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A Review on Heart Disease Prediction by Machine Learning Techniques

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***Abstract* – We discussing data mining healthcare generation based predicting human diseases in biomedical and healthcare communities, accurate analysis of medical data benefits early disease detection, patient care and community services. We propose a novel methodology for disease predictions in different machine learning algorithms using find the user behaviors.We streamline machine learning algorithms for effective prediction of chronic disease outbreak in disease-frequent communities. The Main focus of this process is to implement a simple, reliable and easily applicable deep learning technique for the classification of the selected two different cardiac categories conditions to the best of our knowledge, none of the existing work focused on both data types in the area of medical big data analytics. Finally finding user behaviour based on given dataset.**

***Keywords*– SVM, NB, CNN, RF, AI, Machine Learning, and Heart Disease.**

I. INTRODUCTION

With big data growth in biomedical and healthcare communities, accurate analysis of medical data benefits early disease detection, patient care and community services. However, the analysis accuracy is reduced when the quality of medical data is incomplete. Moreover, different regions exhibit unique characteristics of certain regional diseases, which may weaken the prediction of disease outbreaks. In this paper, we streamline machine learning algorithms for effective prediction of chronic disease outbreak in disease-frequent communities.
Electrocardiography: The heart is one of the most critical organs in the human body, thus the development of methods for monitoring its functionality is crucial. Electrocardiography is considered to be one of the most powerful diagnostic Tools in medicine that is routinely used for the assessment of the functionality of the heart. The Electrocardiogram (ECG) is the conventional method for non-- - invasive interpretation of the electrical activity of the heart in real-- - time.

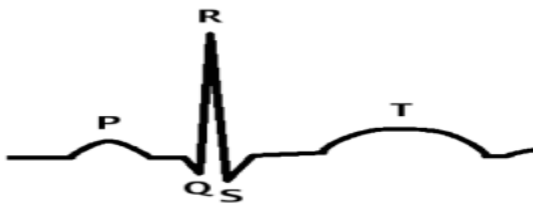

Fig.1.Normal ECG with the waves that is consisted noted.

The electrical cardiac signals are recorded by an external device, by attaching Electrodes to the outer surface of the skin of the patient's thorax. These currents stimulate the cardiac Muscle and cause the contractions and relaxations of the heart [1].

The electrical signals travel through the electrodes to the ECG device, which records them as characteristic waves. Different waves reflect the activity of different areas of the heart which generate the respective flowing electrical currents. Figure 1 shows a schematic representation of a normal ECG and its Characteristics of Normal Electrocardiogram A normal ECG consist of a P wave, a QRS complex, and a T wave. The P wave is caused by electric currents produced by the depolarization of the atria before their contraction, while the QRS complex is caused by electric currents produced by the depolarization of the ventricles prior to their contraction, during the extending of the depolarization in the ventricular myocardium.

The QRS complex usually consists of three different waves, the Q, R, and S waves. Note that both the P- - - wave, and the waves that form the QRS complex, are depolarization waves. The T wave is caused by the electric currents produced during recovery of the ventricles from the state of depolarization. This process is takes place in the ventricular myocardium 0.25s to 0.35s after the depolarization. The T wave is characterized as the wave of depolarization. The Figure 1 shows a

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representation of an ECG with the waves and complexes annotated. The ECG has been established as the most common, easiest, way for accurate and rapid diagnosis and management of numerous cardiovascular incidents. A significant number of patients treated in the emergency room (ER) and in the intensive care unit (ICU), present with cardiovascular complaints. In those cases, the need of early, accurate diagnosis as well as rapid, appropriate therapy, reinforce the importance of electrocardiography. Some examples of incidents that are ideally managed with an ECG are chest pain (presenting ST-- - segment elevation), acute myocardial infarction, acute coronary syndrome, arrhythmias, and even suspected pulmonary embolism[3].

Principal Methods for ECG analysis: Since digital electrocardiography has been established as the fundamental way for ECG data acquisition, algorithms for automatic ECG analysis, and more specifically automatic QRS complex detection have been the focus of intense research activity. The QRS complex is perhaps the most significant waveform within the ECG and thus its detection is the crucial first step in every automated algorithm for ECG analysis. Due to their characteristic shape, the QRS complexes serve as the reference point for the automated heart rate determination. After detection, analysis and feature extraction, provide useful information about the current state of the heart.

