Effective analysis and accurate detection of common diseases in ECG signals and classifications and monitoring through cloud computing technology

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Abstract: In the modern age of technology and advancements, the world is shrinking and accessible to everyone, in all ways including the medical field at the outset to save the lives. As the various experts are spread over the globe with their expertise, even the human dis-orders are also growing equally with the same speed. Hence it requires an assimilation of various sensors, embedded systems and some regularized protocol for hassle free interaction over the finger tips. In the proposed work we are attempting to interface few biosensors to capture ECG signals and to perform parametric estimation on breath-rate, heart beat rate, systolic pulse and other required parameters to classify the signal into any disease oriented or normal human being and uploaded the results along with type of disease. From the cloud, the concern medical experts can access and can treat the patient for further diagnosis. In this paper we are considering Epilepsy, heart beat rate, systolic pulse compared with normal condition of the human being. To classify the recorded ECG signals to discriminate among above condition we make use of Artificial Neural Network model and the entire processing of bio-medical signals are done on Matlab Platform. The processing of database is selected from the standard universally available database MIMIC II. The Matlab processed signals are again processed over a common protocol to communicate to the expert for exact diagnosis of the patient conditions over the captured bio-signals, the entire system we make use of modified LED algorithm and we term it as Health-Raid algorithm.

Key-Words: - ANN, Cloud Computing, ECG, Heart Monitoring System, MLED and RTP-RTCP.

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1 Introduction

Electroencephalographic recording system serves to the examination of a brain activity. Depending on a human brain activity, several types of electroencephalographic (ECG) waves can be distinguished. Deviations of the normal ECG waves corresponding to alpha or beta activity, i.e. sharp spikes, can refer to pathologic patterns accompanying neurotically illnesses. Based on a detection of pathologic patterns recurring with period of one or a few seconds in ECG signal, electroencephalographic recording system has been used to diagnose diseases such as epilepsy or polio. Because of the important role of the ECG examination in neurological diseases diagnostics, there have been several attempts to simulate a real ECG signal by artificial models. Modelling of the ECG signals is a very wide academic area divided in several branches. A brief overview of possible branches of ECG modelling is introduced.

2 Related Work

In the recent century it has witnessed the utilization of advancements in the domain of information and communication technology [15]. The information communication and technology has a major impact including medical clinical field. To diagnosis heart related issues based on ECG, the ECG record obtained is diagnosed on the input data received for further follow up and consultation with the utilization of technology advancements and tis trends. The important organ of cardiovascular system of any human body is the heart. The cardiac tissues that relaxes and contracts in a particular repetitive frequency which is responsible for the circulation of blood over the body. With the usage of the combination of the ECG & ECG signals we are proposing to identify the disorders of the human body i.e., cardiac disorder, paralysis, internal joint disorders and it is compared with the normal human being through the predefined protocol for transmission in real time with suitable media for data exchange [16].

In [2] syncretizes the principal idea of the Sea Computing model in Internet of Things and the steering convention of the remote sensor arrange, and proposes another directing convention CASCR (Context-Awareness in Sea Computing Routing Protocol) for Internet of Things, in view of setting mindfulness which has a place with the key advancements of Internet of Things. Moreover, the paper depicts the subtleties on the convention in the work process, information structure and quantitative calculation etc [14].

At long last, the recreation is given to investigate the work execution of the convention CASCR. Hypothetical examination and analysis check that CASCR
has higher vitality proficient and longer lifetime than the congeneric conventions. The paper improves the hypothetical establishment and makes some commitment for remote sensor system traveling to Internet of Things in this examination stage [17].

In [3] investigated IoT from various points and here we outline the exercises learned by this audit. To start with, from the market openings points of view, venture on this new innovation is sane for associations looking for market intensity. From the design perspective, the layered structure of IoT frameworks is embraced well by IoT systems and research endeavours [4]. In any case, the quantity of layers and their degrees are characterized distinctively relying upon the fundamental frameworks and innovations. As adaptability and interoperability have an extraordinary significance in IoT applications, expanding the design without hardly lifting a finger these issues. The five-layer engineering [4, 5] present such a model. The intense increment in urbanization in the course of recent years requires practical, proficient, and savvy answers for transportation, governance, environment, personal satisfaction, etc. The Internet of Things offers many complex and omnipresent applications for keen urban communities [13]. The vitality request of IoT applications is expanded, while IoT gadgets keep on developing in the two numbers and prerequisites. Along these lines, brilliant city arrangements must be able to productively use vitality and handle the related difficulties. Vitality the executives is considered as a key worldview for the acknowledgment of complex vitality frameworks in shrewd urban communities [6]. In this article, we present a short outline of vitality the executives and difficulties in brilliant urban areas. We at that point give a bringing together structure to vitality productive enhancement and planning of IoT-based shrewd urban communities. We likewise examine the vitality gathering in shrewd urban areas, which is a promising answer for broadening the lifetime of low-control gadgets and its related difficulties [12]. We detail two contextual analyses. The first targets vitality effective planning for brilliant homes, and the second covers remote power exchange for IoT gadgets in shrewd urban areas. Reproduction results for the contextual investigations exhibit the enormous effect of vitality proficient planning advancement and remote power exchange on the exhibition of IoT in shrewd urban areas [7].

