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IOT based Cardio Vascular Signal Analysis using Discrete Wavelet Transform

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Abstract

Investigation of ECG flag incorporates age and recreation of ECG flag, securing of constant ECG information, ECG flag separating and handling, include extraction, correlation between various ECG flag examination calculations and strategy identification of any variations from the norm in ECG, figuring beat rate et cetera utilizing the MATLAB programming. The best possible usage of MATLAB capacities tool compartment and we can work with ECG signals as Simulink can promote us to work with it for handling and with examination and both continuously and by reenactment with incredible exactness and comfort. It is the elucidation of the electrical action done by the heart over some stretch of time. Investigation of ECG flag gives data with respect to the state of heart. Different techniques like Fast Fourier Transforms, Wavelet Transform have been utilized for discovery of cardiovascular maladies. In this venture single ECG flag is extricated, it is then sifted utilizing Savitzky-Golay Filter. It is automated channel that can be associated to an arrangement of cutting edge information centers to smooth the information, that is, to build the flag to-clamor proportion without significantly mutilating the flag. The most extreme Peaks are found in the flag in the wake of smoothening of bend.

1. Introduction

ECG or An Electrocardiogram is an analytic device which measures the electrical movement of the heart beat in course of time. The acknowledgment and examination of the ECG flag is difficult, as their size and shape may in the long run change and furthermore, the nearness of clamor can likewise change the flag. The execution of a computerized ECG examination framework depends vigorously on the solid discovery of various parts of the flag e.g. the QRS complex, the P wave and the T wave. Regarding infection classification, the QRS complex is of neurotic significance and its location fills in as a section purpose of the majority of the computerized ECG examination calculations. A few distinctive methodologies in view of neural systems, some heuristic techniques in view of nonlinear change and wavelet change has been proposed previously. Electrocardiogram is a graphical exhibition of the variety of bio-potential against time. The leads are set on particular areas of the body of the individual to record ECG either on diagram paper or on screens. The human heart consists of four chambers i.e. Right Atrium (RA), Left Atrium (LA), Right Ventricle (RV) and Left Ventricle (LV). The upper chambers are the two Atria's and the lower chambers are the two Ventricles. Under sound condition the pulse starts at the Right Atrium known as Sino Atria (SA) hub and a unique gathering of cells send these electrical flags over the heart. This flag heads out from the Atria to the Atrio Ventricular (AV) hub. It interfaces with a

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gathering of filaments in Ventricles which leads the electrical flag and transmits the motivation to all parts of the lower chamber, the Ventricles. The fundamental structure of heart is portrayed in Figure1.[1-10]

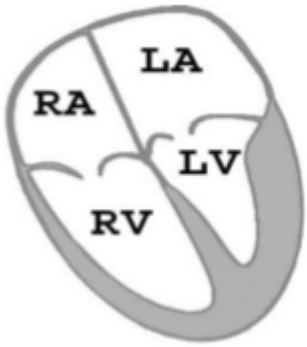

Fig1. Schematic Anatomy of Human Heart

Eachheart beat showed is an arrangement of the electrical waves depicted by tops and valleys. ECG principally gives two sorts of data. One is the traverse of the electrical wave going through the heart and it will pick whether the electrical action is typical or moderate or sporadic. Second is the measure of electrical action going through the heart muscle that finds whether the parts of the heart are too extensive or exhausted. The recurrence scope of an ECG flag is 0.05– 100 Hz and its dynamic range is 1– 10 mV. The ECG flag is depicted by five pinnacles and valleys spoke to by the letters P, Q, R, S, T. [5] Sometimes U wave is likewise present. The execution of ECG investigation depends on the precise and solid discovery of the QRS intricate and T-and P waves. A perfect ECG wave is as appeared in Figure 2. The P-wave speak to the initiation of the two atria, the upper gatherings of the heart, while the QRS complex and T-wave speak to the excitation of the lower council of the heart, the ventricles. QRS recognition is one of the major issues in programmed ECG flag examination. After QRS complex has been identified an intensive examination of ECG flag is finished. The P, QRS and T-waves mirror the cadenced electrical depolarization and repolarization of the myocardium connected with the compressions of the atria and ventricles. The even area of this waveform before the P-wave is named as the benchmark or the isopotential line. The P-wave compares to the depolarization of the atrial musculature. The QRS complex gives the consolidated aftereffect of the repolarization of the atria and depolarization of the ventricles, which happens nearly at same time. The T-wave is the flood of ventricular repolarization, while the U-wave, if introduce is regularly accepted to be the aftereffect of after possibilities in the ventricular muscle. [4] So the length abundancy and morphology of the QRS complex is useful in diagnosing cardiovascular arrhythmias, conduction anomalies, ventricular hypertrophy, myocardial contamination and other ailment states. The standard rate of heart is 60 to 100 thumps for every moment. A slower rate than the normal range is knows as bradycardia (moderate heart) and a higher rate is called as tachycardia (quick heart).

