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AnalyzingObstructive Sleep Apnea(OSA)Using Machine Perception and Wavelet taransforms

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Abstract: ***Obstructive Apnea is a respiratory based sleeping disorder where throat tissues falls back towards airways which it partially or completely blocks the airflow during the sleep. Due to the lack of airflow, oxygen levels in blood will drop suddenly which it increases blood pressure and strains cardiovascular system. This leads to increase the risk of Cardiovascular diseases, Stroke, Obesity, Diabetes, Hypertension etc. One of the most commonly diagnosed methodology for sleeping disorders is Polysomnography (PSG) which is expensive and takes much effort, due to these reasons in most of the cases sleeping disorders were undiagnosed. To overcome the drawbacks of PSG, practical and recent systems concentrate on the usage of electrocardiogram (ECG) for detection of OSA. To get precise ECG interpretation is essentially needed in order to evaluate the useful information inside the ECG signal. The standard method of visual analysis to evaluate the ECG signals by physicians are ineffective as well as time consuming. Therefore, an automated system which includes digital signal integration as well as evaluation is needed This paper proposes a system which it uses machine perception for analyzing ECG images and to detect the OSA abnormalities in ECG. Here the input data is taken in form of images instead of signals for accurate ECG interpretation. This can be done by using wavelet transforms, which is utilized to extract the coefficients of each ECG Simultaneously, auto regressive model (AR) is used to acquire the temporal structures of ECG wave forms, by using AR fit method. Based upon both wavelets transform as well as AR model their coefficients can be taken and integrated with each other to form a 1-D eigen vector where each vector represents a point in space. Based upon improvised Classification Algorithm, it can able to distinguishes between apnea and no apnea. Improvised classification Algorithm involves the combination of both K-Means as well as improvised KNN classifier is utilized to decrease the computation complexity and to increase the accuracy by using the hyper tuning parameters.***

Keywords: ***Obstructive sleep Apnea (OSA), ECG, Polysomnography (PSG), Machine Perception, Wavelet Transforms, Auto Regression (AR), Classification based KNN Algorithm, Clustered based K-means Algorithm.***

I. INTRODUCTION

On an average, humans spent their 1/3 of their life in sleeping. It rejuvenates memory, body, muscles, hormones and repairs by itself where as sleep disorder vanishes the benefits of qualitative sleep and starts effecting physical to emotional and emotional to psychological, which is having direct impact on life.

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Sleep Apnea is a critical berating-disorder problem and taking low breath while a person is sleeping. Breakage in breathing during Sleep is said to be Apnea and the lack of breathing in sleep is said to be Hypopnea. Symptoms of sleep Apnea varies from day time tonight time it won't affect only night time even it will effect by day time and the symptoms which can occur in day time was depression, memory loss, irritability, less concentration, day time sleepiness, fatigue whereasnight time symptoms include Snoring, Sweating, Restless Sleep, impatience[1].

During Sleep Apnea there will be a sudden decrease of oxygen levels in blood which it leads to cardiovascular disorders like hypertension, Myocardial infraction, Stroke, Fibrillation, Metabolic disorders as well. According to studies, Men will suffer more with Sleep disorder than compared to womeneven age can act as a factor for sleep Apnea. Apnea Severity is measured by exploitation symptom classification (AHI) wherever it shows range of apneas takes place during a hour of sleep. If AHI is greater than five per hour then there is no Apnea, if it was >15/hr.,then it was moderate.If it was more than>30/hr. it considered as severe. Sleep disorder causes cyclic variations in heartbeat and increasesthe pressure in circulating blood [2].

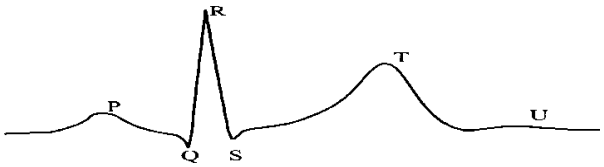

Fig 1: ECG wave representation

Based on severity and some physiological causes. Sleep Apnea is differentiated into three classes. They are: Preventive Sleep disorder (OSA), Central Sleep Disorder and Mixed Sleep Disorder. Obstructive Sleep disorder could be a quite common variety of sleep disorder where, throat tissues fall back towards airways and blocks the airways. It was largely prevailing in overweight males with massive tonsils and little jaw, and little gap for airflow. In Central Sleep Apnea (CSA), majorly the effect goes to brain due to lack of respiration and it is mostly rare and most dangerous case in Sleep Apnea. Mixed Disorder is that the combination of OSA and Central Apnea where they are going to suffer from OSA for a certain long period and CSA is might be in initial stage. Mostly used technique for diagnosing Sleep Apnea is Polysomnography (PSG) where it records and considers Breath flow, Metabolism, O2 Saturation, Position of the body, Electrocardiogram (ECG), Electroencephalogram,diagnostic procedure(EMG), due to all these it became expensive to diagnose and tedious and uncomfortable process.