Constant mixed media applications are frequently sent to give basic data in circumstances, for example, news inclusion of an occasion or an episode or an rescue vehicle racing to give crisis care. Portable cell inclusion

and execution of a supplier system differs both spatially and transiently and moves the capacity of the system to help continuous system access and application progression [20]. We recommend that between suppliers handoffs could reduce this issue, given the ongoing multiplication of Dual SIM Dual Active (DSDA) gadgets what's more, the likelihood of Multi SIM Multi Active gadgets by arranging workstations with numerous remote broadband associations. We propose an application QoS mindful portability the board approach. The product execution is named as SeaMoX and dependent on SeaMo+, a previous usage. We utilize live video spilling for instance application and exhibit the effect of system choice and handoff by looking at the playback at the recipient, which uses a versatile jitter cushion algorithm [21].

3 System Architecture

In the proposed system it can be broadly classified into six different steps namely initially data acquiring through the bio-sensor network for the analysis of various parameters such as Heart rate (HR), Respiration rate (RESP), Systolic blood pressure (ABPsys), PLETH)Oxygen saturation (SpO2) and common diseases. Which are fed as input for the ECG signal construction and after drawing Raw ECG signals it is segmented into five different types of ECG waves which are frequency dependent signals for analysis. The overall representation of the proposed system is as shown in Fig.1.

ECG signal: ECG signals are the powerful tool that has the capability to reflect all the activities of the brain from all the various parts of the brain viz., Central Nervous System (CNS) which comprised of Spinal cord and Peripheral Nervous System (PNS). ECG signals are essential enough to understand the dynamism of brain and also to monitor the various physiological states with its diagnosis of neurological analysis. These ECG signals are the respondent signals recorded with 10000–100000 neurons parallel and gathered with various bio-sensors attached to human body in part of the scalp region. These signals not only limited to study of neurons but also it is highly subjective to detect Epilepsy, tumorous cell behaviours and compared with the normal recording of ECG [8, 9].

Majorly ECG systems in these days, are digital are amplified and is digitized via an available analogy-to digital converter, after being passed through an anti-aliasing filter. Analogy-to digital sampling typically occurs at 256-512 Hz in clinical scalp ECG; sampling rates of up to 20 kHz are used in some research applications [18]. In these Scalp ECG signals are recorded using various biosensors which are similar to older electrodes to capture raw ECG signal for processing.

The ECG signals are comprised of five different types of signals which are classified based on the frequency range with the RAW data analysis ranging from 0.5 - 45 Hz and it is digitally enhanced with 8 or 9 bit representation to get 256 Hz or 512 Hz [23].

ECG Signal: Electrocardiography (ECG) is the process of recording the electrical activity of the heart over a period of time using electrodes placed over the skin. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle's electrophysiological pattern
of depolarizing and repolarising during each heartbeat. It is very commonly performed to detect any cardiac problems [10].

Database:

In this paper standard clinical database from the MIMIC is an openly available dataset developed by the MIT Lab for Computational Physiology, comprising de-identified health data associated with ~40,000 critical care patients. Test images: convert to packets and transmit through our network simulation. The Properties of image having 360*360mm dimension. Test images having same file type PNG File with the file size of 320kB [22]. The ECG and ECG signals are acquired from standard database of MIMIC-II and through pre-processing of the signals are converted into packest based header format shown in Fig.3. In this work, totally four different multimedia metadata's are considered such as ECG, EEG, Audio and Image data's and all datasets are converted into packets, these packets has session ID, sun-SID, sub-sub-SID, flow ID, sub-sub-FID, node counter and timing setup for counter of packets shown in Fig.3.

With the acquired database from the ECG different sensors from the human body, the complete set of data received from the sensor will form the wireless body sensor network ready for the data transmission using the required protocols i.e., RTP & RTCP for error free communication, then as defined by the essential software for analytics and data processing.

Thinkspeak is considered with the peculiar password in which only expert doctor can view from the remote place for the consultation and advice by receiving the cumulative data from RTP & RTCP through e-health monitoring system, in the proposed system in the RTP & RTCP protocol data compression and decompression is achieved using wavelet based technique with consideration of symlet and debauche method.

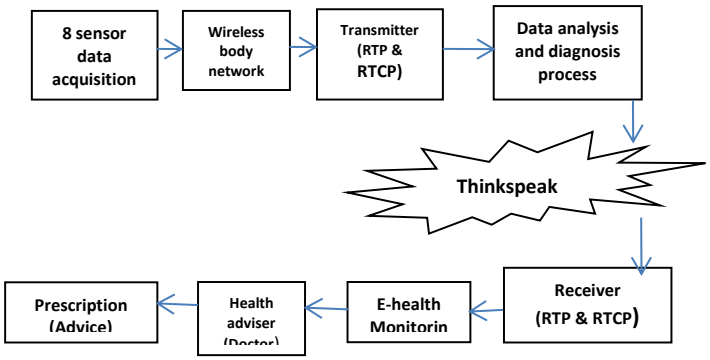

Fig.1. Proposed block diagram of Data Packets transmission and storage in Cloud

3.1 Holomorphic Cryptography algorithm

ECG signal is input to the algebraically holomorphic which are converted into integers for the given plaintext $P \in Z \cap [-2^{P-1}, 2^{P-1}]$ and any key integer$KI \in KI_p$[28].
Inputs: Plaintext and Secrete Key: P_1 and SK_1
Outputs: Integer Value: I_v