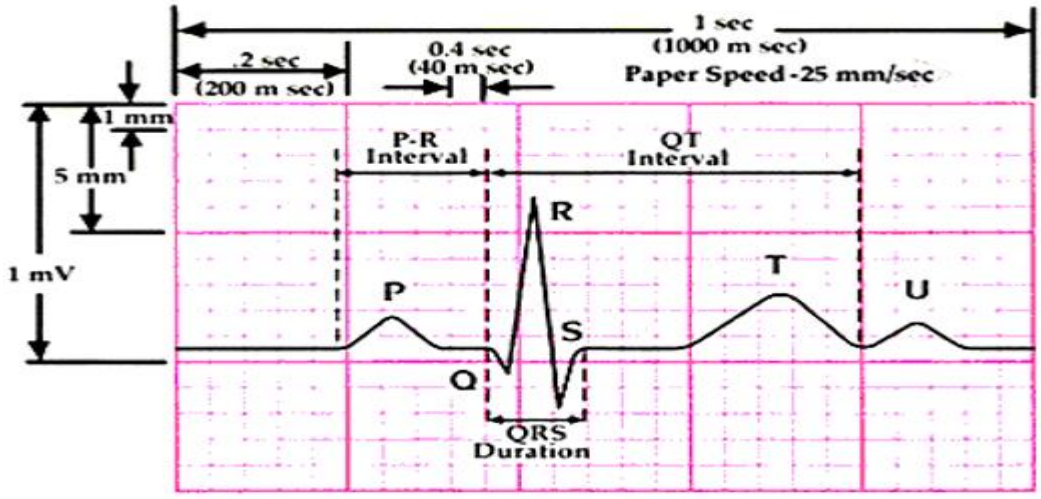

Fig2. ECG Waveform

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2. Literature Review

ECG flag investigation and location has been a fascinating theme from numerous years and stillthe research is happening in this field. Different strategies have been produced for ECG investigation as Fast Fourier change, Short time Fourier change, and so on.

- Fast Fourier Transform (FFT):

Prior the strategy utilized for ECG flag examination was time space technique. In any case, the impediment was that it was not adequate to ponder all attributes of ECG flag. So another strategy FFT was produced. It an outstanding technique which changes time area flag to recurrence space to acquire the recurrence coefficients. FFT is a rudimentary change in computerized flag handling and has different applications in recurrence examination, flag preparing and so forth. It is a quick and more skilled calculation to work out the Discrete Fourier Transform (DFT) and acquires a similar impact.

$$X(k) = \sum_{n=0}^{N-1}(\text{x e\^{} } -$$

(nk2πi/n)..... (1)

Where k is a whole number extending from 0 to N-1. ECG signs can be packed by utilizing assortment of procedures. A standout amongst the most imperative strategies is FFT. The aggregate procedure comprises of the accompanying advances:

• Obtaining an ECG test or information flag.

• Compressing the info motion by evacuating the low recurrence segments.

• Recovery of the first flag by utilizing reverse FFT. [2]

Be that as it may, the drawback of FFT is that it neglected to give the data with respect to the precise area of recurrence segments in time.

- Short Time Fourier Transform (STFT):

It is known as Windowed-Fourier change, i.e. Gabor change. STFT has both time and recurrence data. It is utilized to decide the sinusoidal recurrence and stage substance of the flag as it fluctuates with time. The STFT based spectrogram is a basic and quick method in contrast with other time– recurrence investigation. It is a simple approach of cutting the waveform of enthusiasm into various short-portions. At that point it examines each section utilizing standard Fourier change. A window work is connected to a section of information, effectively separating that portion from the general waveform, and Fourier change is connected to that fragment. This is called as the spectrogram or the Short-Time Fourier Transform. [2]

$$X(\tau, f) = \int_{-T/2}^{T/2} x(t)w(t - \tau e^{-i2\pi ft})\, dt \quad .$$

Where w (t) is a window, having term T, focused at time area t, the Fourier change of the windowed flag x (t) w (t - τ) is the STFT. In any case, the constraint of STFT is that its chance recurrence accuracy isn't ideal. Subsequently a more appropriate strategy is picked to conquer this downside[11-20].

3. Proposed Method

Wavelet device is an intense instrument for bio medicinal signs, which tend to change their factual properties with time. Albeit effective, however the past methodologies endure because of the nearness of commotion components. As edge is constantly reliant on the commotion and modulus maxima alone could experience the ill effects of the discontinuities or the state of the flag also. In STFT window ought to dependably have a settled size and along these lines it doesn't give multi determination data of the flag. In any case, Wavelet Transform has the multiresolution property which provides both time and recurrence data through factor window estimate[20-25].

The Wavelet implies a little wave and the investigation of Wavelet Transform is another instrument for seismic flag examination. Immediately, Alex Grossmann hypothetical physicists contemplated the opposite recipe for the wavelet change. A Wavelet is a little wave which has vitality moved in time and gives an instrument to the investigation of transient, nonstationary or time-fluctuating signs[25-30].

A few highlights which make them helpful are:

• Wavelets are limited in both time and recurrence.

• For breaking down non-stationary flags, for example, ECG which have visit level varieties and uneven highlights.

• Wavelet isolates a flag into many multiresolution segments. [3]

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The Wavelet Transform is a period scale portrayal which has been utilized viably in an assortment of utilizations, specifically flag pressure. It is a straight procedure that deteriorates the flag into various scales related with recurrence parts and investigates each scale with a specific determination. Another preferred standpoint of Wavelet system is different Wavelet capacities accessible, that permits choosing the best capacity for breaking down the flag while if there should arise an occurrence of Fourier investigation it is confined to one element morphology which is the sinusoid[30-35].