For that reason, we need some better System to identify Sleep Apnea faster and better and inexpensive manner. For that we can use ECG which is easy to define [3].

ECG represents cardiacaction of the heart.In general ECG can betakenina paper for further diagnosis as shown in Fig.3 where physicians interpret the ECG based on shapes of the waves and their complexes and calculates parameters like height, interval of each wave. Conventional process is tedious and Error prone. For examining and retrieving the information in conventional manner takes lot of time as well as not effective hence there is a need for automatic System which should give more accurate, efficient & user friendly to analyze & to report the abnormalities in ECG. Wavelet Transforms is used to extract the data from ECG, it is used for classification based on training Algorithm[4].

Machine Perception is the capability of a computer in which it acts and interprets the data like a human even it achieves better than humans in terms of accuracy and in terms of time.Converting the physical records like ECG into digitalized time series reduces physical storage space as well as it enables improvisedtechniques for extracting the information[5].

ECG is widely classified into distinct waves to represent the heartbeat. They are P, QRS,T, U wave as shown in fig 1.Wave P regards todepolarized atria. The wave QRS constitutes the Depolarized ventricles. It contains small dip which follows large spike. T wave represents ventricular repolarization. Depolarization is also called as Hypopolarization where the action potential of a cell goes towards positive side. Repolarizationwhere cells internal charge goes towards negative side in ECG. Hyperpolarization is the opposite process towards Depolarization[5].

The main parameters in considering ECG is ST Elevation, inversion of T wave, Deep Q wave, RR interval. ECG contains twelve standardleads as shown in fig 2. In this paper a standardtwelve lead ECG recordings during sleep is considered as shown in fig .2[6]

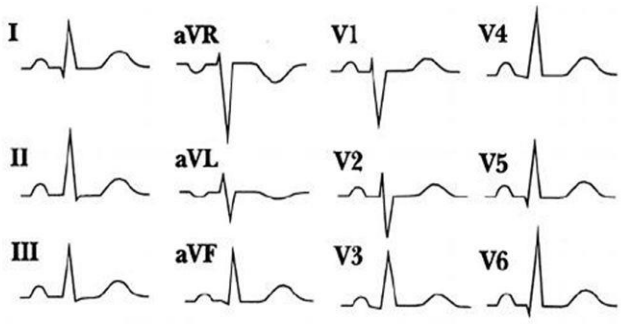

Fig.2: 12 leads of ECG

Directional Coupling of both Cardiac and Respiratory System depends on both classes of Sleep and OSA extremity.Respiratory Arrhythmia of Cardio respiration represents variation in heart rate. Where OSA is linked with both Cardio vascular & chronic diseases[7].

Integration of both clustered K-Means,classification based KNNby using on reevaluating the weights to decrease the processing complexity, the cluster centers of K-Means output used as the training sample for theK-NN algorithm achieves 87% accuracywith better computational speed[8].

The main objective is analyzing the ECG images based on the machine perception. Where ECG is taken in terms of images instead of signals to get the accurate results in orderto distinguish OSA. This can be done by using Wavelet Transforms and Auto Regressions (AR) models and classifiers based on combination of K-Means andimprovisedKNN using Hyper parameter tuningprocess. The introduced system will considerably reduce the overall computational time and provides efficiency and better accuracy than compared to previous methods which is mainly required indetecting OSA Which it is further leads to many other diseases.

II. LITERATURE SURVEY

Identifying OSA by collecting overnight ECG data within the type of signals, and it uses SVM for classification and tests whether the patient is having OSA or not[1].

Detecting Apnea based on heart rate analysis. And distinguishes the difference between Sleep disorder & Central Apnea disorder. Mainly concentrates on combining the both ECG as well as Oximetry methodologies in which it uses heart rate based upon ECG. Analysis of Cardio respiratory Coupling can be done to determine various Sleep stages based on breathing disorder[2].

