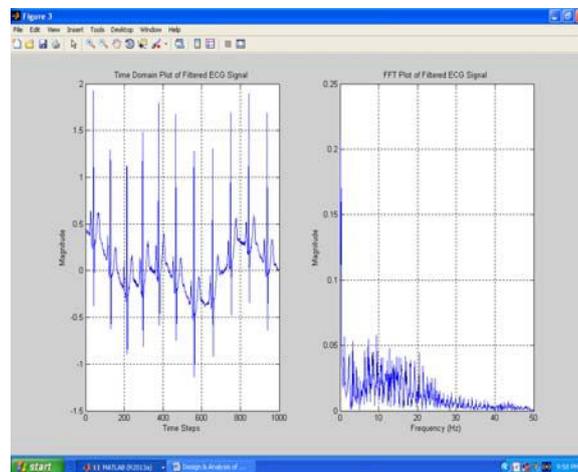**Figure 3: Schematic diagram of proposed method**



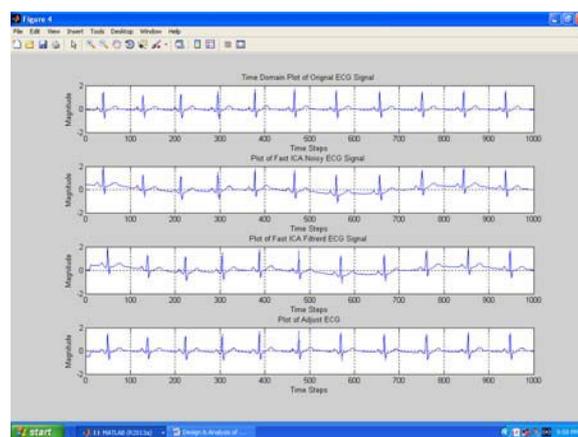**Figure 4: Schematic diagram of proposed method**



**Figure 5: Schematic diagram of proposed method**
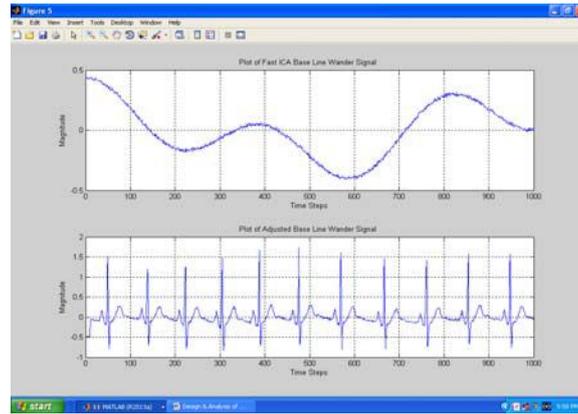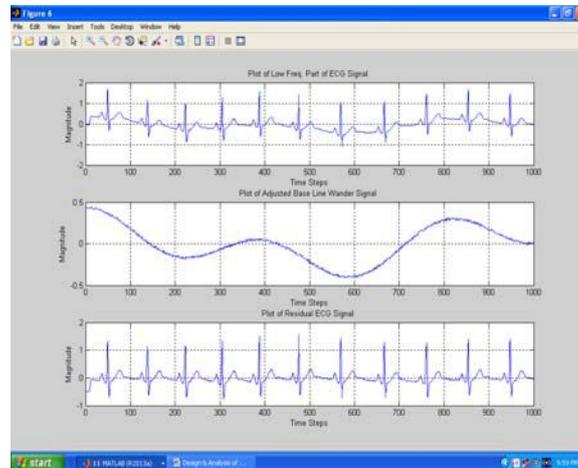
**Figure 6: Schematic diagram of proposed method**



**Figure 7: Schematic diagram of proposed method**
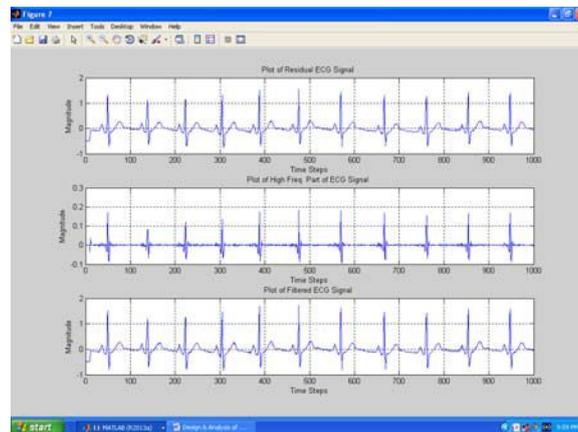


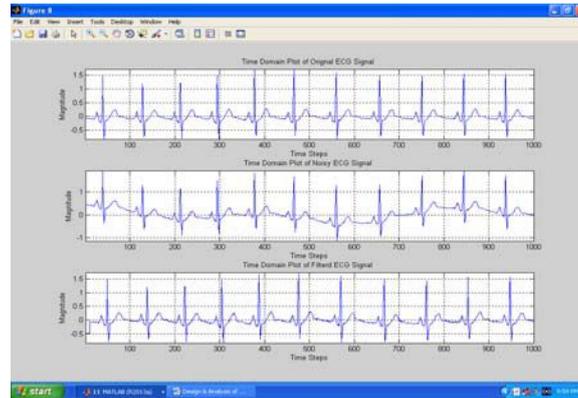**Figure 8: Schematic diagram of proposed method**

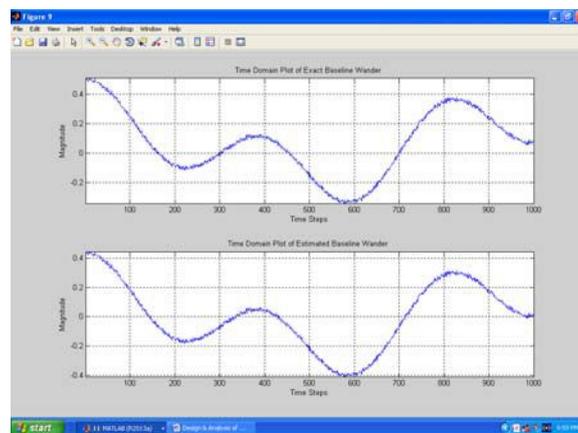**Figure 9: Schematic diagram of proposed method**



**Figure 10: Schematic diagram of proposed method**

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