Wavelet changes can be characterized mainly into two classifications:

- CWT or Continuous Wavelet Transforms
- DWT or Discrete Wavelet Transforms

Discrete Wavelet Transform

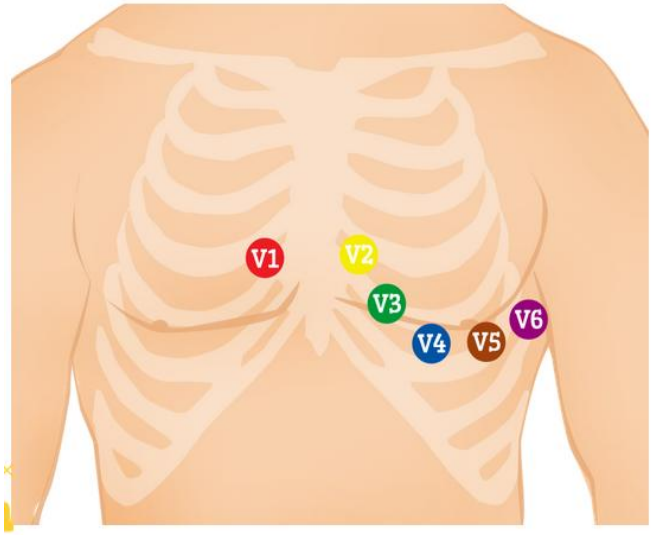
The N boisterous information focuses are changed through the discrete wavelet change, to acquire N uproarious wavelet coefficients. The DWT of a flag x is computed by going it through a progression of filters. After couple of cycles in multiscale examination, the guess coefficients compare to the lower recurrence benchmark float part of the ECG flag. The focusing of the scaling coefficients brings about evacuating the impact of pattern float. So as to get great outcome, the essential parameter to consider in this approach is the level of deterioration. The wrong choice of the decay level may bring about either finished fitting impact in gauge guess or on the other hand with poor estimate because of abnormal state. [3]

$$a_{j+1}[p] = \sum_{n=-\infty}^{\infty} h[n-2p]a_j[n]$$

This strategy utilizes Savitzky-Golay channel which is utilized for convolution, through fitting progressive sub-sets of nearby information concentrations with a low-degree polynomial through the technique for direct minimum squares. At the point when the information focuses are similarly dispersed, a logical answer for even the slightest squares conditions can be found, as a solitary arrangement of "convolution coefficients" that can be connected to all information sub-sets, to give appraisals of the smoothed flag, (or subordinates of the smoothed flag) at the essential issue of each sub-set.

4. Setup

1) Chest (Precordial) Electrodes and Placement



» V1 - Fourth intercostal space on the right sternum
» V2 - Fourth intercostal space at the left sternum
» V3 - Midway between placement of V2 and V4
» V4 - Fifth intercostal space at the midclavicular line
» V5 - Anterior axillary line on the same horizontal level as V4
» V6 - Mid-axillary line on the same horizontal level as V4 and V5

Fig3. Setup of ECG Signal Recording (Chest)

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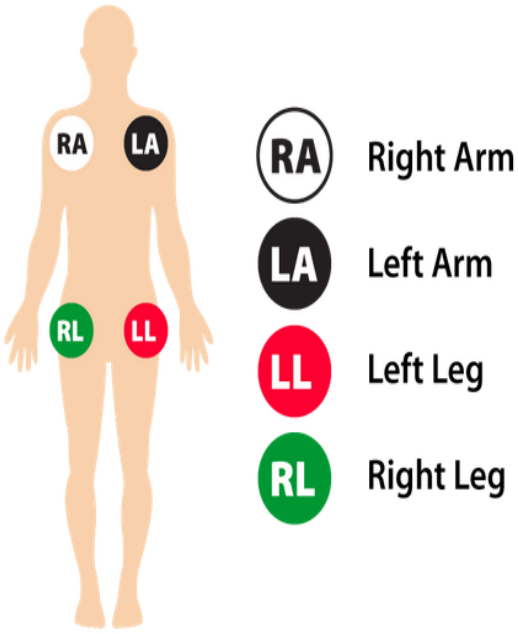
2) Limb (Extremity) Electrodes and Placement



» RA (Right Arm) - Anywhere between the right shoulder and right elbow

» RL (Right Leg) - Anywhere below the right torso and above the right ankle

» LA(Left Arm) - Anywhere between the left shoulder and the left elbow

» LL (Left Leg) - Anywhere below the left torso and above the left ankle

Fig4. Setup of ECG Signal Recording (Limb)