QRS Detection-- - Brief review: Algorithms, which have been developed for the purpose of QRS detection and analysis, have been derived from Artificial Neural Networks [7,10], genetic algorithms , wavelet transforms, and filter banks. Neural Networks have been used for QRS detection, by training adaptive, non-- - linear ECG signal predictors . In another method, an estimate of the ECG samples was derived by a number of adaptive filters. That estimate was given as a weighted summation of previous samples, with the weights adapting according to the statistics of the signal.

Other approaches included signal derivatives, for detection of the steep slope of the QRS complex .cross-- - correlation methods, where an initial template was aligned to the current ECG signal and syntactic approaches, where the ECG signal was represented as a piecewise linear approximation and was analyzed using syntactic rules . Almost all of the proposed algorithms so far, share a common algorithmic structure, that is, a preprocessing stage, including filtering, a feature extraction stage, and a decision stage in which peak detection and decision logic are included .

Time- - Frequency Analysis: Traditional methods of signal processing in general, and biomedical signal processing in particular, tend to assume stationary signals. However, most of the biological processes are, in general, characterized as non-stationary, that is, they dynamically change over time. In such cases, analyzing the signal in the time or frequency domain separately might not be so comprehensive. Although time domain gives information about amplitude, it is vulnerable to noise and it provides no information about the frequency spectrum of the signals. On the other hand, the frequency domain offers much information about the spectral content of the signal but lacks most of the information on how the signal changes with time. Hence, a method that combines these two could lead to a combination of the advantages of each individual

Method.Time-- - Frequency Analysis (TFA) effectively provides a description of the spectral content as a function of time Time–Frequency Representations (TFRs) are two-- - dimensional (2D) functions, which describe, at the same time, the signal temporally and spectrally. The TFRs show the distribution of the signal's spectrum over the Time- - Frequency plane and contains both the time variations and frequency bands which define the signalThe ECG waveform is a series of positive and negative waves produced due to different deflection in each port of heartbeat typical ECG tracing consists of P-wave, a QRS complex, and T-wave in each cardiac cycle.

The ECG detects the transfer of ions through the myocardium, which changes in each heartbeat. The is electric line is the baseline voltage of ECG which is traced following the T-wave and preceding the next P-wave. The upper chambers of heart make the first wave called P-wave. The P-wave is first to be generated due to contraction of the upper chamber of the heart followed by a flat line due to electrical impulse goes to the lower chambers. The contraction of ventricles makes the QRS complex and final T-wave produced for resting state of the ventricles [10]. The repetitive cycle of the electrical activity of heart is represented by the P-QRS-T sequences.

II. RELATED WORK

Algorithm (e.g., logistic regression and regression analysis, etc.), and especially a supervised learning algorithm by the use of training data with labels to train the model. In the test set, patients can be classified into groups of either high-risk or low-risk. These models are valuable in clinical situations and are widely studied. Proposed a healthcare system using smart clothing for sustainable health monitoring. the heterogeneous systems and achieved the best results for cost minimization on tree and simple path cases for heterogeneous systems. Patients' statistical information, test results and disease history are recorded in the EHR, enabling us to identify potential data-centric solutions to reduce the costs of

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medical case studies. an efficient flow estimating algorithm for the telehealth cloud system and designed a data coherence protocol for the PHR (Personal Health Record)-based distributed system.[11[12]an optimal big data sharing algorithm to handle the complicate data set in telehealth with cloud techniques. One of the applications is to identify high-risk patients which can be utilized to reduce medical cost since high-risk patients often require expensive healthcare. In the existing system the data set is typically small, for patients and diseases with specific conditions; the characteristics are selected through experience. However, these pre-selected characteristics maybe not satisfy the changes in the disease and its influencing factors.

III. LITERATURE REVIEW

In this paper [1] author has presented the concept namely, "Disease prediction using Machine Learning over Big Data". The big data is fastest concept in current trend, so this concept is applied in more fields. The big data is most widely used in each every field because it is very large. The big data is applied in medical field both side developing the better growth in both fields, that is big data is applied in medical fields develops the medical fields at the same time increase the growth in big data field. The big data helps to achieve the better growth in medical and health care sectors. It additionally, provides the more merits gives, medical data analysis with accuracy, early prediction for disease, patient oriented data with accuracy, The medical data, is securely stored and used in many places,

