ECG SIGNAL ANALYSIS AND SECURITY

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for the partial fulfillment of the requirements to award the degree of

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and Sciences

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[December, 2022]

Certificate

Date: 12-Dec-22

This is to certify that the work present in this Project entitled "**ECG SIGNAL ANALYSIS AND SECURITY**" has been carried out by **[P.Sahitya, R.Pooja sri, S.Pooja sree, M.Dimple sai]** under my/our supervision. The work is genuine, original, and suitable for submission to the SRM University – AP for the award of Bachelor of Technology/Master of Technology in **School of Engineering and Sciences**.

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Designation,

Affiliation.

Acknowledgements

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We would like to thank HOD Head of the department of computer science and technology **DR. Jatindra Kumar Dash** sir, for giving us a great opportunity.

Table of Contents

Abstract

Electrocardiogram (ECG) is the transthoracic interpretation of the electric pastime of the coronary heart over a length of time. Analysis of ECG sign gives facts concerning the condition of coronary heart. Various techniques like Fast Fourier Transforms, Wavelet Transform, etc. had been used for detection of cardiac illnesses In this paper we've given a r view at the paintings carried out in the region of ECG sign evaluation in past few years[1].

The blood flow machine in a human frame gives a unique and herbal accept as true with sector for stable facts communications in wi-fi healthcare structures inclusive of frame place networks. Unfortunately, biometric sign authentication and the usage of physiological attributes in wi-fi healthcare has now no longer been drastically studied. In this paper, we recommend a fact authentication method utilizing electrocardiography (ECG) sign styles for decreasing key alternate overhead[6].

With the help of an ECG analysis machine we can find the heartbeat and heart rate with the help of waves and these will detect the diseases in the human body.

Abbreviations

ECG	Electrocardiogram
GA	Genetic Algorithm
SVM	Support vector machine

List of Tables

List of Figures

1.Introduction

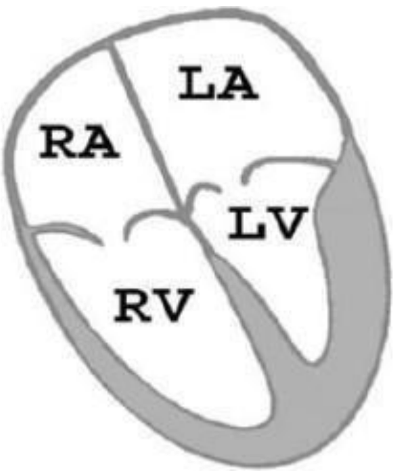
ECG:-

Electrocardiogram

The ECG signals are the recordings of the bioelectrical activities of cardiac system and the changes in this recordings are used in determining the heart condition and any diseases based on various observations[7].

·ECG is represented in the form of a voltage vs time of electrical activity graph[5].

·There are 3 types of ECG leads



HUMAN HEART

1. Limb leads(Bipolar)
2. Augmented limb leads(Unipolar)
3. Chest leads(Unipolar)

· This test detects heart disease, heart attack, an enlarged heart or abnormal rhythms which can motive heart failure

· An ECG can recognize the signs of blocked Arteries but for further accuracy ACT(Coronary Angiogram) can reveal plaque build up & identify blockages in the arteries[2].

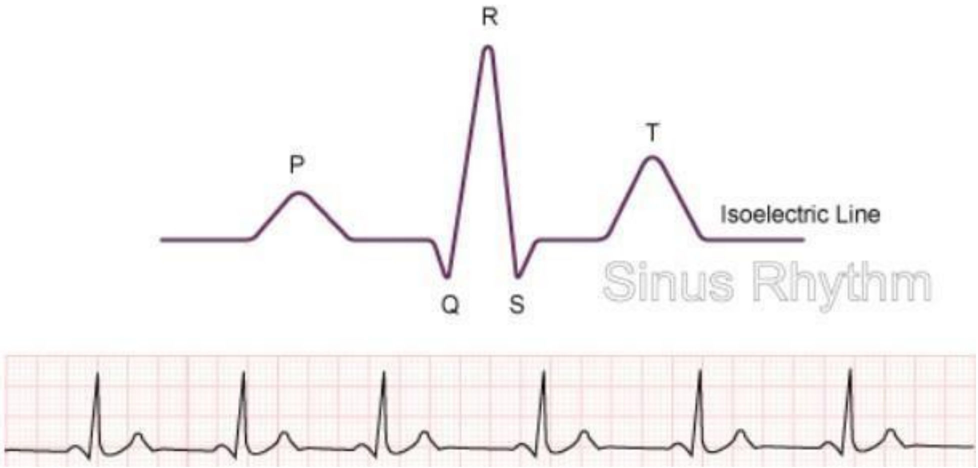
· ECG is painless and takes around 5-10 minutes to perform.