5. Results

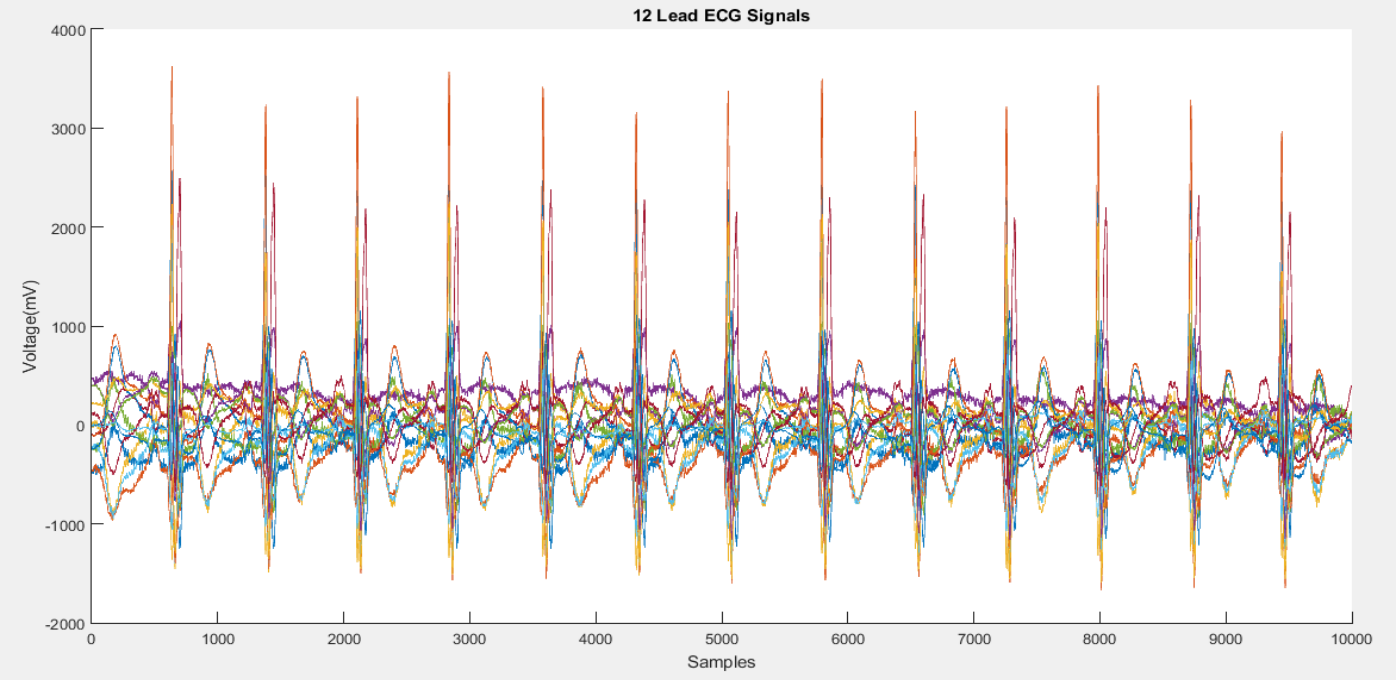


Fig5. 12 Lead ECG Signals.

The figure5 represents the 12 lead ECG signals which are placed at various parts of the chest. Each lead records its own ECG waveform and is displayed in the above figure5.

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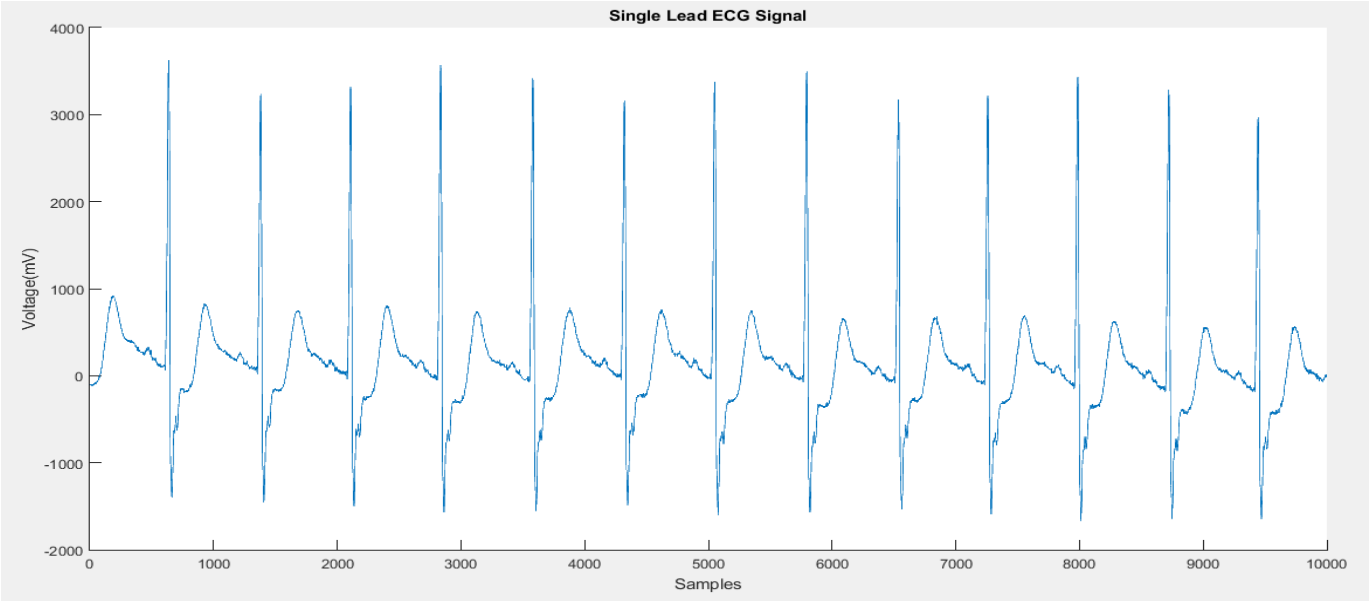

Fig6. ECG Signal of Single Lead

The above figure6 represents the ECG waveform of single lead. This waveform has P, QRS Complex & T waves. The Peak represents the R point in the waveform. The local minima are represented by the S point. The starting wave of the signal is P wave.

