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# Peak Detection for Discrimination of False Arrhythmia Alarm in ICU Using ECG Signals

DR. S. MARY PRAVEENA [1], R.M.VYSALI [2], D.SAKTHISNEKA [3], M.PRAVEENA [4]
[1, 2, 3, 4] *Final Year ECE, Sri Ramakrishna Institute Technology, Coimbatore, India*
DR. VIKNESWARAN VIJEAN[5]
[5]*School of Mechatronic Engineering, University Malaysia Perlis, Malaysia*

***Abstract-*** ***The False Arrhythmia alarm is the insignificant alarm caused by the monitoring systems. This project is proposes an algorithm that is capable of distinguishing arrhythmia into true and false alarm events accurately .The Electrocardiogram signals is pre processed to remove the common noise like baseline wander, trends and the pacemaker spiking. The feature extraction process is done by fast independent component analysis and principle component analysis methods. The peaks of the ECG signal R wave is detected by using the Pan Tompkins algorithm. This paper proposes the peak detection process in the ECG signal. This project uses various methods to reduce the occurrence of false alarms in emergency unit using the ECG Signals.***

***Indexed Terms -- false alarm, ECG signal, peak detection***

## I. INTRODUCTION

False arrhythmia alarm is the insignificant alarm caused by the existing monitoring instruments that are with an algorithm that sets off alarms in high decibel sounds. This paper proposes an algorithm that is capable of distinguishing arrhythmia into true and false alarm events accurately .The Electrocardiogram signals is pre processed to remove the common noise like baseline wander, trends and the pacemaker spiking. The feature extraction process is done by fast independent component analysis and principle component analysis methods**.** The peaks of the ECG signal R wave is detected by using the Pan Tompkins algorithm. This paper uses various methods to reduce the occurrence of false alarms in emergency unit using the ECG Signals. The purpose of this project is to develop algorithms to lower the incidence of false arrhythmia alarms in the ICU using information from independent sources, namely electrocardiogram (ECG), arterial blood pressure (ABP) and photo plethysmogram (PPG). This approach relies on robust adaptive signal processing techniques in order to extract accurate heart rate (HR) values from the different waveforms.

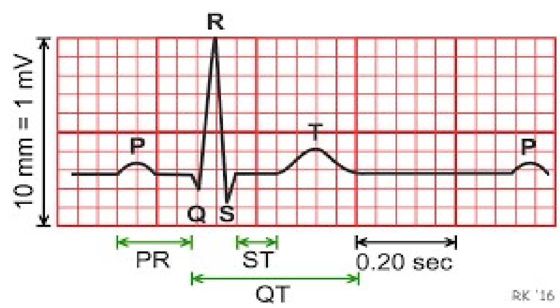



Fig. 1: ECG Signal Representation

## II. PROBLEM STATEMENT

The main problem is stated as the false alarm rate in ICU always gets a constant attention. The unnecessary alarm noise that are being exposed by the monitors capable of causing excitation of nervous system leads to intense cardiac work causing difficulties on muscle function. Not only this is the major cause these noises from frequently occurring false alarms had also lead to the conditions such as increase in cortisol hormone levels due to repeated number of alarms, sleep deprivation, impaired wound healing and mental distress of the patients. The target is to develop an algorithms to lower the incidence of false arrhythmia alarms in the ICU using information from independent sources .Our algorithm uses pulsatile waveforms and simultaneous ECG in order to detect and enhance the determination of the life-threatening arrhythmia alarms. Eventually leading to the establishment of better algorithm that can be implemented into hardware in future.

## III. OBJECTIVES

- To develop and describe a robust false arrhythmia alarm reduction system for use in the ICU.
- To analyze several signal quality assessments to remove and identify the effects of noise and others artifacts.
- To identify suitable segmentation methods to extract the part of ECG signals
- To carry out feature extraction process to get proper feature to be analyzed and used in classification process.

## IV. ARRHYTHMIA

An arrhythmia is abnormal heart rhythm. It may feel like fluttering or a brief pause. it may be so brief that it doesn't change your overall heart rate to be too slow or too fast. some arrhythmias don't cause any symptoms. Others can make you feel lightheaded or dizzy. There are two basis kind of arrhythmia.

1. Bradycardia is when the heart rate is too slow- less than 60 beats per minute.
2. Tachycardia is when the heat rate is too fast - more than 100 beats per minute.