· Three main components of an ECG Graph

About p,q,r,s,t and EKG

Regular EKG rhythm

Image: P,QRS & T Wave



P wave: -

Atrial Contraction

It originates with in side the peace maker of the heart which beats at 60 to a hundred beats in line with minute in so dysrythmias you whenever you even examine a wave you need to examine
your p wave this is in which you begin due to the fact a few p waves may be tousled they
may have a lang PR c program language period and it tells
you lots approximately how your patients
doing so there may be your p wave once more it represents atrial contraction it's the ones atriums[4]

In the heart contracting which is like wise the flowery time period referred to as depolarization they are contracting

QRS complex: -

It is also called as ventricle contraction which they call ventricle depolarization this is when your ventricles are contracting, they are pumping that blood so the ventricles are just so big that they produce this huge complex

T wave: -

Ventricles repolarizing

They are resting again ventricles are so big whenever they contract, they make the huge QRS complex that whenever they rest you can see the repolarization because they are so big

- In some cases, we will see U waves and it is not very common

U wave: -

- It is produced by the resting of the PNG fibers

QRS Detection: -

Electrocardiography, or ECG, is a technique for gathering the electrical signals produced by the heart. This helps us comprehend a person's level of physiological arousal and can also be applied to comprehend a person's psychological state.

An ECG signal will be acquired using a biopotential amplifier and then displayed using instrument software, where again control will be created to adjust its amplitude. Finally, the recorded ECG will be analyzed[10].

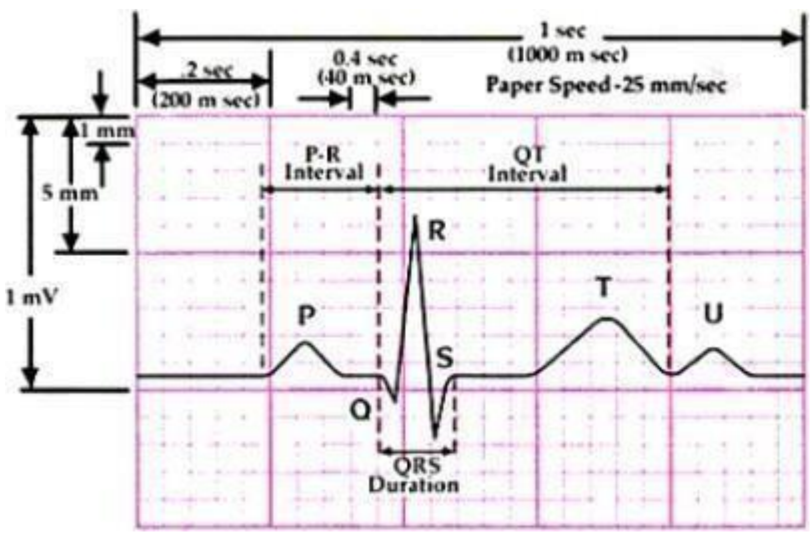


Figure2. A typical Cardiac Waveform [4]

Table 1. Abnormalities

ABNORMALITY	CHARACTERISTICS
Bradycardia	R-R interval>1s
Tachycardia	R-R interval<0.6s
Hypercalcaemia	QRS interval<0.1s
Dextrocardia	Inverted P-wave
Hyperkalemia	Tall T-wave and absence of P-wave
Sudden cardiac death	Irregular ECG
Sinoatrial block	Complete drop out of a cardiac cycle
Myocardial ischemia	Inverted T-wave