Incomplete regional data are reduced and give the accuracy result. Goal of the concept is choose the region and collects the hospital data or medical data of particular selected region, this process is using the machine learning algorithm. This term based on the data mining technique is used for disease prediction with accuracy. Then, finding the missing data based on latent factor get the incomplete data and it is reduced. The previous system use the CNN-UDRP (Unimodal Disease Risk Prediction), then continuously implements the next level use the CNN-MDRP (Mulimodal Disease Risk Prediction). The CNN-MDRP is overcome the drawback of CNN-UDRP. A Survey on Disease Prediction by Machine Learning over Big Data from Healthcare Communities Page .the CNN-MDRP is uses the hospital data, that is structured and unstructured data. The CNN-MDRP algorithm based prediction is produce more accurate, this accuracy is compared with previous system. The advantages of the concept is, better feature description and better accuracy, and the disadvantages of this system is, this feature is only applicable for the structured data so it is not good in disease description.

Shraddha Subhash Shirsath et.al: Now a day's big data is the fastest and more widely used in every field .With the help of big data medical and health care sectors achieves their growth and with help of big data benefit of a accurate medical data analysis , early disease prediction, accurate data of an patient can be securely stored and used .Moreover the accuracy of an analysis can be reduced due to an various reason like incomplete medical data, some regional disease characteristics which can be outbreaks the prediction. In this paper we can use a machine learning algorithm for the accurate disease prediction for that purpose we can collect the hospital data of a particular region. For missing data we can use latent factor model to achieve the incomplete data. In the previous work for disease prediction Convolution Neural Network Based Unimodel Disease Prediction (CNN-UDRP) Algorithm is used. Convolution Neural Network Based Multimodal Disease Prediction(CNN-MDRP) algorithm is overcome the drawbacks of CNN-UDRP algorithm only focus work on a structured data but CNN-MDRP algorithm uses both structured and unstructured data from the hospital. None of the existing work focused on both data types in the area of medical big data analysis .CNN-MDRP algorithm prediction is more accurate than compared to the previous prediction algorithm

Aditi Gavhane et.al.: with the rampant increase in the heart stroke rates at juvenile ages, we need to put a system in place to be able to detect the symptoms of a heart stroke at an early stage and thus prevent it. It is impractical for a common man to frequently undergo costly tests like the ECG and thus there needs to be a system in place which is handy and at the same time reliable, in predicting the chances of a heart disease. Thus we propose to develop an application which can predict the vulnerability of a heart disease given basic symptoms like age, sex, pulse rate etc. The machine learning algorithm neural networks has proven to be the most accurate and reliable algorithm and hence used in the proposed system

Min Chen et.al: With big data growth in biomedical and healthcare communities, accurate analysis of medical data benefits early disease detection, patient care and community services. However, the analysis accuracy is reduced when the quality of medical data is incomplete. Moreover, different regions exhibit unique characteristics of certain regional diseases, which may weaken the prediction of disease outbreaks. In this paper, we streamline machine learning algorithms for effective prediction of chronic disease outbreak in disease frequent communities. We experiment the modified prediction models over real-life hospital data collected from central China in 2013-2015.

To overcome the difficulty of incomplete data, we use a latent factor model to reconstruct the missing data. We experiment on a regional chronic disease of cerebral infarction. We propose a new convolution neural network based multimodal disease risk prediction (CNN-MDRP) algorithm using structured and unstructured data from

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hospital. To the best of our knowledge, none of the existing work focused on both data types in the area of medical big data analytics. Compared to several typical prediction algorithms, the prediction accuracy of our proposed algorithm reaches 94.8% with a convergence speed which is faster than that of the CNN-based unimodal disease risk prediction (CNN-UDRP) algorithm. **Mamatha Alex P et.al:** we are living in a post modern era and there are tremendous changes happening to our daily routines which make an impact on our health positively and negatively. As a result of these changes various kind of diseases are enormously increased. Especially, heart disease has become more common this days. The life of people is at a risk. Variation in Blood pressure, sugar, pulse rate etc. can lead to cardiovascular diseases that include narrowed or blocked blood vessels.

It may causes Heart failure, Aneurysm, Peripheral artery disease, Heart attack, Stroke and even sudden cardiac arrest. Many forms of heart disease can be detected or diagnosed with different medical tests by considering family medical history and other factors. But, the prediction of heart diseases without doing any medical tests is quite difficult. The aim of this project is to diagnose different heart diseases and to make all possible precautions to prevent at early stage itself with affordable rate. We follow 'Data mining' technique in which attributes are fed in to SVM, Random forest, KNN, and ANN classification Algorithms for the prediction of heart diseases. The preliminary readings and studies obtained from this technique is used to know the possibility of detecting heart diseases at early stage and can be completely cured by proper diagnosis.