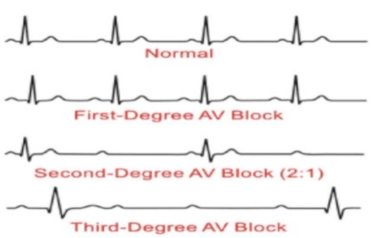



Fig. 2: Arrhythmia signals of abnormal heart rate

## V. CAUSES OF FALSE ALARM:

An alarm is an automatic warning that results from a measurement, or any other acquisition of descriptors of a state, and indicates a relevant deviation from a normal state. False alarms are conventionally defined as alarms without clinical or therapeutic Bsorry'-logic: A large number of false alarms are accepted rather than risk missing one valid alarm. Alarms can be differentiated into technically correct, technically false and clinically relevant, clinically not relevant. Alarms can be classified as technically correct, if they are based upon a technically correct measurement. Technically false alarms are not based on a technically correct measurement. Because not all technically correct alarms are clinically relevant, they can be further differentiated into clinically relevant or not relevant. The main cause for the false alarm in the emergency unit is various fluctuation and noises created within the signals. Also improper maintenance of monitoring systems. This leads to miscaring of caretakers. As this is very big disadvantage , the reduction of the false alarm plays a major role in medical services.

## VI. PRE-PROCESSING IN ECG SIGNAL

Pre-processing is the crucial stage of this paper as most of the false arrhythmia alarms was claimed as due to the presences of artifacts and power line inferences. The noises in the signal is the primary focus as the same signal source to be used in this paper, therefore the algorithm to be developed should have the best signal that has to be processed. The noises like baseline wandering, flat line artifacts, and pacemaker spikes are removed

## VII. DETECTION AND REMOVAL OF NOISE

Heart disease is one of the significant reason of death worldwide, the effective ways to diagnose heart disease is the electrocardiogram (ECG). The electrical functioning of the heart is translated into a waveform is utilized to find the condition of the heart. This paper deals with the ECG noise removal and its analysis in MATLAB environment. This work includes ECG analysis consisting of three main basic steps. The first step is collecting the sample ECG signals. The sample ECG signal has various kinds of noise such as power line interference, baseline drift, patient electrode motion. The second step is elimination of these noises from the signal. The third step is development of algorithm for finding various peaks and detection of intervals between those peaks in MATLAB environment.

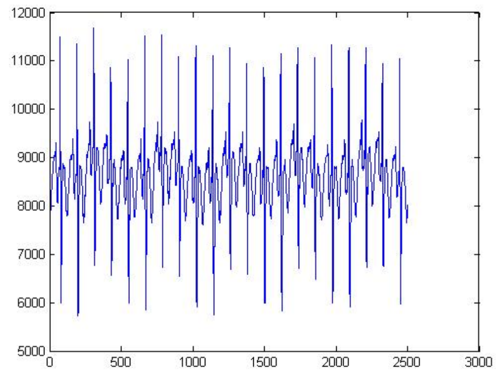
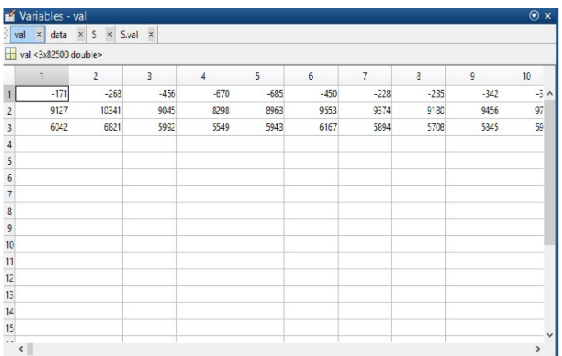



Fig. 3: Noise detected Signal Output



Variables - val

val | data | S | S.val

val <3x82500 double>

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -171 | -263 | -456 | -670 | -685 | -450 | -228 | -235 | -342 | -3 |
| 2 | 9127 | 10341 | 9045 | 8298 | 8963 | 9553 | 9374 | 9130 | 9456 | 97 |
| 3 | 6042 | 6821 | 5992 | 5549 | 5943 | 6167 | 5894 | 5708 | 5345 | 59 |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |

Fig. 3.1 Database of ECG sample signals

## VIII. PEAK DETECTION PROCESS

The Noise is first removed from the original signal to a smooth filtered signal. After certain preprocessing stages the main segment of peak detection is done. In peak detection process the threshold value of each sample signal is set for detecting the various peak like R Peak, S Peak, Q Peak, P Peak, T Peak respectively. The peaks are detected from the smoothened signal, and thus here the sample signals are smoothened first and threshold values are set at 45 percent of the maximum value as per assumption. The sample signal taken has the threshold value of 0.45 at the maximum based on the height of the signal. The signal which exceeds the maximum value will be considered as the peak values of the particular signal respectively. The position of each of the peak values is stored whenever they meet each other at their intervals. The heart rate of the sample signal is computed from the following peak detected signal, this process of computation is needed for detecting the variations in the heart rate which is called as heart rate variation. The signals are further decomposed from the original signal. This process is done by using the coefficient of wavelets used in decomposition.