ECG Feature extraction Techniques: -

ECG function extraction plays a significant role in the diagnosis of the majority of heart disorders. The P-QRS-T waves in an ECG signal represent one cardiac cycle. The amplitudes and intervals in the ECG signal are determined by this characteristic extraction method for further investigation. The P-QRS-T segment's amplitude and interval value demonstrate how each human heart beats. For analysing the ECG signal, numerous studies and methodologies have recently been created[8].

. The suggested schemas were mostly based on signal analysis approaches such as Fuzzy Logic, Artificial Neural Networks, Genetic Algorithms (GA), Support Vector Machines (SVM), and others.

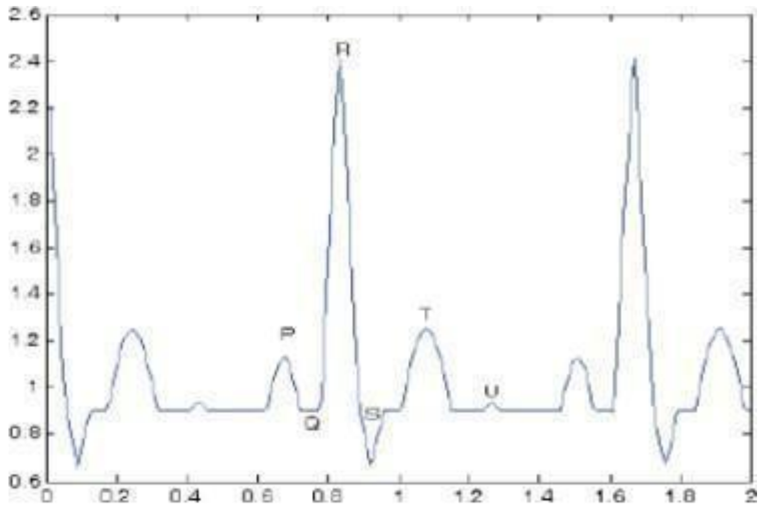


Figure3. Normal sinus rhythm [6]

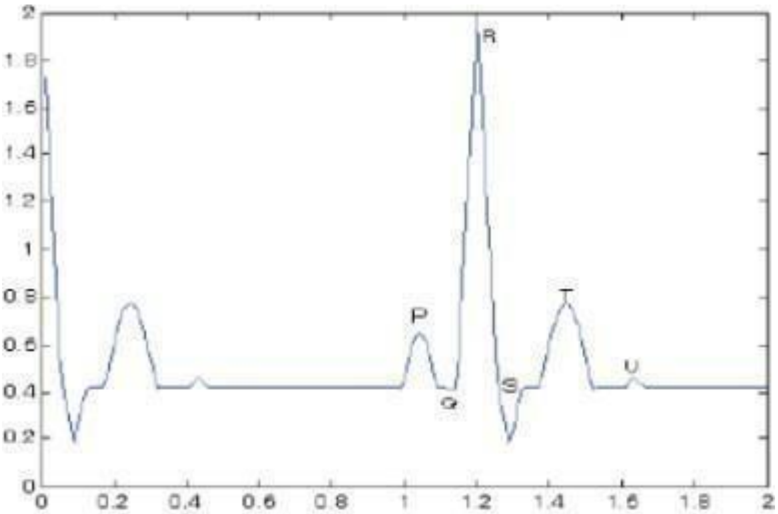


Figure 4. Sinus Bradycardia [6]

