A Real Time Application to Identify Alcoholics from ECG Signals

by

Akarsh N Kolekar, Apoorv Vatsal & Rakshith Vishwanatha

USN: 1PI13EC009, 1PI13EC017, 1PI13EC075

Under the Guidance of
Dr. B. Niranjana Krupa
Professor, ECE,
PES Institute of Technology

Department of Electronics and Communication Engineering
PES Institute of Technology, Bangalore

1. Introduction

Technology has advanced in various fields at rapid rates, however in an area that concerns the common well being of humans, technology has remained dormant. Identifying accurately if a person is intoxicated is utmost important to keep public harm and nuisance at bay. The most common device used, the breathalyser has drawbacks that we aim to rectify. The common drawbacks of a breathalyser are:

i) Contamination of SiO_2 sensor requires frequent recalibration and replacement
ii) Breathalysers being a medium for propagation of contagious diseases
iii) Interfering components (like acetone) being higher in the breath of dieters and diabetics make them more prone to being detected falsely
iv) Infrared sensors detect the absorbance of the compound as a function of the wavelength of the beam when the infrared beam is passed through the sample breath chamber. The chamber is prone to environmental pollutants and aerosols leading to errors.

These disadvantages mentioned above are addressed with the use of infallible computers and well trained machine learning algorithms.

HRV (Heart rate variability) obtained from ECGs is a useful biomarker and is used extensively in our paradigm to extract features. The features extracted are then used to train the system to classify patients as chronic alcoholic or otherwise. This may be useful in discriminating individuals based on their habits while preventing other external environmental conditions from altering or corrupts the readings.

2. Problem Statement

To develop a prototype to read ECG signals, extract features to perform HRV analysis, and classify the person under test as an alcoholic (person under the influence of alcohol) or otherwise.

3. Objectives

(a) To study the recently developed ECG sensor and improve it
(b) Identify an effective method to extract and analyse Heart Rate Variability (HRV) features from the raw ECG sensor data to accurately classify results for Alcoholic and Normative data.
(c) Implement algorithms on a Raspberry-Pi to perform real time feature extraction and classification.