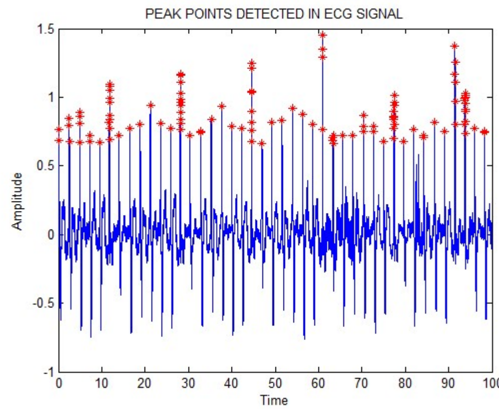



Fig. 4: Peak points detection

The variation of heart rate is computed in linear form to view the separate heights of the sample signal and to detect the peak based on the heights. The following output sample signal represents the variation in heart rate by decomposition of the signals from the original signal.

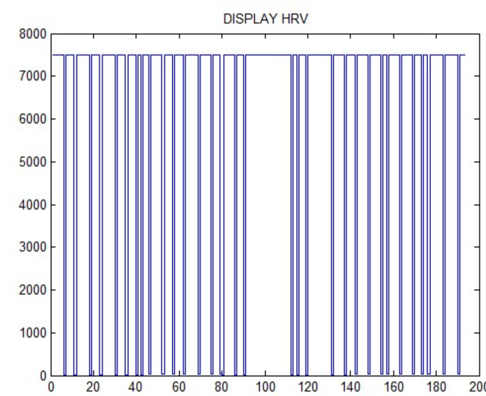



Fig. 4.1: Decomposition of peak signals

Here the conditions for the occurrence of R Peak are given in the code and thus the result of R peak detection is shown below.

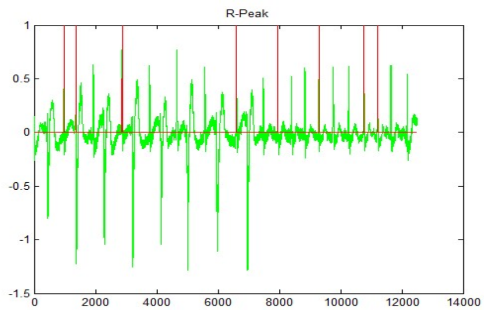



Fig. 4.2: R - Peak Detection

Here the conditions for the occurrence of Q Peak is given in the code and thus the result of Q peak detection is shown below.

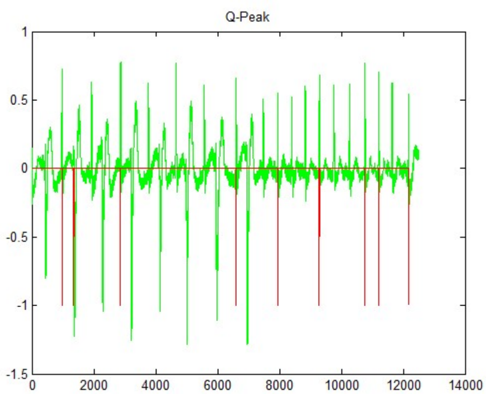



Fig. 4.3: Q - Peak Detection

Here the conditions for the occurrence of S Peak is given in the code and thus the result of S peak detection is shown below

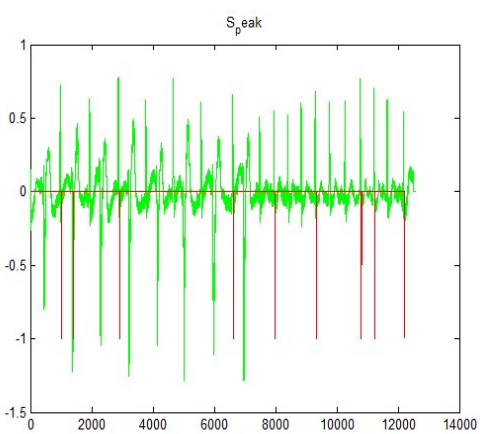



Fig. 4.4: S - Peak Detection

Here the conditions for the occurrence of P Peak is given in the code and thus the result of P peak detection is shown below

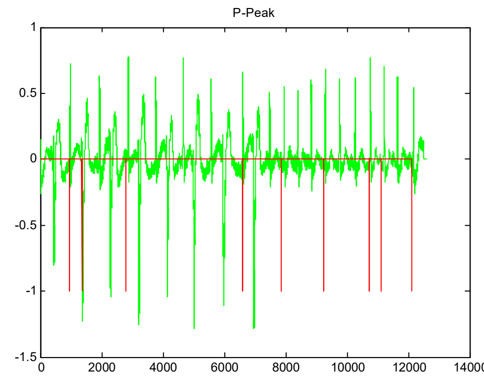



Fig. 4.5: P - Peak Detection

Here the conditions for the occurrence of T Peak are given in the code and thus the result of T peak detection is shown below.