Based on overnight ECG signals, it compares the the well-known Classification methods developed and used in previous experiments for sleep apnea detection. Based on experimental results on variety of classifiers where it uses same data as well as same features which it proves KNN classifier is the best for sleep Apnea detection[3]

Extracting the features from ECG based on Wavelet Transforms. Mainly focuses to differentiate between abnormal rhythms and with regular heart rhythm by using single led ECG signals. Feature Extraction is used to recognize reliable heart rhythm where it can be done by using Wavelet Transforms as well as with Automatic Regression Models [AR] based On ECG Signals. For Classification of ECG Signals SVM with Gaussian kernel is used[4]

Capturing of Data by Using Digital Image Processing. Visual analysis of ECG for detecting heart attack done by medical practitioners is inefficacious and time intense. An Automated device is required, for digitizing integrating, and analyzing the ECG wave. Resulted Report shows patients data as well accurate heart rate calculation and compares with other procedures of data capturing in terms of ECG image processing[5] By analyzing ECG, it is possible to identify a person from a predetermined group by using feature extraction. For that A 12-lead ECG is considered during rest and Multivariate analysis is used for identifying a person-based features extracted [6] Finding the relation between Cardio respiratory system and OSA which indicates how sleeping disorder increases the chance of risk & describes about sleep stages and their severity Shows the directional coupling between Cardio respiratory System and with OSA and indicates how the abnormality in one physiological system[7]

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Transforming, RGB to grey format is a complicated process where it loses contrast, sharpness and format of the image Where it mainly focuses to improve quality of grayscale image by calculating luminance and chrominance values[9]

Classification can't be performed if the data is larger it becomes harder.

Neural Network is efficacious in classifying the data yet choosing hyperparameter is a complex task. Focuses on hyper parameter tuning by using neural networks and evolutionary algorithms [10]

Evaluating different approaches which are used in previous cases and finding Which approach is giving better result in detecting OSA.[11]

Classifying the text by using text mining and combining the approaches of both k means and K-NN by using reweighting concept and evaluates how it is giving better performance. [8]

III. PROJECT DESCRIPTION

To speed up the detection of Sleep Apnea and to assist medical professionals, an expert automated sleep detection system is needed, seen in fig 3 For that, a 12-lead ECG image database is considered. By using the raw ECG images from the database and loading them into developed software, OSA which it leads to further diseases is being detected by machine perception using improvised classification algorithms. The process contains changing the raw ECG images to Binary image format and extracting the features contains 1D Feature Vector using the wavelet transform and auto regression models. The coefficients are concatenated together for obtaining featured 1D vector.

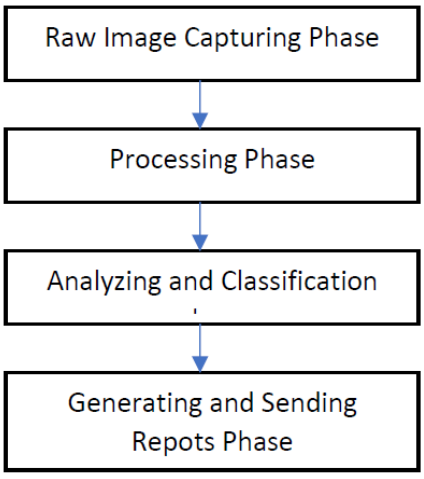

Fig. 3 Architectural model for developed software

The featured 1D vector contains all the calculated values present in the ECG image, where the improvised classification algorithm detects the calculated values automatically as shown in fig 3.

The feature vector mainly contains the points like P, Q, R, S and T are located. Different parameters like PR interval, RR interval QT interval, height of P, Q, T points and depth of Q, S points are calculated. We concatenated these parameters and considered them as a 1D feature vector.

The process is to analyzing the ECG images based on the machine perception. Where ECG is taken in terms of images instead of signals to get the accurate results in order to distinguish OSA. This can be done by using Wavelet Transforms and Auto Regressions (AR) models and classifiers based on combination of K-Means and KNN using Hyper parameter tuning process. The introduced system will considerably reduce the overall computational time and provides efficiency required indetecting OSA by using raw ECG images**.**

There are decent advantages for this proposed system,

- The system is more accurate and efficient to analyze. The automated system is user friendly as the output is in the readable format by the normal user.
- In order to get the accurate ECG interpretation of values, proposed system uses the digitization of image processing and the experimental results shows the accurate results.
- This statistical tool integrates the digitized ECG image which further used for analyzing ECG whether it contains any misplacement of leads
- By combining the improvised KNN with K-Means algorithm the proposed system decreases the calculation complexity and time by increasing the efficiency of the overall process.
- Using the Hyper parameter tuning the best value is set before the training process to achieve the best accuracy.