Vinitha S, Sweet: et.al in Due to big data progress in biomedical and healthcare communities, accurate study of medical data benefits early disease recognition, patient care and community services. When the quality of medical data is incomplete the exactness of study is reduced. Moreover, different regions exhibit unique appearances of certain regional diseases, which may results in weakening the prediction of disease outbreaks. In the proposed system, it provides machine learning algorithms for effective prediction of various disease occurrences in disease-frequent societies.

It experiment the altered estimate models over real-life hospital data collected. To overcome the difficulty of incomplete data, it use a latent factor model to rebuild the missing data. It experiment on a regional chronic illness of cerebral infarction. Using structured and unstructured data from hospital it use Machine Learning Decision Tree algorithm and Map Reduce algorithm. To the best of our knowledge in the area of medical big data analytics none of the existing work focused on both data types. Compared to several typical estimate algorithms, the calculation exactness of our proposed algorithm reaches 94.8% with a convergence speed which is faster than that of the CNNbased unimodal disease risk prediction (CNN-UDRP) algorithm.

Hu Yuliang et.al in order to analyze heart valve disease accurately and effectively, a new quantized diagnosis method was proposed to analyze four clinical heart valve sounds, namely cardiac sound characteristic waveform(CSCW). BIOPAC acquiring system was used to collect signal. The recorded data is transmitted to a computer by ethernet for storage, analysis and display in real-time. Analytical model of single degree-of-freedom (SDOF) was established to extract characteristic waveform. Furthermore, diagnosis parameters were calculated to discriminate heart sound of normal and heart valve disease by easy-understanding graphical representation, so that, even for an inexperienced user is able to monitor his or her pathology progress easily. Finally, a case study on a heart valve disease patient before and after surgery is demonstrated to validate the usefulness and efficiency of the proposed method.

M.A.Jabbar et.al :Coronary heart disease is a major cause of death worldwide. The diagnosis of heart disease is a tedious task. There is a need for an intelligent decision support system for disease prediction. Data mining techniques are often used to classify whether a patient is normal or having heart disease. Hidden Naïve Bayes is a data mining model that relaxes the traditional Naïve Bayes conditional independence assumption. Our proposed model claims that the Hidden Naïve Bayes (HNB) can be applied to heart disease classification (prediction). Our experimental results on heart disease data set show that the HNB records 100% in terms of accuracy and out performs Naïve bayes.

G Krstacic et.al: The article emphasizes clinical and prognostic significance of non-linear measures of the heart rate variability, applied on the group of patients with coronary heart disease (CHD) and age-matched healthy control group. Three different methods were applied: Hurst exponent (H), Detrended Fluctuation Analysis (DFA) and approximate entropy (ApEn). Hurst exponent of the R-R series was determined by the range rescaled analysis technique. DFA was used to quantify fractal long-range-correlation properties of heart rate variability. Approximate entropy measures the unpredictability of fluctuations in a time series. It was found that the short-term fractal scaling exponent (/spl alpha//sub 1/) is significantly lower in patients with CHD (0.93 /splplusmn/ 0.07 vs. 1.09 /splplusmn/ 0.04; $p < 0.001$). The patients with CHD had lower Hurst exponent in each program of exercise test separately, as well as approximate entropy than healthy control group ($P < 0.001$).

Pavani Majety et.al: stethoscope is one of the critical tools used to assess a patient's health by performing auscultation. There is a necessity to develop a device

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which can recognize the heart disease that a patient might have in the initial stages of examination. This paper proposes a stand-alone system based on DSK6713 that can identify an abnormality in a heart sound while the auscultation is being performed. The technique that has been developed involves sound amplification and analysis techniques. Analysis of the recorded auscultation sounds is performed by using stochastic algorithms, which are tested on a database of recorded heart sounds collected from Michigan Heart Library. The algorithm has been implemented on DSK6713 to make the system stand alone. The analysis includes identification of a probable heart disease. The system's output is recognizing the patient's state of the heart, i.e., diseased or normal - if diseased, what is the possible heart disease and where the abnormality is occurring. The future work includes real time classification of the abnormality using training sets that are recorded on actual patients.