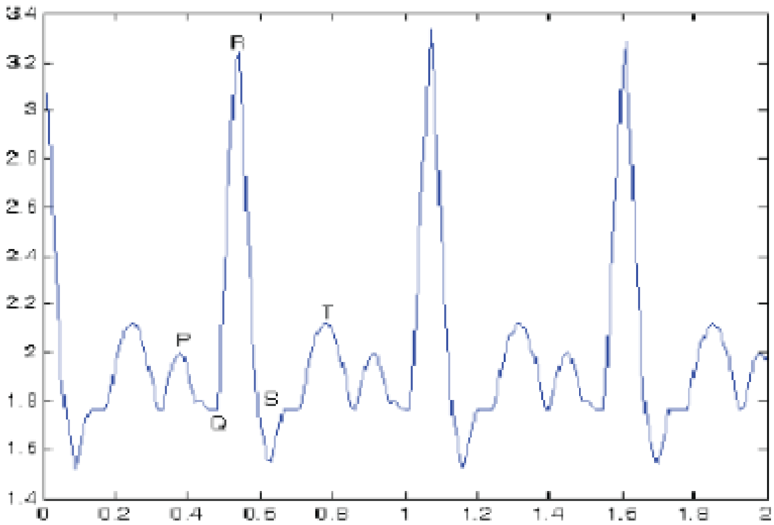


Figure 5. Sinus Tachycardia [6]

ML Techniques:

- Supervised:

It implies to keep track of and oversee the performance of (a task, project or activity)

How will we supervise a machine learning version?

By coaching the version that is, we load the version with information in order that we can have it are expecting destiny instances

Model: -

In general, the model used to predict the results of sample data is one that has been trained on a labelled dataset.

Rows are called attributes

Columns are called features which include data.

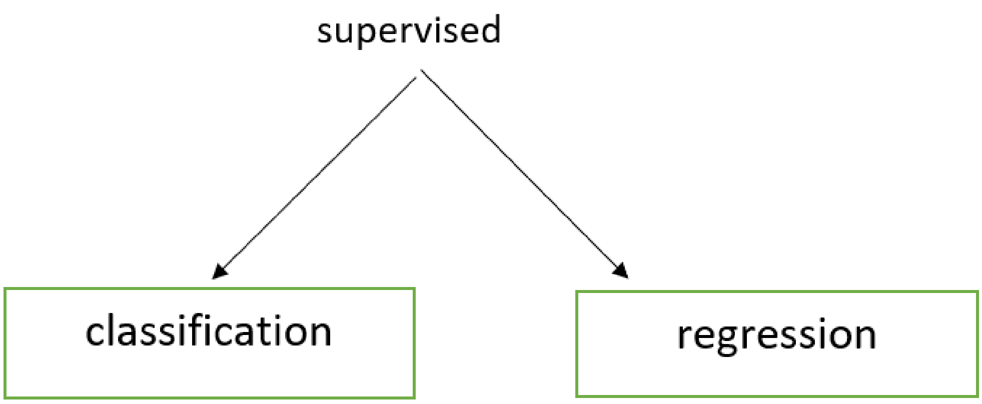


Figure 6.supervised

Unsupervised: -

The model is left to function alone in order to find information that might not be visible to the human eye.

It applies machine learning techniques to make judgments about UNLABELED.

- Groups/clusters
- Perform density estimation
- Dimensionality reduction

DIFFERENCE: -

Unsupervised data learning uses unlabeled data while supervised data learning uses labelled data.

We have machine learning algorithms for classification and regression in supervised learning.

Supervised:

Classification: - classifying labeled data.

Regression: - pretending trends using previous labeled data.

Unsupervised:

Clustering: - Finding and grouping from unlabeled data.

Coronary artery sickness: -

- Damage or sickness withinside the coronary heart's main vessels.

High blood pressure: -

- A circumstance wherein the pressure of the blood in opposition to the artery partitions is simply too high.

Cardiac arrest: -

- Sudden, surprising lack of coronary heart function, breathing & consciousness.

Congestive coronary heart failure: -

- A persistent circumstance wherein the coronary heart would not pump blood as properly because it should.

Arrhythmia: -

- Improper beating of the coronary heart, whether. irregular, too rapid or too slow.

Stroke: -

- Damage to the mind from interruption of its blood supply.

Congenital heart disease: -

- An abnormality in the heart that develops: before the baby was born.

Peripheral artery disease: -

- A circulatory condition in which is limited. blood vessels reduces the blood flow through, the limbs.