IV.BLOCK DIAGRAM

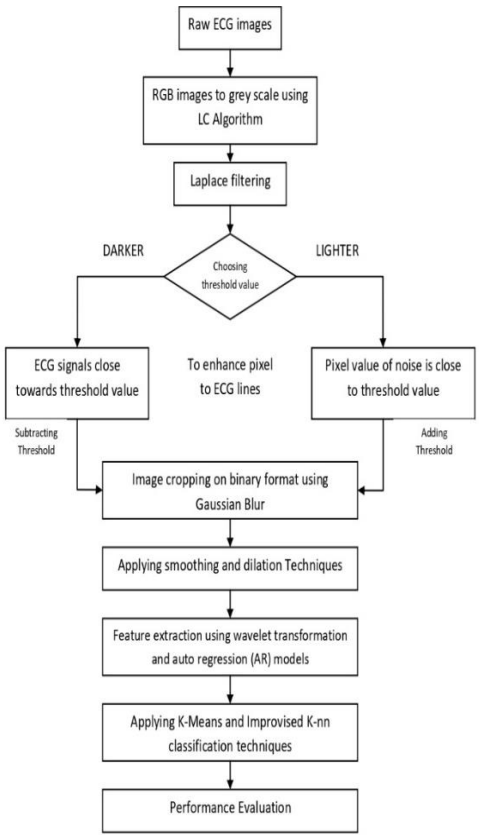

Fig 4: DetailedAlgorithmic view for Analyzing OSA methodology

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V. EXISTING SYSTEM

Existing system has used SVM, for classification and they used heart rate variability & Oxygen Saturation was considered in detecting OSA Which is providing 82% of accuracy. The combination of K-Means and K-NN algorithm using the term Re-weighting achieves the accuracy of least 88%.

DISADVANTAGE

- Takes more time for computation of the results.
- SVM classification accuracy is very low
- Considering the ECG signals as they are not as accurate as ECG wave interpretation.

VI.PROPOSED SYSTEM

Building an Improvised classification algorithm to detect the OSA abnormality. The proposed system used toanalyze the ECG images based on the machine perception. ECG is considered in terms of images to get the accurate results in order to distinguish OSA. The process contains changing the raw ECG images to Binary image format and extracting the features contains 1D Feature Vector using the wavelet transform and auto regression models. The coefficients are concatenated together to obtain1D featured vector. Featured 1D vector contains all the calculated values present in the ECG image, where the improvised classification algorithm detects the calculated values automatically.The feature vector mainly contains the points like P, Q, R, S and T are located. Different parameters like PR interval, RR interval QT interval, height of P, Q, T points and depth of Q, S points are calculated. We concatenated these parameters and considered them as a 1D feature vector. The process uses the combination of K-Means and KNN using Hyper parameter tuning process. The introduced system will considerably reduce the overall computational time and provides efficiency required indetecting OSA by using raw ECG imagesas seen in fig 4

ADVANTAGES

- Reducing the Computational Complexity
- Using Hyper parameter tuning to achieve the better accuracy and efficiency.
- Digitalization of ECG records with patients' electronic medical records.
- Precise, efficient and User friendly as the results are in readable format.

VII. ECGIMAGEPROCESSING

An ECG image is given as an input to automated system Where it should detect whether that patient contains Obstructive Sleep Apnea (OSA) or not which it furtherleads to heart attack based on severity.ECG image loads into software-based on improvised classification algorithm. ECG usually presented on a thermal paper which it contains the boxes plotted over it as well as the ECG signals as shown in fig 5.While takingImage as an input, instead of signal which it includes unclear and ambient noises. In our proposed system,all kinds of image format is supported. To get rid of all those and to retain the image, filteringis used.