X_2 = [P1, SK1] mod

X_0= P_1. (QQ'+PQ_1) mod X
= QQ'+PP_1Q_1-T_1 PQ_0 for any integer values of T_1
$=QQ'P_1 + P(P_1Q_1 - K_1Q_0) = QQ'P_1 + PQ'$

I_v = [outputs] =$[Y + Y_2.X_2]modX_0$

$$Y + N_2 mod P_1$$

$Y + QQ'P_1 + P(Y_2Q^1)mod$ X_0 for the integer K_2

=Y+QP_1+PQ for the given integer P and Q.

The output of the CT is a nearly to numerous of integer P.

In a traditional 12-lead ECG, ten cathodes are put on the patient's appendages and on the outside of the chest. The general extent of the heart's electrical potential is then estimated from twelve unique points ("leads") and is recorded over some stretch of time (normally ten seconds) [11]. Right now, by and large greatness and bearing of the heart's electrical depolarization is caught at every minute all through the cardiovascular cycle. The chart of voltage versus time delivered by this non-invasive clinical technique is an electrocardiogram. There are three primary parts to an ECG: the P wave, which speaks to the depolarization of the atria; the QRS complex, which speaks to the depolarization of the ventricles; and the T wave, which speaks to the repolarization of the ventricles [19].

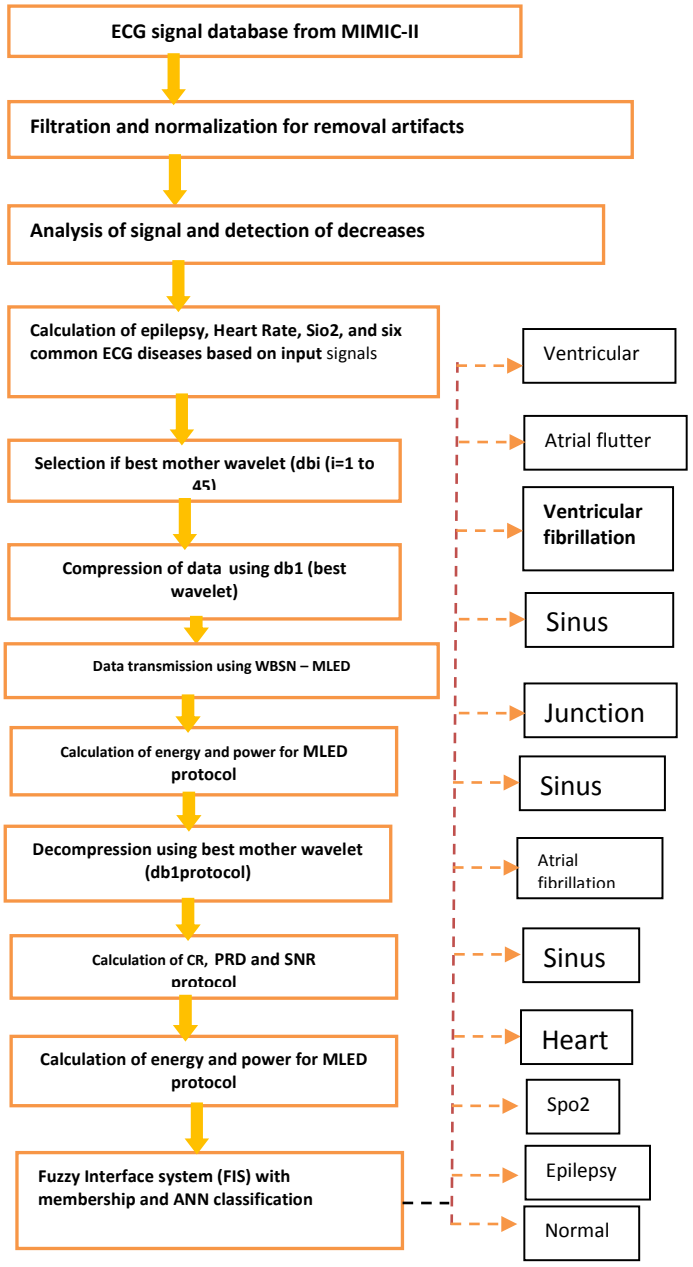

Fig 2: Proposed Automated diagnosis system using advanced protocol and adaptive compressive sensing technique with cloud storage.

By the analysis of individual ECG signals it considered for the analysis of wavelet based approach in which CWT and DWT are used in combination as mother wavelet due to its advantage of variable window size with wider response for the low frequency and sharp for the higher frequency signals of ECG. These mother wavelets are derived from the

various functions through the dilation and translation which are well suited for analysis for sudden and transient signal variation. These wavelet based approach is opted for the reason of its capability of irregular impulse signal arrival at various interval of time.