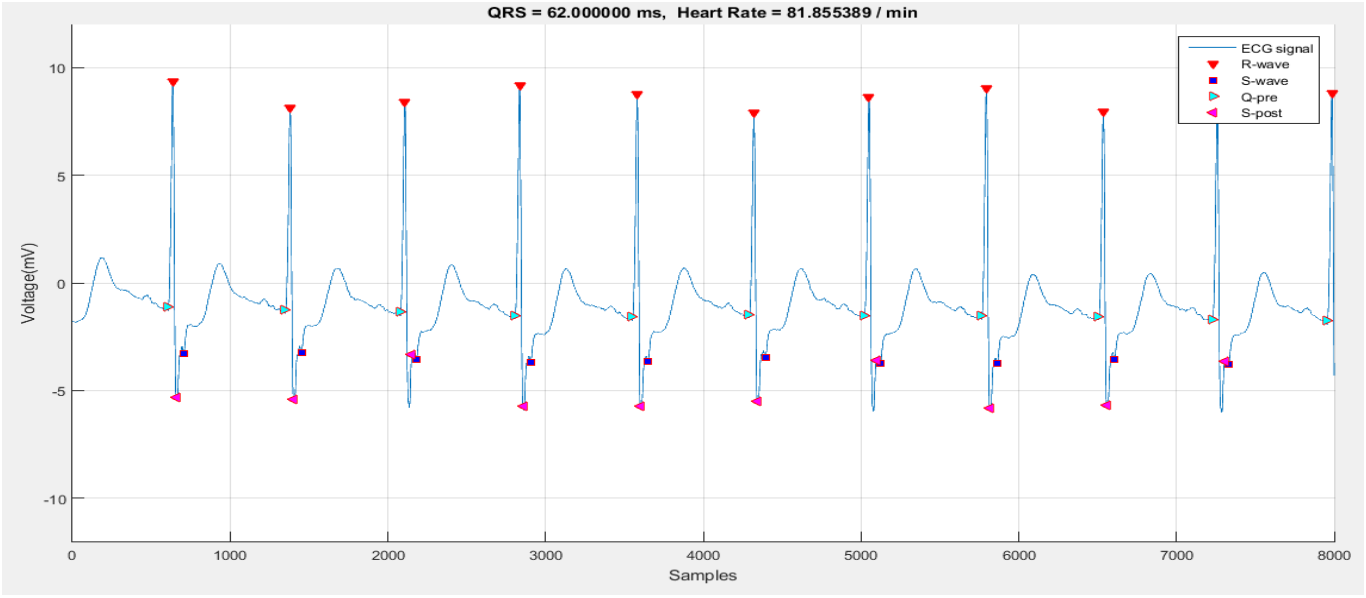

Fig7. Wave Depiction of ECG

In the above figure7, R point is represented by heart symbol in red color. The Q wave is represented by the sky blue color and the S point is represented by pink color and the S-post wave is represented by the violet color symbol.

Case 1)

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Ventricular Fibrillation: The Ventricles twitch in feeble, uncoordinated fashion with no blood being pumped from the heart. The ECG is very much uncoordinated as shown in fig-8.