The main steps that have been carried out for extracting the features from an ECG image database are:

- Converting raw ECG image to a gray scale image
- Separation of the desired signal from its background
- Identification and finding the points of interest for feature extraction

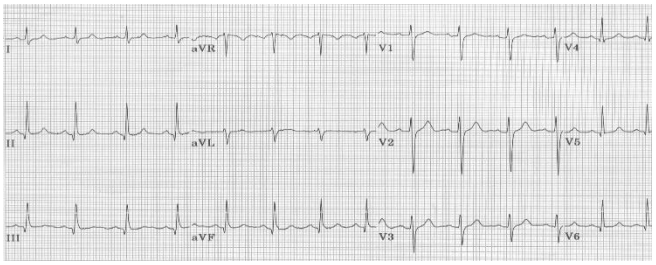

Fig.5: Capturing Raw ECG Image as input

Filtering can be applied on grey scale image format (8-bit). While converting the RGB (24-bit) format to gray scaled imageformat it will loses some data like contrast, Sharpness, Shadow, and its structure. To avoid data loss RGB values are approximated and reduced based on L*a*b Luminance Chrominance Algorithm and still it will regain all its properties at the time of Binary image format. Filtering is used for extricatingappropriateone and to get rid of unsought signal from the raw image. To interpret the ECG signal from raw image as crisp, compared toambient noise Laplace's filter is used. InLaplace'sfilter alpha is the parameter and it regulates the appearance of the image in extent between zero to one as its shown in equation 1 and 2 below.

$$\nabla^2=\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2} \qquad (1)$$

$$\nabla^2=\frac{4}{(\alpha+1)}\begin{bmatrix}\frac{\alpha}{4} & \frac{1-\alpha}{4} & \frac{\alpha}{4}\\ \frac{1-\alpha}{4} & \frac{\alpha}{4} & \frac{1-\alpha}{4}\\ \frac{\alpha}{4} & \frac{1-\alpha}{4} & \frac{\alpha}{4}\end{bmatrix} \qquad (2)$$

To ensure the Quality and for accurate digitization of image Enhancement can be done where it converts the image pixels into desired signals. For conversion of pixels to lines one threshold value is needed.

Based on the pixel values in the ECG signal as well in the pixel values from the ambient noise one threshold value can be chosen. Taking threshold value, into consideration separation can takes place and makes it either dim or bright which it further leads distinct lines from pixels which it was further converted to binary image format which contains two possible values seen in above fig 6.

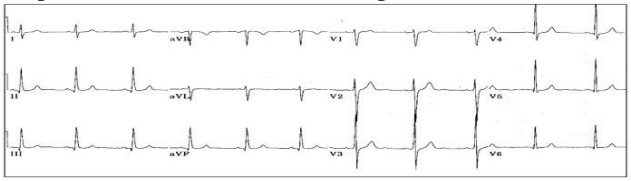

Fig.6: After thresholding

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To reduce noise and to increase the intensity of waveforms of the image, smoothing and dilation techniques are used. In Smoothing less pixelated image is produced and removes unwanted noise and it mainly depends on median value of the image and it uses low pass filters.

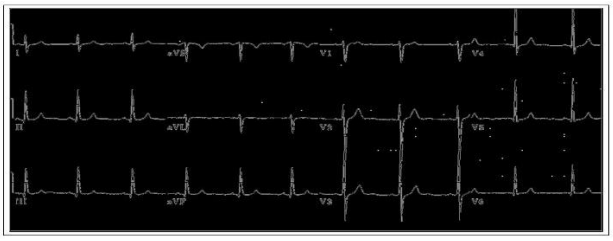

Fig.7: Edge detection

Dilation is another technique where it adds pixels to edges in an image. Adding or Removing pixels depends on size and shape of the processingimage. If the pixel value of an ECG signal close towards threshold then the pixels made to be dark by removing fixedpixels. If, pixel values of noisy background are nearer to the threshold valueit made to be light in addition of fixed pixels. While repeating this step the resultant ECG image will obtaina distinct signal withoutnoise. Canny edge detection is used for identifying proper elevation and depression of wave forms seen in fig 7. Again, after applying dilation over an image to obtain continuous wave form as seen in below fig.8.