In the mother wavelet based approach g(n) shown in Fig.1. Acts as high pass filter and h(n) will serve as low pass filter in DWT analysis [24].
In CWT analysis it is analysed as scaling and translation parameter for signal representation. With the feature extraction from the wavelet based analysis it is an essential parameter for the neural network based classifier for identification of normal or any disorder oriented ECG signals viz., Epilepsy, tumour or any other kind of disorders of the patient under consideration. These neural network based approach has been provided with parameters such as homogeneity, energy, correlation and contrast at the input layers. All the parameters under consideration is treated with predefined weights W_i and applied with transformations for the frequency and time domain. The decision network is provided with the activation parameter such as 'φ' for classification of ECG signal as shown in Fig.2.

	Co-efficient	GAMMA	BETA	ALPHA	THETA	DELTA	PRD
SYMLET Wavelet for TUMOUR ECG Signal	5	26	13	13	6	1	-1.55
	10	53	28	15	5	1	1.33
	15	57	14	7	7	1	0.69
	20	29.00	29	14	4	1	1.36
DEBAUCHE Wavelet for TUMOUR ECG Signal	5	47	24	12	6	1	0.09
	10	53	14	7	3	1	-0.88
	15	30	29	14	9	1	0.83
	20	36	36	14	4	1	0.48
SYMLET Wavelet for EPILEPSY ECG Signal	5	16	8	8	4	1	-0.9
	10	33	18	9	3	1	0.92
	15	35	9	4	2	1	0.54
	20	18	18	9	5	1	0.96
DEBAUCHE Wavelet for EPILEPSY ECG Signal	5	29	15	7	4	1	0.13
	10	33	9	4	2	1	-0.38
	15	18	18	8	6	1	0.34
	20	23	23	9	3	1	0.09

Table 1: Various values of ECG signals, Wavelets and co-efficient.

The PRD analysis is done based on two different wavelets namely Symlet wavelet and debauche wavelet with the available coefficient in the range of 1 to 20.

The wavelet with the co-efficient 5, 10, 15 and 20 are tabulated in the table 2 and comparative graph is plotted as shown in fig 10, for the ECG signal with Tumour detection and Epilepsy disorder it is noted that PRD value should be as minimum as possible almost located around the axis would be good for accurate identification of disorder when compared with the normal condition. The various values of PRD is compared and analysed as shown in table1. Different signal analysis and to increase the accuracy of disorder detection.

The entire proposed algorithm is implemented based on modified LED (Local Emergency Detection) protocol as disused below

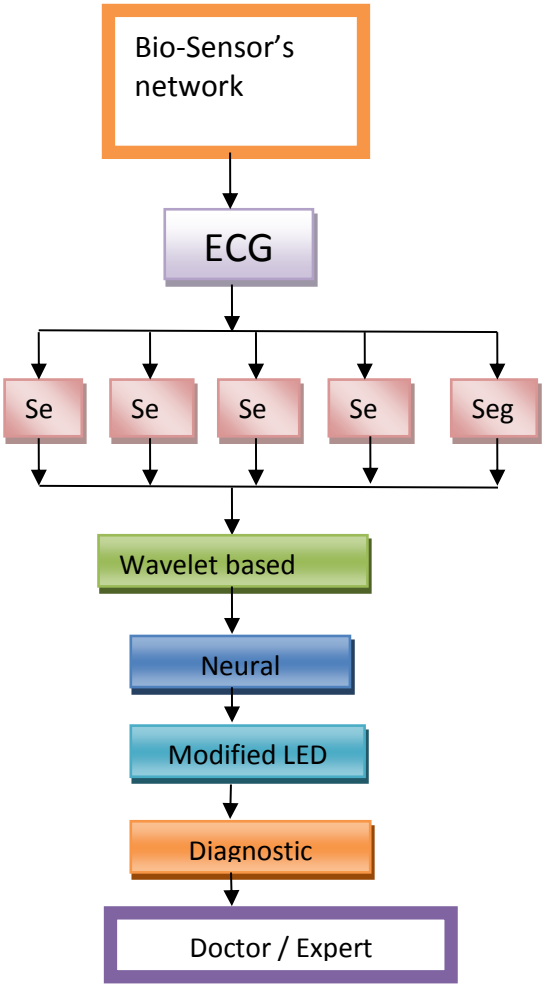

Fig.3. Proposed Automated diagnosis system using advanced protocol and adaptive compressive sensing technique with cloud storage.

3.2 FORMATION OF THE CLUSTERS FOR WSN

In this proposed work, four sensors are placed on the human body, one on head to acquired ECG signals, second on the heart to acquired ECG signals, third on the mouth to record the audio signals and fourth one database fundus images. These datasets are processed for cluster formulation to find the cluster head and base station of each signal as shown in Fig.4. Let that A is the cluster for CL1, CL2, CL3,……. CLA and their base stations are b1, b2, b3,…… bA. The equation (1) states that k-means objective function with base station bi, this can be update the CLi using equation (2).