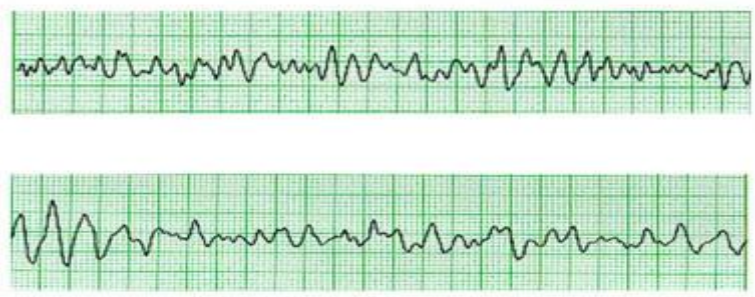

Fig8. Ventricular Fibrillation

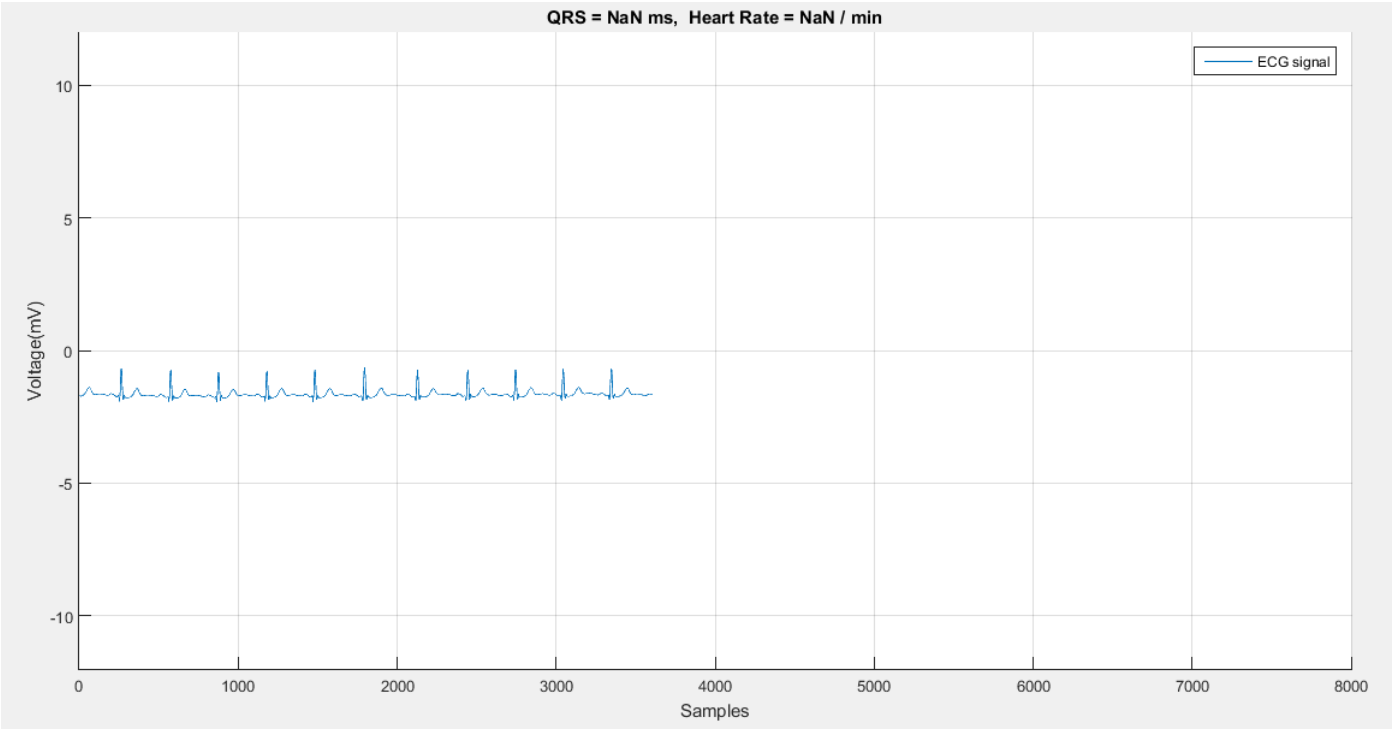

Fig9. ECG wave for Ventricular Fibrillation

In the figure9, the ECG signal for Ventricular Fibrillation has been displayed. The waveform shows that only P wave can be detected. The QRS complex does not exist and hence Heart Rate cannot be calculated.

Case 2)

Atrioventricular Block: It is a state of complete heart block. Cells in the AV node are dead and activity cannot pass from atria to ventricles. Atria and ventricles beat independently.

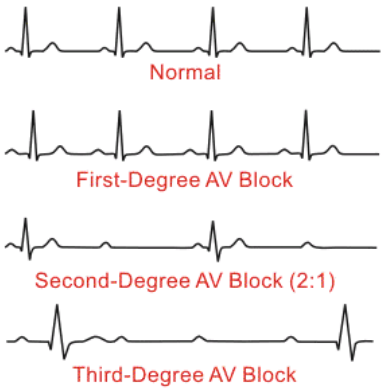

Fig10. Atrioventricular Block (AV Block)

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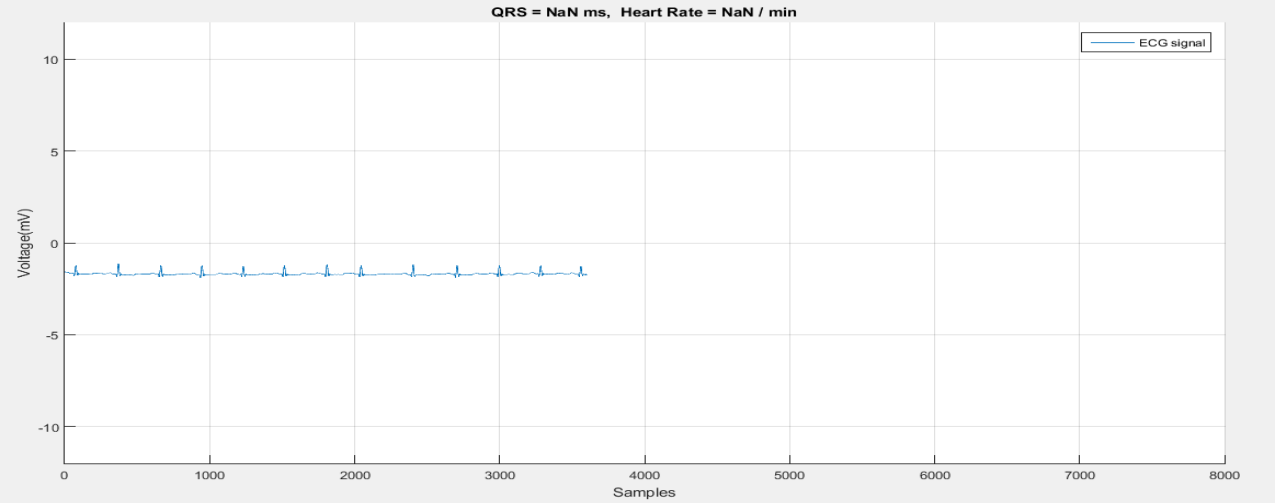

Fig10: Atrioventricular Block for ECG Signal

There is no correlation between atria and ventricular observed in fig-10.

6. Conclusions:

Heart Rate = 81.85 beats/min.

QRS Period = 62 milliseconds.

Data set: The ECG signals which are used in this work are a part of MIT-BIH Arrhythmia Database given on the website of MIT [6]. This work proposes a new method to detect the QRS complex from wavelet based approaches. The main contribution of this work is in the detection of QRS complex by using the properties of R peaks. We have distinguished the sharp variation in the ECG by relating them to the local maxima and minima in wavelet transform across different scales. At this stage the algorithm has been tested on part of MIT-BIH arrhythmia database and the result obtained were quite encouraging to improve and test this algorithm for other data set as well. In the future, this algorithm can be used to detect the type of disease the person may be suffering through. This algorithm can give us the time period for P-wave, Q-wave.