The main steps that have been carried out for extracting the features from an ECG image database are:

- Converting raw ECG image to a gray scale image
- Separation of the desired signal from its background
- Identification and finding the points of interest for feature extraction

Fig.8: Dilated image

After converted it into binary image format dilation is applied to enlarge the ECG signal. Image cropping can be done by using Gaussian Blur to obtain interested region and to avoid noise which are located higher than R peak seen in fig 9

Fig.9:Scaling of images by using Gaussian blur

VIII. Feature Extraction using Wavelet Transform and Auto Regression.

To extract the features from ECG, signal the more effective way is to use wavelet transformations and AR model over the image.All the features of an ECG image are calculated with reference to the base line. The base line of an ECG image is defined as a horizontal line that starts from the starting point of the signal. It is used to measure the elevation and depression of different waves in an ECG seen in fig 10 To detect the baseline, scanning the image vertically can be taken place and it found the starting point of the signal. A straight line is drawn using that starting point. Thebluelinerepresentsbaseline shown

Wavelet oscillates like a wave and choosesamplitude as a factor which starts from zero andraises and at last comes back to zero. Wavelet transforms is a function that exactly describes a wavelet. By using wavelet transforms, time frequency transformations can be calculated more effectively

Similarly, an ECG starts at a point, increases or decreases and comes back to the initial point. So, we can simulate an ECG wave with a wavelet transform. We have fit a wavelet to each ECG image and calculated the coefficient matrix. The values in the matrix are queued row-wise and a 1D feature vector is formed. Selecting a proper suitable wavelet and decomposition level number plays a crucial role in analyzing images. Based on tests by using distinct wavelet types, the one which provides the most efficiency is choosen. Multilevel 2D Discrete Wavelet Transform decompositionofdb1model (member of Daubechies families) at a decomposition level of 7 is used.

AR models represents the type of a random process. Multi regression model predicts the variable based on linear combination of predictors. AR model predicts thevariable based on linear as well as with previous values. Auto regressive (AR) model with orderm is shown in equation 3 and the time series can be calculated for RR interval is shown in equation 4.

$$y_t = k + \varphi_1 y_{t-1i} + \varphi_2 y_{t-2i} + \ldots\ldots + \varphi_m y_{t-mi} + s_t. \quad (3)$$

$$rr(s) = r(s+1) - r(s),\ s = 1, 2, \ldots\ldots, x-1. \quad (4)$$

Herek is constant, mis number of dimensions and $s_t$is with noise.AR modelcan handle a wide extentrange of distinct time series patterns. Based on tests withmultipledimensionswhere better results are obtaining with4dimensions.ARfitmethodis used to fitatimeseriesmodeltoourECGandthismodelparametersareconcatenated withtheparametersobtainedfromwavelettransformtofor obtaining a 1D featured vector.

At last final 1D featured vector contains coefficients of bothwaveletstransforms andAR. Byfitting the corresponding models'coefficients of both wavelet and AR can be obtained. And thecoefficientsarecombined with each othertogether toform1Dfeaturedvector, used in classifying a model.

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Onefeaturedvector representsonepointinspace. Based on KNN, points belong tooneclass should beclose to each other andthe pointsbelongs todistinctclassesshouldbefarfrom each other.

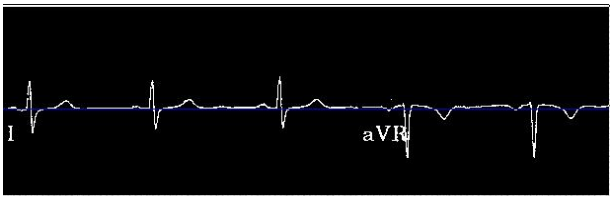

Fig.10: Binary ECG image with baseline

The wave of ECG mainly contains the points like P, Q, R, S and T are located. Different parameters like PR interval, RR interval QT interval, height of P, Q, T points and depth of Q, S points are calculated. We concatenated these parameters and considered them as a 1D feature vector.

Based on Digitized ECG image, Distance measurement can be done from one R peak to another R peak. QRS complex plays a key role in calculating RR interval Thesefeaturesarethenused by the automated classification KNN based algorithm to build a model and to classify our data into normal and abnormal classes.

For 1D Feature Vector, K-Means clustering and improvised K-Nearest Neighbor along with hyper parameter tuning is used for classification.

IX .ANALYTICS USING K-MEANS AND IMPORVISED K-NEAREST NEIGHBOR ALONG WITH HYPER TUNING PARAMETERS

Everyvectorrepresents asonepointinthespace. Based on KNN models the points which belong to same class are nearer to each other if they belong to distinct classes then they will be far from each other. And calculates the Euclidean distance based on 5 and 6 equations

In order to decrease the calculation complexity, we are using K-Means to build the cluster and by using the Hyper Parameters tuning, improvised the K-NN classification to achieve the better results and higher accuracy.