$F(b_i, CL_i) = \sum_{i=1}^{b} \sum_{q_i \in CL_i} |q_i - b_i| \vee^{2}$ ----(1)

$b_i = \frac{1}{CL_i} \sum_{q_i \in CL_i} q_i$ ------(2)

For determination of distance between sensors and base stations is measured by using Euclidean distance and it is given by equation (3)

D ----------(3)

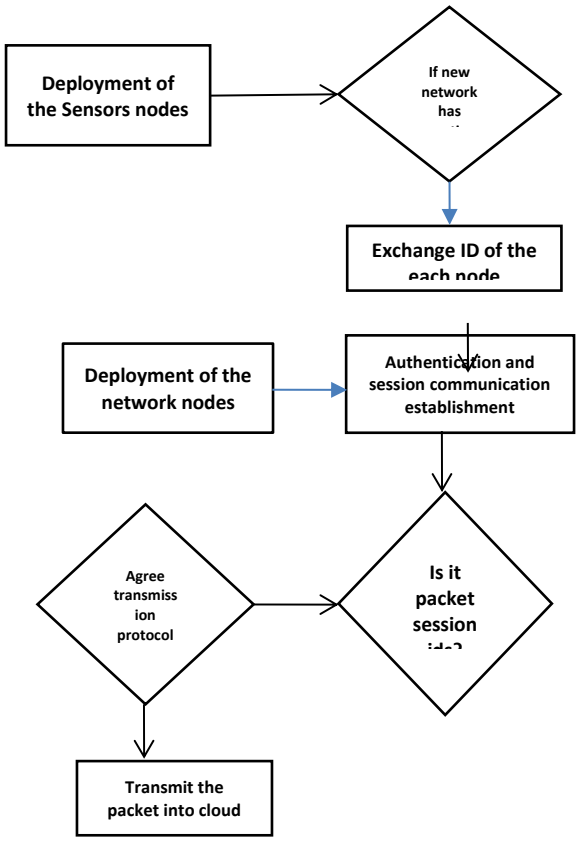

Fig.4. Proposed flow diagram of network creation and session ID and data storage in Cloud

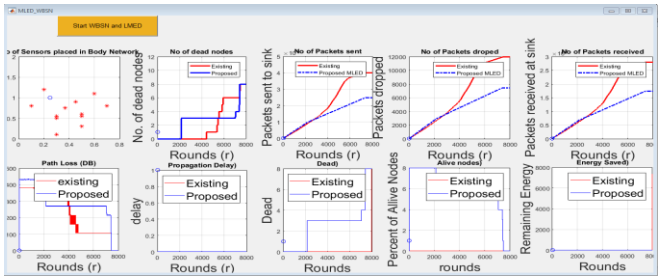

Fig.5. Simulation output towards the parameters of modified LED protocol.

The Fig.5. Shows the transmission of packets and uploading into cloud through MLED protocol and measurements of delay, energy consumed per packet and number packets lose during the process. The results shows that, delay and losses in the proposed work are optimized as compared to existing LEACH protocol. Every packet data is compressed using adaptive compressive sensing technique which uses the best mother wavelet selection i.e Daubechies approach with lessor PRD. The vanishing moment (P) of Daubechies is various from 1 to 45, out of which, one of the P will be selected based on lessor value of PRD. The lessor PRD values gives the more compression as shown in Fig. 8 [26, 27,29] and same packet is transmitted through RTP-RTCP protocol and its flow chart is depicted in the Fig.4.

3.3 RESULTS AND DISCUSSION

The complete design as per Fig.2. has been developed in MATLAB 2017a for more than 1000 sample of ECG of both normal and abnormalities and sample taken from MIMIC-II standard from Physionet.org. Each and every sample is tested with proposed algorithm for effective feature extraction and classifications, finally the results produced by proposed system are compared with standard results given in the physionet.org and it is found that 98% of sample are matched with standard results.

The identified abnormalities are successfully uploaded into cloud by making use of MLED which includes RTP-RTCP protocols with lesser energy consumption and higher throughput. All ECG signals along their abnormalities are stored in cloud for remotely monitoring by medical experts, the abnormalities calculations are measured by using heart rate and the detailed discussion as follows.

The six common diseases in ECG are measured from heart rate which has been calculated based on R-R

interval in seconds or minutes

i.e $heartrate = \frac{60}{R-R(Interval \in seconds)}$

The bradycardia disease will occurs in ECG signals when heart rate is less than 60bpm, the R wave in ECG signal is called Ventricular depolarization and it plays major role to detect bradycardia disease, the time interval between one R to another R has measured and as shown in Fig.6(a).