ECG Signal application in heart diseases Prediction: -

- The early detection of ordinary coronary heart Conditions is critical to pick out heart problems and keep away from unexpected cardiac death.

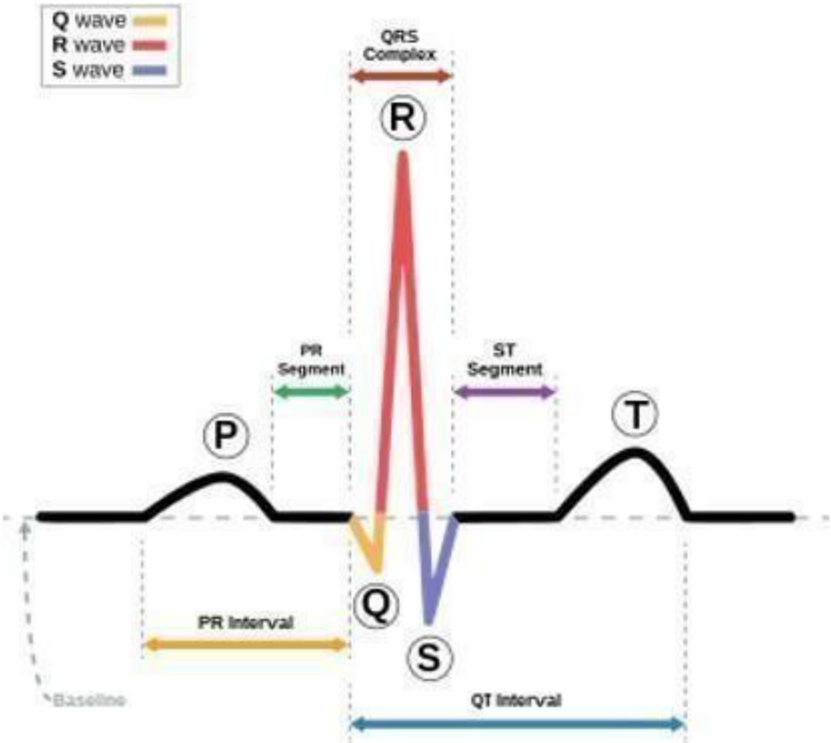
- The human beings with comparable coronary heart situations nearly have comparable ECG alerts. By analyzing the ECG sign styles you possibly can expect arrhythmia. Since the conventional strategies of arrhythmia detection depend on staring at morphological features of the ECG Signals which might be tedious and really time Consuming, the automatic detection of arrhythmia is extra preferable[3].

- In order to automate detection of coronary heart illnesses a good enough set of rules is required which Could classify the ECG alerts with unknown capabilities according to the similarities among them and the ECG alerts with acknowledged capabilities. If this classifier can discover the Similarities exactly the chance of arrhythmia detection is improved and this set of rules can turn out to be a beneficial way in Laboratories[9].

1. Methodology

Pan Thompkins algorithm

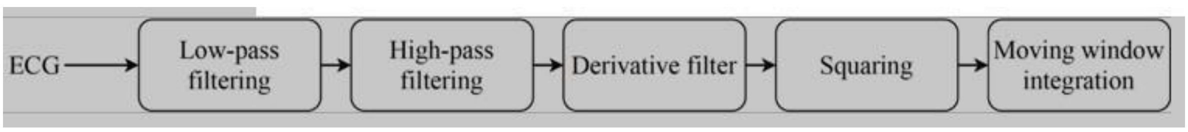
The Pan-Tompkins method employs a series of filters to draw attention to the frequency content of this quick cardiac depolarization and eliminate background noise.



The QRS complex is easier to identify once the signal is squared to magnify the QRS contribution.

An annotated arrhythmia database was used to test the method's effectiveness, and noise levels were taken into consideration as well. According to Pan and Tompkins, 99.3 percent of QRS complexes were accurately identified[1].