Jayshril S. Sonawane et.al: In medical field the diagnosis of heart disease is most difficult task. It depends on the careful analysis of different clinical and pathological data of the patient by medical experts, which is complicated process. Due to advancement in machine learning and information technology, the researchers and medical practitioners in large extent are interested in the development of automated system for the prediction of heart disease that is highly accurate, effective and helpful in early diagnosis. In this paper we present a prediction system for heart disease using multilayer perceptron neural network. The neural network in this system accepts clinical features as input and it is trained using back-propagation algorithm to predict that there is a presence or absence of heart disease in the patient with highest accuracy of 98% comparative to other systems. The accuracy thus obtained with this system shows that it is better and efficient than other systems.

Made Satria Wibawa et.al: cardiovascular diseases are the major cause of mortality and PCG provides a non-invasive way to monitor the heart. In this paper, we give a unique approach to classify Normal and Abnormal heart rhythms using Machine Learning. The heart sounds are digital signals recorded from electronic stethoscope. In the initial phase Signal Quality assessment and feature extraction is done after which we explore different data models to find the relation between the features and the results, achieving poor results. In the second phase, audio files are segmented into Systolic and Diastolic phases using Logistic Regression-Hsmm .These segments of systoles and diastoles are then individually analyzed and individual feature extraction is done. In the segmentation process a lot of de-noising is also done removing the background noises. This approach yields an accuracy of 79% which concludes that analyzing the heart signal at Systolic and Diastolic phase is a very essential step to solve this problem.

Wenbo Zhang et.al: Electrocardiogram (ECG) signal is widely used in medical diagnosis of heart diseases. Automatic extraction of relevant and reliable information from ECG signals has not been an easy task for computerized system. This study proposes to use 12-layer 1-d CNN to classify 1 lead individual heartbeat signal into five classes of heart diseases. The proposed method was tested on MIT/BIH arrhythmia database and results were measured using positive predictive value, sensitivity and F1 score. Our proposed method obtained a positive predictive value of 0.977, sensitivity of 0.976, and F1 score of 0.976. Comparing with the results obtained by other four methods on the same database, our method was found superior on all three measures.

Yaowei Li et.al: Congestive heart failure (CHF) is a serious path physiological condition with high morbidity and mortality, which is hard to predict and diagnose in early age. Artificial intelligence and deep learning combining with cardiac rhythms and physiological time series provide a potential to help in solving it.

In this paper, we proposed a novel method that combines a convolution neural network (CNN) and a distance distribution matrix (DDM) in entropy calculation to classify CHF patients from normal subjects, and demonstrated the effectiveness of this combination. Specifically, three entropy methods were used to generate the distribution matrixes from a 300-point RR interval (i.e., the time interval between the successive cardiac cycles) time series, which are Sample entropy, fuzzy local measure entropy, and fuzzy global measure entropy. Then, three high representative CNN models, i.e., Alex Net, Dense Net, and SE_Inception_v4 were chosen to learn the pattern of the data distributions hidden in the generated distribution matrixes. All data used in our experiments were gathered from the MIT-BIH RR Interval Databases (http://www.physionet.org). A total of 29 CHF patients and 54 normal sinus rhythm subjects were included in this paper. The results showed that the combination of Fuzzy GMEn-generated DDM and Inception_v4 model yielded the highest accuracy of 81.85% out of all proposed combinations.

Fatih Demir et.al: In this study, the heart which is one of the most important organ affecting life-sustaining function is examined whether it works properly in a certain rhythm or not. In this regard, an effective algorithm both analyzing and categorizing Phono-cardiogram signals (PCG) which is significant at diagnosis of diseases is presented. First of all in this context, as collared spectrogram images of heart sounds are established to be able to analyze PCG signals, the characteristic extraction maps of Convolution Neural Networks (CNN) are used to educate the data of images obtained. CNN-VGG16 model educated previously is used when these maps are established and it is categorized

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with Support Vector Machine (SVM) which is an effective classifier at machine education.

The performance of all rating labels is evaluated separately for experimental study with two different data. While max performance improves about %8 in one data set (DATASETA), max performance is obtained at other dataset (DATASETB) for normal rating label.

B. S Chandra et.al: Objective: Heartbeat detection remains central to cardiac disease diagnosis and management, and is traditionally performed based on electrocardiogram (ECG). To improve robustness and accuracy of detection, especially, in certain critical-care scenarios, the use of additional physiological signals such as arterial blood pressure (BP) has recently been suggested. Therefore, estimation of heartbeat location requires information fusion from multiple signals. However, reported efforts in this direction often obtain multimodal estimates somewhat indirectly, by voting among separately obtained signal-specific Heartbeat detection remains central to cardiac disease diagnosis and management, and is traditionally performed based on electrocardiogram (ECG).