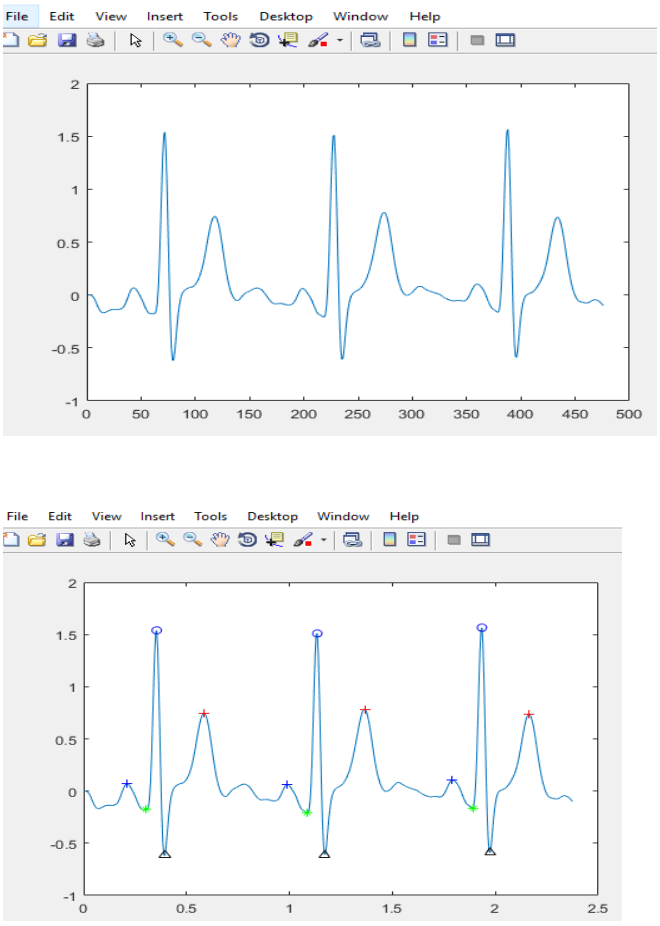

Fig.6 (a) Detection of R-R wave peaks

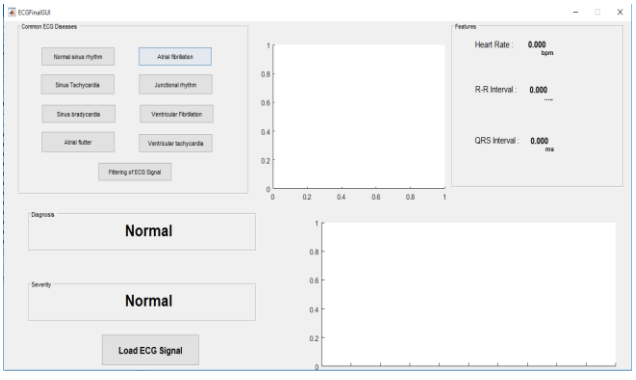

Fig.6.(b).Empty GUI of proposed diagnosis tool for effective classification of different diseases.

The complete design is developed in MATLAB 2017a in the form of GUI as shown in Fig.6 (b). in which, there are different options for selection of ECG from data base, analysis of different diseases and their characteristics. The Fully Automated Online Artifact Removal (FAOAR) algorithm has been used to remove or reduce the artifacts which is influenced in ECG signal during the acquisition from neurological operation. FAOAR is able to remove the maximum blinks and artifacts in ECG signals as shown in Fig.7.

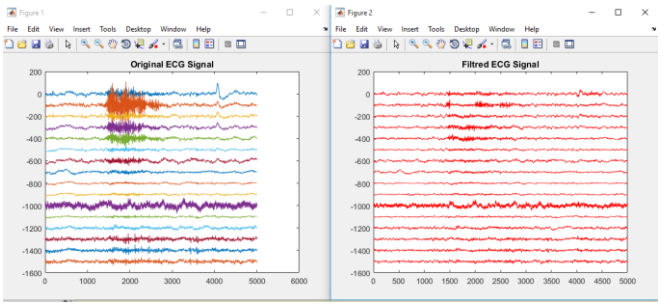

Fig.7. Simulated results of pre-processing for artifacts removal

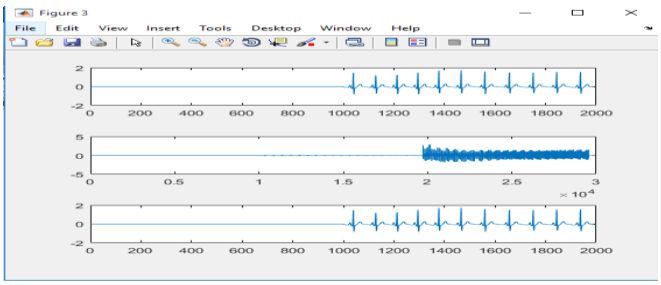

Fig.8. Simulated results of Data compression sensing techniques using Best Mother Wavelet

As observed in Fig.8, which depicts the representation of normal condition of ECG signal with mother wavelet which is majorly used for compression of data during transmission. It is noted that the density of ECG signals are normal no abnormalities can be noted majorly information is found in the main lobe of the mother wavelet when compared with the other two disorders as shown in Fig.7, which is used to represent Epilepsy and tumour condition respectively. It can be observed clearly that the density of the ECG signal is high for the Epilipsey disorder than the tumour signal under consideration. The mother wavelet output is the normalized output of the main lobe the variability is also depleted for the epilepsy whereas the tumour condition retain the similar value of normalization. The advantage of our proposed algorithm and system ie., modified LED algorithm is disorders can be identified noted by observing the ANN as shown in Fig.9, 10, 11,12,13 & 14.