Pre-processing:



1) Noise cancellation

2) Derivative step

3) Squaring and integration

Decision rules:

1) Fiducial mark

2) Thresholds

3) Search back for missed QRS complexes

4) T wave discrimination

Application:

The heart rate is calculated once the QRS complex has been successfully identified as a function of the time in seconds that passes between two successive QRS complexes (or R peaks), where bpm stands for beats per minute. Heart rate variability (HRV), a measurement of the variability of the time interval between heartbeats, is frequently calculated using the heart rate (HR). In addition to being utilized frequently in affective computing research to examine new approaches to determining a person's emotional state, HRV is also frequently employed in the therapeutic area to diagnose and track the treatment of pathological diseases[5].

Code: -

Project Execute Tools AStyle Window Help

TDM-GCC 4.9.2 64-bit Release

[*] Untitled1

```c
real_time_QRS_detection
#include <stdio.h>
#include <stdlib.h>


typedef int boolean;
#define true  1
#define false 0

#define M               5
#define N               30
#define winSize         250
#define HP_CONSTANT     ((float) 1 / (float) M)

void detect(float* ecg, int* result, int len);

int main(int argc, char** argv){
    float new_pt;
    float ecg[1000000] = {0};
    int result[1000000] = {0};
    int i, j;

    // read in ECG data
    FILE *fid = NULL;

    if(argc > 1){
        fid = fopen(argv[1], "r");
    }
    else{
        fid = fopen("data.csv", "r");
    }

```

Project Execute Tools AStyle Window Help

TDM-GCC 4.9.2 64-bit Release

[*] Untitled1

```c
    }


    while( EOF != fscanf(fid, "%f\n", &new_pt) ){
        ecg[i++] = new_pt;

//      printf("%f\n", new_pt);
    }

    fclose(fid);

    // perform realtime QRS detection
    detect(ecg, result, i);

    // save detection results
    fid = fopen("QRS.csv", "w");

    for(j = 0; j < i; j++){
        fprintf(fid, "%d\n", result[j]);
    }

    fclose(fid);

    return 0;
}

void detect(float* ecg, int* result, int len) {
    // circular buffer for input ecg signal
    // we need to keep a history of M + 1 samples for HP filter
    float ecg_buff[M + 1] = {0};
    int ecg_buff_WR_idx = 0;
    int ecg_buff_RD_idx = 0;
```

Project Execute Tools AStyle Window Help

TDM-GCC 4.9.2 64-bit Release

[*] Untitled1

```
    int ecg_buff_WR_idx = 0;
    int ecg_buff_RD_idx = 0;

    // circular buffer for input ecg signal
    // we need to keep a history of N+1 samples for LP filter
    float hp_buff[N + 1] = {0};
    int hp_buff_WR_idx = 0;
    int hp_buff_RD_idx = 0;

    // LP filter outputs a single point for every input point
    // This goes straight to adaptive filtering for eval
    float next_eval_pt = 0;

    // running sums for HP and LP filters, values shifted in FILO
    float hp_sum = 0;
    float lp_sum = 0;

    // parameters for adaptive thresholding
    double treshold = 0;
    boolean triggered = false;
    int trig_time = 0;
    float win_max = 0;
    int win_idx = 0;

    int i = 0;

    for(i = 0; i < len; i++){
        ecg_buff[ecg_buff_WR_idx++] = ecg[i];
        ecg_buff_WR_idx %= (M+1);

        //printf("i - %d\n", i);

```

```
//printf("i - %d\n", i);

/* High pass filtering */
if(i < M){
    // first fill buffer with enough points for HP filter
    hp_sum += ecg_buff[ecg_buff_RD_idx];
    hp_buff[hp_buff_WR_idx] = 0;

    //printf("hp_buff[hp_buff_WR_idx] - %f\n", hp_buff[hp_buff_WR_idx]);
}
else{
    hp_sum += ecg_buff[ecg_buff_RD_idx];

    int tmp = ecg_buff_RD_idx - M;
    if(tmp < 0) tmp += M + 1;

    hp_sum -= ecg_buff[tmp];

    float y1 = 0;
    float y2 = 0;

    tmp = (ecg_buff_RD_idx - ((M+1)/2));
    if(tmp < 0) tmp += M + 1;

    y2 = ecg_buff[tmp];

    y1 = HP_CONSTANT * hp_sum;

    hp_buff[hp_buff_WR_idx] = y2 - y1;

    //printf("hp_buff[hp_buff_WR_idx] - %f\n", hp_buff[hp_buff_WR_idx]);
}
```