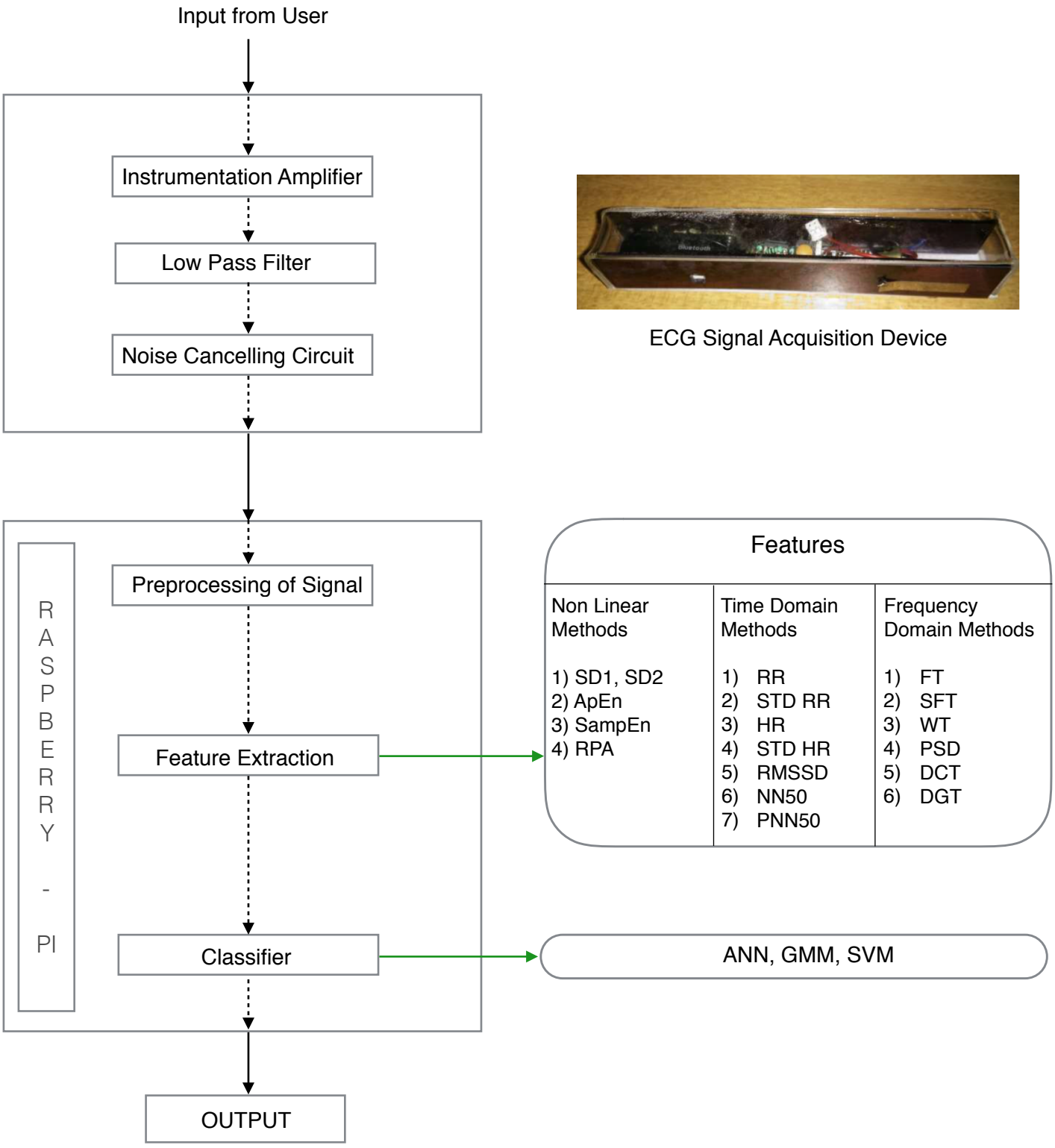

Figure-1: System Block Diagram

4. Methodology

(a) Study of the advantages of HRV (Heart Rate Variability) analysis over other markers for cardiovascular health.
(b) Survey of various tools (KubiosHRV) for feature extraction to perform HRV analysis
(c) Familiarisation with the form and structure of the ECG signals.
(d) Survey of the available devices for measuring and recording ECG signals.
(e) Study and improvement of the device previously developed to record ECG signals.
(f) Selection of a controller board on which HRV analysis will be performed.
(g) Study and selection of feature extraction techniques.
(h) Understanding the data set obtained from Autonomic Lab, Department of Neurophysiology, NIMHANS available to train the system. It consists of 30 ECG samples of alcoholic and normative subjects.
(i) Implementation of a feature extraction technique on data set.
(j) Selection of a classification algorithm to classify the extracted features as chronic alcoholic or otherwise.
(k) Implementation of the selected classifier on the processing board.

5. Components of the Block Diagram (Figure-1)

The system consists of three main components. The description and role of each of them is as follows:

A. ECG data acquisition device — Used to acquire real time ECG data from the patient. This device can further be broken down into the
- Instrumentation amplifier: used to amplify the weak signals obtained at the electrodes
- Low pass filter: to remove unwanted frequency components
- Noise cancelling circuit: to remove AWGN

B. Raspberry Pi — Used to run all the code for the classification algorithms
- Preprocessing: Includes procedures like normalisation and
- Feature Extraction: Apply time domain and frequency domain transforms to obtain features
- Classifiers: Use the features obtained and a classification algorithm to classify the input data into its respective class

5. Software and Hardware Requirements

(i) Software:
  (a) MATLAB
  (b) Python Libraries
  (c) MultiSim

(ii) Hardware:
  (a) Raspberry Pi - processing board to implement the classifier
  (b) ECG Sensor

6. **Expected outcome:**

By the end of the project we should have an end to end working model of the system proposed. Real time ECG graphs will be obtained, features from the graph will be extracted, and classification of test subject as alcoholic or normative will be performed.

7. **References**

[1] Chung Kit Wu, Kim Fung Tsang, Hao Ran Chi and Faan Hei Hung. (2016, May). "A Precise Drunk Driving Detection Using Weighted Kernel Based on Electrocardiogram". *Sensors*. [Online]. 16(5), pp. 659. Available: http://www.mdpi.com/1424-8220/16/5/659/htm [Jan. 13, 2016].

[2] George Sereny. (1971, Oct.). "Effects of Alcohol on the Electrocardiogram". *American Heart Association.* [Online]. 44(4), pp. 558-564. Available: http://circ.ahajournals.org/content/44/4/558 [Jan. 13, 2016].

[3] Evans, William . "The Electrocardiogram of alcoholic cardiomyopathy", British heart journal Vol. 21.4, Page 45, 1959.

[4] V.X. Afonso. ECG QRS detection. In W.J. Tompkins, editor, Biomedical Digital Signal Processing,chapter 12, pages 237–264. Prentice Hall, New Jersey, 1993.

[5] M. Brennan, M. Palaniswami, and P. Kamen. Do existing measures of Poincar´e plot geometry reflect nonlinear features of heart rate variability. IEEE Trans Biomed Eng, 48(11): 1342–1347, Nov 2011

[6] S. Carrasco, M.J. Cait´an, R. Gonz´alez, and O. Y´anez. Correlation among Poincar´e plot indexes and time and frequency domain measures of heart rate variability. 25(6):240–248, November/December 2001.

[7] Kotsiantis, Sotiris B., I. Zaharakis, and P. Pintelas. "Supervised machine learning: A review of classification techniques." 3-24., (2007)