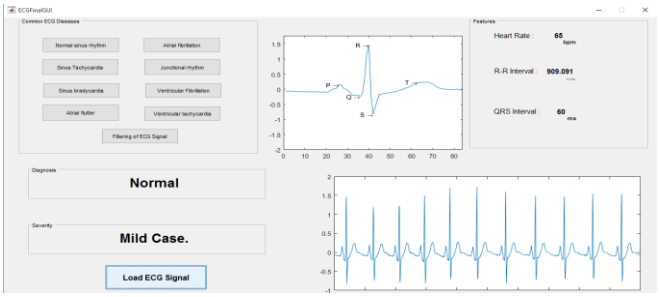

Fig.9. Normal ECG signal and its heart rate, R-R interval and QRS interval

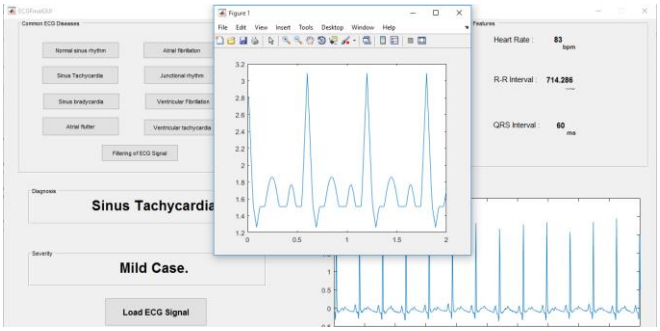

Fig.10. Detection of Sinus tachycardia disease and its heart rate, R-R interval and QRS interval.

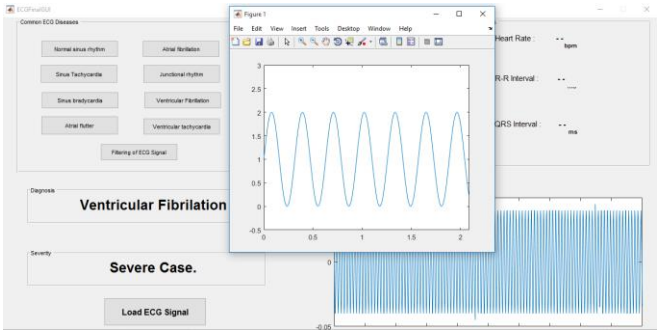

Fig.11. Severe case detection for Ventricular fibrillation disease and values of heart rate, R-R interval and QRS interval are more the limit.

The diagnosis of different diseases are analysed through the GUI and their results and classifications are shown in Fig.9 to Fig.14

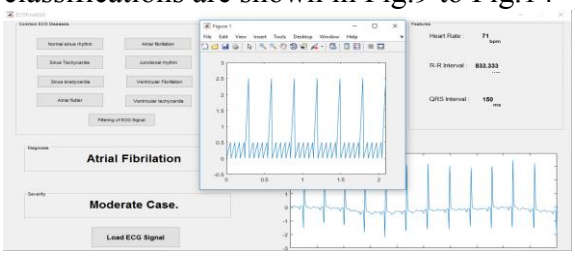

Fig.12. Moderate case detection in atrial fibrillation disease and values of heart rate, R-R interval and QRS interval are moderate values.

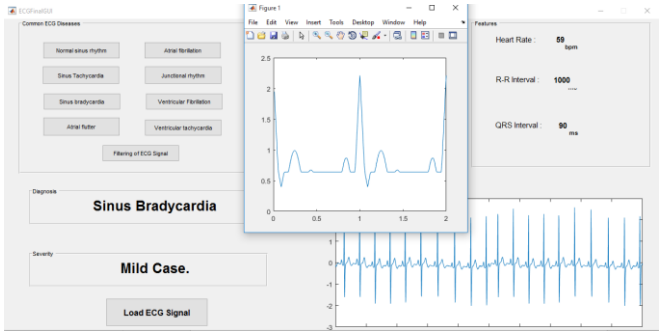

Fig.13. Mild case detection in sinus bradycardia disease and values of heart rate, R-R interval and QRS interval are moderate values

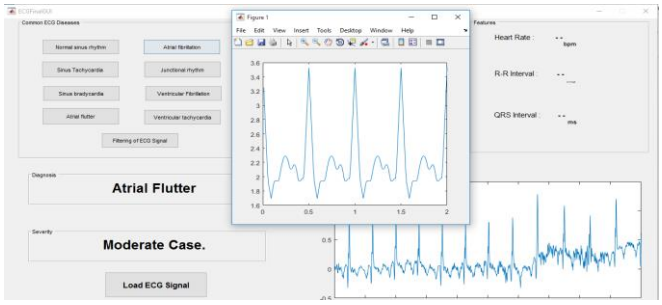

Fig.14. Moderate case detection in atrial flutter disease and values of heart rate, R-R interval and QRS interval are more than limit.