Reference

1. [Online]. Available: http://zone.ni.com/devzone/cda/tut/p/id/6349
2. [Online]. Available: http://matlab-project-codes.blogspot.com/2010/08/algorithms-for-ecgs ignal-analysis.html
3. [Online]. Available: http://matlab-project-codes.blogspot.com/2010/08/ecg-noisereduction. html
4. [Online]. Available: http://www.owlnet.rice.edu/~cmoran/ELEC301FI NAL_POSTER_EE EEEEEEE.pdf.
5. D. Balasubramaniam and D. Nedumaran, “Implementation” of ECG Signal Processing and Analysis Techniques in Digital Signal Processor based System,” MeMeA 2009 - International Workshop on Medical Measurements and Applications, Cetraro, Italy, May 29-30, 2009.
6. S. Correia, J. Miranda, L. Silva, and A. Barreto, “Labview and Matlab for ECG Acquisition, Filtering and Processing,” 3rd International Conference on Integrity, Reliability and Failure, Porto/Portugal, pp. 20-24, 2009.
7. A. K. M. F. Haque, H. Ali1, M. A. Kiber, and Md. T. Hasan, “Detection of Small Variations of ECG Features Using Wavelet,” ISSN 1819-6608, ARPN Journal of Engineering and Applied Sciences, vol. 4, no. 6, pp 27-30, 2009.
8. P. R. Gomes, F. O. Soares, and J. H. Correia, “ECG Self – Diagnosis System at P- R Interval,”.
9. Y. D. Lin and Y. H. Hu, “Power-Line Interference Detection and Suppression in ECG Signal Processing”- IEEE Transactions On Biomedical Engineering, vol. 55, no. 1, January 2008.
10. K. Jamshaid, O. Akram, F. Sabir, S. I. Shah, and J. Ahmed, “Application of Adaptive and Non Adaptive Filters in ECG Signal Processing”. [12] J. Merilahti, M. V Gils, T. P. Hult, O. K. E. Hyvärinen, J. Hyttinen, and H. Kailanto “ECG monitoring of cardiac patients at home: experiences with scenarios and signal processing methods”.
11. V Vinoth Kumar, K. S. Arvind, S. Uma Maheswaran, Suganya K.S, **“**Hierarchal Trust

Published by: The Mattingley Publishing Co., Inc.

January - February 2020
ISSN: 0193 - 4120 Page No. 7872 - 7881

Certificate Distribution using Distributed CA in MANET" International Journal of Innovative Technology and Exploring Engineering, (2019), Vol.08, Issue.10, pp.2521-2524.