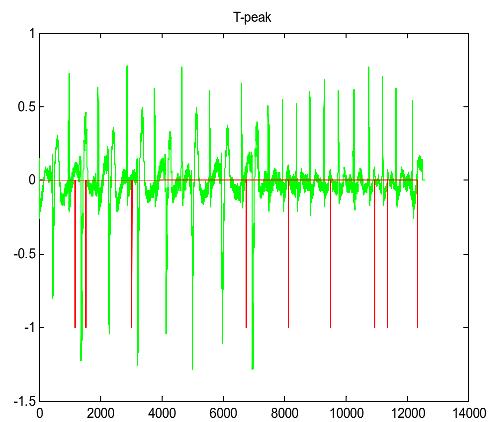



Fig. 4.6: T - Peak Detection

## VIII. FUTURE EXTENSION

Peak detection followed by feature extraction and classification. Finally the mat lab code is converted in to c code and uploaded to Pic microcontroller. The hardware module shown below has an ECG board instead of a monitor and is connected to a instrumentation amplifier and electrodes and a pic with LED to display the voltage which is interfaced with Bluetooth module. The results of the ECG graph of the patient will be displayed in Bluetooth graphics and records will be stored in IOT cloud.

Fig. 5: Hardware module

Fig. 5.1: Project testing

## IX. RESULTS AND DISCUSSION

Thus the pre-processing step is completed by detection and removal of noise in the sample ECG signal. The scope of the paper is that the methodology been developed using ECG data obtained from physionet database. Training records of ECG signal is contaminated with art effects is identified manually, which is done by three human annotators .These recordings could then be used to train a classifier which identifies to make an accurate decision. MATLAB Tool is been used throughout the project to develop the algorithm.

False alarms are extremely common in the intensive care unit (ICU), and research has found that in certain settings, only 17% of alarms are classified as clinically relevant [8]. The resulting constant barrage of clinical alarms can lead to disruption of care and caregiver alarm fatigue, resulting in slower response time to real life threatening events due to desensitization of clinical staff. A number of algorithms to try to reduce the false arrhythmia alarm rate have been investigated and developed to varying degrees of success in recent years [7]. In particular, as part of the 2015 Physio Net/Computing in Cardiology (CinC) Challenge, participants were invited to specifically address the issue of high false alarm rates in the ICU. The goal is to detect the five critical arrhythmias comprising a systole (ASY), extreme Bradycardia (EBR), extreme tachycardia (ETC), ventricular tachycardia (VTA), and ventricular flutter or fibrillation (VFB). The different characteristics of the arrhythmias suggested the application of individual signal processing for each alarm and the combination of the algorithms to enhance false alarm detection. Thus, different features and signal processing techniques were used for each arrhythmia type. Therefore various studies conclude that this reduction process gives better results in multimodal approach method.

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## APPENDIX

```
%R-peak
b=0;
j=1;
for i=1:length(e11)
if e11(i)>0.1
    r(i)=1;
    b(j)=i;
    j=j+1;
else
    r(i)=0;
end
end
j=1;
k=1;
l=1;
for i=1:(length(b)-1)
if (b(i+1)-b(i)<50)
      d(k)=s(b(i));
      k=k+1;
else
      d(k)=s(b(i));
      [c,j]=max (d(1:k));
r_max(l)=c;
r_ind(l)=b(j);
      d=0;
      k=k+1;
      l=l+1;
end
```

```
end

d(k)=s(b(i+1));
[c,j]=max(d(1:k));
r_max(l)=c;
r_ind(l)=b(k);
rwave(length(s))=0;
for i=1:length(b)
if(s(b(i))>0.1)
rwave(b(i))=1;
else
rwave(b(i))=0;
end
end
j=1;
r_peak(length(s))=0;
while(j<length(r_ind))
for i=1:length(r)
r_peak(r_ind(j))=1;
end
   j=j+1;
end
figure
plot(1:length(s),s,'g',1:length(r_peak),r_peak,'r');
title('R-Peak');
```