Data Preprocessing in Combination of K-Means and K-NN

begin

1). Read data

2). Initializeand identify k value using hyperparametertuning. //It will find the optimal parameter

Begin

3)Clustering the data points into k number of clusters

//gather the categories of neighborsand cluster using majority vote, based on memory

4)Generate centroids c_i1, c_i2…...c_ik randomly

5). Repeat step 6 to 8 // For assigning an object to closet centroid

6)for each data point y_i: find the nearest centroid (c_i1, c_i2 ... c_ik) assign that point to that cluster

//Determine the distances using between two data items. Euclidean distance

7) for each cluster m = 1...k:

new centroid = mean of all points assigned to that cluster

8) Updating the centroid value based on existing centroid value in cluster;

9)Repeat step 4 and 5,6 until the centroids no longer move (convergent).

10)Determine the class labels for the centroids using K-NN. It reduces the computation [11]in Evaluation Phase (Evaluating ECG)

Applying K-NN to the Data Set

11) Calculate the distance d (m, k) =1,2, 3…Ibetween the training data by Euclidean distance

$$d(m,k)=d(k,m)$$

$$=\sqrt{(k_1-m_1)^2+(k_3-m_3)^2+\cdots+(k_n-m_n)^2} \quad (5)$$

$$=\sqrt{\sum_{i=1}^{n}(y_i-x_i)^2} \quad (6)$$

12) Sort the distance in ascending order

13) Get the first top k rows from the list

14) get the most frequent row from class

15) return predicted_class

End

Repeat from steps 3 to 10

End;

X. EXPERIMENTAL RESULTS

Experimenting theData using in this paper is taken from physionet an opensource which is available to download the database where physionet is funded by National Institute of Health (NIH), a U.S Agency devoted medical research and supported by National Institute of General Medical Science(NIGMS) and National Institute of Biomedical Imaging and Bioengineering(NIBIB) .The Apnea ECG image Database one is used for training another ECG image database is used for testing . And life in the fast lane and from ECG library. Before improvising the Algorithm KNN shows an accuracy of 86% as mentioned in Table 1.

Table 1: Confusion Matrix for improvised K-means and KNN

Training/Testing	No OSA	OSA
No OSA	82%	18%
OSA	0%	100%

Based on Machine perception, a software is developed to Analyze OSA Which it uses ECG images database as an input from that it will Extract the Features by using Wavelet Transforms and AR models and forms a 1D vector on that vector we apply Improvisedand combined Clustered K-Means and K-NN along with Hyperparameter tuning Algorithm is proposedwhen k is 3 which it is giving anaccuracy of 96.5% as seen in below table2.

Table 2: Confusion Matrix for improvised KNN and K means along with hyper parameter tunining.

Training/Testing	No OSA	OSA
No OSA	0.88%	0.12%
OSA	0%	100%

Based on the Analysis done based on RR interval as well with classification algorithm a report is generated and sentto the user

XI. CONCLUSION AND FUTURE WORK

In this paper, based upon machine assumption, digitization of ECG image can be taken for getting accurate ECG interpretation, and it can be achieved by taking ECG image and transforming it into a binary layout by eliminating all the sounds and interruptions. On that binary layout using wavelet transforms as well as AR Models and calculating their coefficients and integrating them to create a create a 1-D vector, where each vector represents a point in space. After that improvised classification Algorithm is used to classify the normal ECG and apnea ECG. Automated Classification Algorithm is the mixed layout of both K-means and K-NN. It entails major phases which includes pre-processing and evaluation phase where it utilizes K-means, as well as K-NN strategies final efficiency can be examined by utilizing KNN in addition to hyper parameter tuning. Speculative outcomes mention that, Traditional KNN cannot able to accomplish more precision, and takes longer time for computations. After integrating conventional KNN as well as K-means speculative values states that examined value is greater than contrasted to standard KNN Where value of K is 3, which it determines the k value automatically based on hyper parameter tuning with an average value between 0.96.5 – 0.97, increases the accuracy in detecting OSA by using ECG visual representation For future work, experiments can be performed by analyzing OSA from ECG and considering apnea indexing as a factor and severity of OSA to detect all abnormalities like heart attack and stroke, abnormalities leading by OSA. And to detect Whether the ECG report was correct, or any misplacement was done during lead placement.

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