12. Basu, S., Kannayaram, G., Ramasubbareddy, S., &Venkatasubbaiah, C. (2019). Improved Genetic Algorithm for Monitoring of Virtual Machines in Cloud Environment. In *Smart Intelligent Computing and Applications* (pp. 319-326). Springer, Singapore.
13. Somula, R., &Sasikala, R. (2018). Round robin with load degree: An algorithm for optimal cloudlet discovery in mobile cloud computing. *Scalable Computing: Practice and Experience*, *19*(1), 39-52.
14. Somula, R., Anilkumar, C., Venkatesh, B., Karrothu, A., Kumar, C. P., &Sasikala, R. (2019). Cloudlet services for healthcare applications in mobile cloud computing. In *Proceedings of the 2nd International Conference on Data Engineering and Communication Technology* (pp. 535-543). Springer, Singapore.
15. Somula, R. S., &Sasikala, R. (2018). A survey on mobile cloud computing: mobile computing+ cloud computing (MCC= MC+ CC). *Scalable Computing: Practice and Experience*, *19*(4), 309-337.
16. Somula, R., &Sasikala, R. (2019). A load and distance aware cloudlet selection strategy in multi-cloudlet environment. *International Journal of Grid and High Performance Computing (IJGHPC)*, *11*(2), 85-102.
17. Somula, R., &Sasikala, R. (2019). A honey bee inspired cloudlet selection for resource allocation. In *Smart Intelligent Computing and Applications* (pp. 335-343). Springer, Singapore.
18. Nalluri, S., Ramasubbareddy, S., &Kannayaram, G. (2019). Weather Prediction Using Clustering Strategies in Machine Learning. *Journal of Computational and Theoretical Nanoscience*, *16*(5-6), 1977-1981.
19. Sahoo, K. S., Tiwary, M., Mishra, P., Reddy, S. R. S., Balusamy, B., &Gandomi, A. H. (2019). Improving End-Users Utility in Software-Defined Wide Area Network Systems. *IEEE Transactions on Network and Service Management*.
20. Sahoo, K. S., Tiwary, M., Sahoo, B., Mishra, B. K., RamaSubbaReddy, S., &Luhach, A. K. (2019). RTSM: response time optimisation during switch migration in software-defined wide area network. *IET Wireless Sensor Systems*.
21. Somula, R., Kumar, K. D., Aravindharamanan, S., &Govinda, K. (2020). Twitter Sentiment Analysis Based on US Presidential Election 2016. In *Smart Intelligent Computing and Applications* (pp. 363-373). Springer, Singapore.
22. Sai, K. B. K., Subbareddy, S. R., &Luhach, A. K. (2019). IOT based Air Quality Monitoring System Using MQ135 and MQ7 with Machine Learning Analysis. *Scalable Computing: Practice and Experience*, *20*(4), 599-606.
23. Somula, R., Narayana, Y., Nalluri, S., Chunduru, A., &Sree, K. V. (2019). POUPR: properly utilizing user-provided recourses for energy saving in mobile cloud computing. In *Proceedings of the 2nd International Conference on Data Engineering and Communication Technology* (pp. 585-595). Springer, Singapore.
24. Vaishali, R., Sasikala, R., Ramasubbareddy, S., Remya, S., &Nalluri, S. (2017, October). Genetic algorithm based feature selection and MOE Fuzzy classification algorithm on Pima Indians Diabetes dataset. In *2017 International Conference on Computing Networking and Informatics (ICCNI)* (pp. 1-5). IEEE.
25. Somula, R., &Sasikala, R. (2019). A research review on energy consumption of different frameworks in mobile cloud computing. In *Innovations in Computer Science and Engineering* (pp. 129-142). Springer, Singapore.
26. Kumar, I. P., Sambangi, S., Somukoa, R., Nalluri, S., &Govinda, K. (2020). Server Security in Cloud Computing Using Block-Chaining Technique. In *Data Engineering and Communication Technology* (pp. 913-920). Springer, Singapore.
27. Kumar, I. P., Gopal, V. H., Ramasubbareddy, S., Nalluri, S., &Govinda, K. (2020). Dominant Color Palette Extraction by K-Means Clustering Algorithm and Reconstruction of Image. In *Data Engineering and Communication Technology* (pp. 921-929). Springer, Singapore.
28. Nalluri, S., Saraswathi, R. V., Ramasubbareddy, S., Govinda, K., & Swetha, E. (2020). Chronic Heart Disease Prediction Using Data Mining Techniques. In *Data Engineering and Communication Technology* (pp. 903-912). Springer, Singapore.
29. RuhinKouser R, Manikandan T,Vinoth Kumar V, "Heart Disease Prediction System Using Artificial Neural Network, Radial Basis Function and Case Based Reasoning " Journal of Computational and Theoretical Nanoscience,Vol.15,No(9/10),pp.2810-2817,(2018), ISSN: 1546-1963
30. Srinivas, T. A. S., Ramasubbareddy, S., Govinda, K., &Manivannan, S. S. (2020). Web Image Authentication Using Embedding Invisible Watermarking. In *International Conference on*

January - February 2020
ISSN: 0193 - 4120 Page No. 7872 - 7881

Intelligent Computing and Smart Communication 2019 (pp. 207-218). Springer, Singapore.
31. Krishna, A. V., Ramasubbareddy, S., &Govinda, K. (2020). A Unified Platform for Crisis Mapping Using Web Enabled Crowdsourcing Powered by Knowledge Management. In *International Conference on Intelligent Computing and Smart Communication 2019* (pp. 195-205). Springer, Singapore.
32. Saraswathi, R. V., Nalluri, S., Ramasubbareddy, S., Govinda, K., & Swetha, E. (2020). Brilliant Corp Yield Prediction Utilizing Internet of Things. In *Data Engineering and Communication Technology* (pp. 893-902). Springer, Singapore.
33. Kalyani, D., Ramasubbareddy, S., Govinda, K., & Kumar, V. (2020). Location-Based Proactive Handoff Mechanism in Mobile Ad Hoc Network. In *International Conference on Intelligent Computing and Smart Communication 2019* (pp. 85-94). Springer, Singapore.
34. Bhukya, K. A., Ramasubbareddy, S., Govinda, K., & Srinivas, T. A. S. (2020). Adaptive Mechanism for Smart Street Lighting System. In *Smart Intelligent Computing and Applications* (pp. 69-76). Springer, Singapore.
35. Srinivas, T. A. S., Somula, R., &Govinda, K. (2020). Privacy and Security in Aadhaar. In *Smart Intelligent Computing and Applications* (pp. 405-410). Springer, Singapore.
36. Dhilip Kumar V, Vinoth Kumar V, Kandar D, "Data Transmission Between Dedicated Short-Range Communication and WiMAX for Efficient Vehicular Communication" Journal of Computational and Theoretical Nanoscience, Vol.15, No.8, pp.2649-2654, (2018), ISSN: 1546-1963
37. V.VinothKumar,S.Ramamoorthy, "A Novel method of gateway selection to improve throughput performance in MANET",Journal of Advanced research in Dynamical and Control Systems",2017, ISSN 1943-023X
38. Karthikeyan T, Karthik Sekaran,Vinoth kumar V**,** Balajee J M, **"**Personalized Content Extraction and Text Classification Using Effective Web Scraping Techniques"International Journal of Web Portals (IJWP),11(2), pp.41-52, (2019)
39. JayasuruthiL,ShaliniA,Vinoth Kumar V.,(2018) "Application of rough set theory in data mining market analysis using rough sets data explorer" Journal of Computational and Theoretical Nanoscience,15, pp.2126-2130.
40. Umamaheswaran, S., Lakshmanan, R., Vinothkumar, V., New and robust composite micro structure descriptor (CMSD) for CBIR. International Journal of Speech Technology (2019) doi:10.1007/s10772-019-09663-0 (Springer)