Project Execute Tools AStyle Window Help

TDM-GCC 4.9.2 64-bit Release

[*] Untitled1

```c
            //printf("hp_buff[hp_buff_WR_idx] - %f\n", hp_buff[hp_buff_WR_idx]);
        }

        // done reading ECG buffer, increment position
        ecg_buff_RD_idx++;
        ecg_buff_RD_idx %= (M+1);

        // done writing to HP buffer, increment position
        hp_buff_WR_idx++;
        hp_buff_WR_idx %= (N+1);

        /* Low pass filtering */

        // shift in new sample from high pass filter
        lp_sum += hp_buff[hp_buff_RD_idx] * hp_buff[hp_buff_RD_idx];

        if(i < N){
            // first fill buffer with enough points for LP filter
            next_eval_pt = 0;

        }
        else{
            // shift out oldest data point
            int tmp = hp_buff_RD_idx - N;
            if(tmp < 0) tmp += N+1;

            lp_sum -= hp_buff[tmp] * hp_buff[tmp];

            next_eval_pt = lp_sum;
        }

        // done reading HP buffer, increment position
```

Project Execute Tools AStyle Window Help

TDM-GCC 4.9.2 64-bit Release

[*] Untitled1

```c
        hp_buff_RD_idx %= (N+1);

        /* Adapative thresholding beat detection */
        // set initial threshold
        if(i < winSize) {
            if(next_eval_pt > treshold) {
                treshold = next_eval_pt;
            }
        }

        // check if detection hold off period has passed
        if(triggered){
            trig_time++;

            if(trig_time >= 100){
                triggered = false;
                trig_time = 0;
            }
        }

        // find if we have a new max
        if(next_eval_pt > win_max) win_max = next_eval_pt;

        // find if we are above adaptive threshold
        if(next_eval_pt > treshold && !triggered) {
            result[i] = 1;

            triggered = true;
        }
        else {
            result[i] = 0;
        }
```

Compile Log Debug Find Results

Project Execute Tools AStyle Window Help

TDM-GCC 4.9.2 64-bit Release

[*] Untitled1

```
        hp_buff_RD_idx %= (N+1);

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        if(next_eval_pt > treshold && !triggered) {
            result[i] = 1;

            triggered = true;
        }
        else {
            result[i] = 0;
        }
```

es Compile Log Debug Find Results

Literature Survey

Author	ECG	Software/ Technology	Technique
M.H. Vafaie	Signal Analysis	Windows	Fuzzy classifier
Adyasha Rath, Debahuti Mishra	Deep Learning	Linux	**RBFN**, **AE, SOM, RBM**
Rajini, Inderbir Kaur	abnormalities	Windows	Fast Fourier transform, Short time Fourier trans form, Wavelet Transform
H.R. Koofigar, M. Ataei	Control processing	MatLab	Dynamic model Genetic Algorithm
Dimitris Bertsimas, Luca Mingardi	Spot Anomalies, Machine Learning	Jupyter Notebook	Novel methodology
Ganapati Panda, Suresh Chandra Satapathy	Sustainable Computing	Linux	DL based CAD Classification

1.Concluding Remarks

In this we will use machine learning techniques and we will known about the ECG Electrocardiogram and how it works and more about the Electro waves P,Q,R,S,T waves in monitors what are their roles and how it used we will learn about the different types of heart diseases by using the ECG we will known about our heart condition whether it is in good condition or in bad condition and we can be safe by knowing it

we used Pan Thompkins algorithm in it ,it is used to known about the frequency whether it is low in frequency or high in frequency when it process the filters

1. Future Work

In this we used Pan Thompkins algorithm by that algorithm we can say that the frequency Is low or high in the electro waves.

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