The atrial flutter disease occurs when heart rate is between 250 to 350 bpm which is too fast that the P wave are unable to identifiable.
In this paper, we have demonstrated to use multimedia data of the patient data which is captured using wireless capsule endoscopy images are processed using protocols RTP and RTCP protocol. As our application in the consideration is the data processing using the wavelet and uploading onto cloud storage

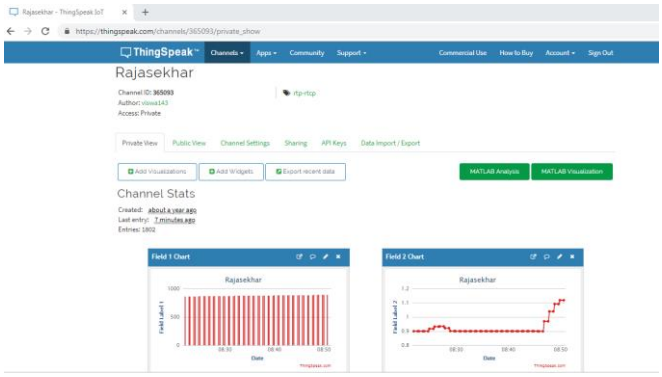

Fig.15. Interfacing of multimedia datasets to cloud through RTP-RTCP protocol by using thingSpeak.com

Parameter	Previous work	Proposed work
Packet loss	37.42%	19%
Throughput	230Mb	1.0744e+03
End to End delay	200ms	196ms
Delay Jitter	0.02s	0.0981s
Energy Efficiency	18.35%	21.33
Average energy dissipation for all rounds	NA	0.02004Jouls

Table 2: Comparative statement between previous work and proposed work

The proposed work i.e RTP and RTCP protocol for transmission of wireless capsule endoscopy images, ECG, EEG and audio signals which are called as multimedia data are successfully simulated in MATLAB 2017a and tested for WCE images and real time biomedical signals, from the obtained results, it is concluded that there is improvement for packet loss is 18.42%, improvement in throughput is 15%, energy efficiency is 3.02% and end to end delay is 4% as shown in Table.1

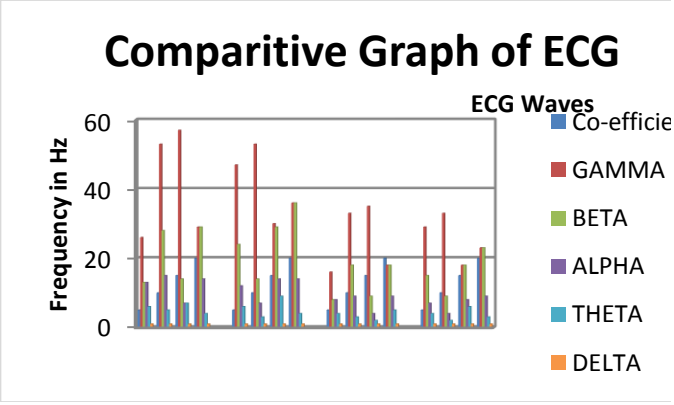

Fig 16: Comparative graph of various ECG signals and its frequency

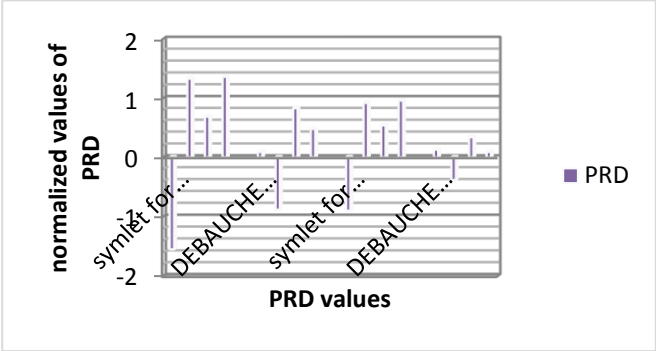

Fig.17: various PRD values for different wavelets and co-efficient

4 Conclusion

Patient monitoring and exact diagnosis of the disorder is becoming an challenging requirement for the existing healthcare system, meanwhile communication of the patient information through an dependable channel is more required without loss of any kind of information and data which are essential for patient analysis. Hence to meet the requirement of the today's world we have proposed a new system which is the combination of the kind of wireless body sensor network is termed as Health RAD system which incorporates the modified LED protocol by calculating the PRD values, thus provides the exact analysis of the disorder. In this context we have discussed three different conditions namely Normal ECG signal, ECG with Epilepsy and EEG signal with tumour, with the dependence of kind of ECG signal further it has analysed keenly with the consideration if all the five different types of ECG i.e., alpha, beta, gamma, delta and theta signals, it is noticed that delta waves have observed common frequency. For all the conditions, the data before transmission are compressed using mother wavelet technique for the better analysis of compress data with essential PRD values.

We have examined with two different kind of wavelets i.e., Symlet and Debauche, it is also pointed and studied the effect of variability of coefficients in the range of 5 to 20 in the interval of 5 units and the best coefficient is 15 for symlet in tumour detection, 5 for debauche wavelet. For epilepsy EEG signal coefficient 15 sample well in terms of symlet and coefficient 20 meets good for the debauche wavelet.

For data transmission using packet switching network is employed in terms of nodes, packets sent, packet dropped, propagation delay with its energy it is also observed that proposed method is best among the existing method and the comparative graph are plotted. The interesting factor of our consideration is the heart rate and Spo2 are constant in all the conditions under consideration.

5. Future Enhancement

Monitoring and accurate diagnosis of the disorder can be improved by adding video feature to the proposed work to meet the challenging requirement for the existing healthcare system.

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