To improve robustness and accuracy of detection, especially, in certain critical care scenarios, the use of additional physiological signals such as arterial blood pressure (BP) has recently been suggested. There, estimation of heartbeat location requires information fusion from multiple signals. However, reported efforts in this direction often obtain multimodal estimates somewhat indirectly, by voting among separately obtained signal-specific intermediate estimates. In contrast, we propose to directly fuse information from multiple signals without requiring intermediate estimates, and thence estimate heartbeat location in a robust manner.

Method: We propose as a heartbeat detector, a machine learning based techniques that learns fused features from multiple physiological signals. This method eliminates the need for hand-picked signal-specific features and ad hoc fusion schemes. Further, being data-driven, the same algorithm learns suitable features from arbitrary set of signals. Results: Using ECG and BP signals of PhysioNet 2014 Challenge database, we obtained a score of 94%. Further, using two ECG channels of MITBIH arrhythmia database,Both those scores compare favourably with previously reported database-specific results. Also, our detector achieved high accuracy in a variety of clinical conditions.In medical signal monitoring systems, our technique would accurately estimate heartbeat locations even when only a subset of channels is reliable.

IV. METHODOLOGY DESCRIPTION

Five main waves are normally embedded into the ECG signal, P,Q,R,S and T. The combination of Q,R and S is called QRS complex. QRS complex part plays a significant role in detection of ECG arrhythmias and irregular rhythm in order to classify each ECG signal into normal or arrhythmia for certain type. Accurate QRS detection method must be able to evaluate the QRS complex part with few seconds delay. QRS complex indicates a signature point for the following signal processing steps of ECG classification and biometric systems, i.e. feature extraction techniques and classification algorithms. Without accurate QRS detection method, it is impossible to process each beat of ECG stream individually. In this chapter, many QRS detection techniques are explained and tested to pin point the QRS complex such as filter bank, differentiation and discreet wavelet transform methods ECG is the most common and basic test to run on patients to check any kind of anomalies in the heart. In the ECG result 10 to 20 minutes long continuous data of a patient's heart is down sampled and printed as a 1D graph.

We have develop a program which will take the continuous dataset from the ECG machine and analyses the data and extracts various features of the ECG wave. At first we decompose the data using Wavelet decomposition. Then the data is reconstructed in 4 levels which removes the noise from the signal. In the same time we detect major components of the ECG wave which is P wave, QRS complex and T wave. An electrocardiogram (ECG)is an important diagnostic tool for the assessment of cardiac arrhythmias in clinical routine. In this process, we introduce the a deep learning based convolution neural network framework, which is previously trained on a general signal data set is transferred to carry out automatic ECG arrhythmia diagnostics by classifying patient ECG's into corresponding cardiac conditions. The Main focus of this process is to implement a simple, reliable and easily applicable deep learning technique for the classification of the selected two different cardiac categories conditions

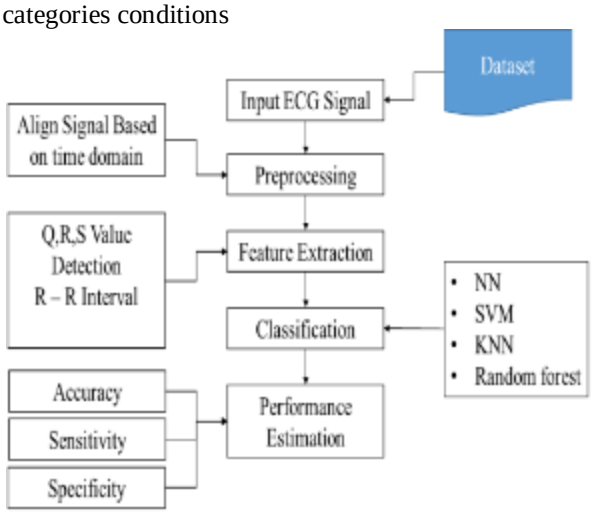

Fig. 3. proposed flow chart.

V. CONCLUSION

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The advancement of bio-signal analysis becomes an important investigative field for solutions to a specific problem. Since several decades, the study of ECG is amongst the most research interest in bio-signals. The ECG analysis became a common tool for the diagnosis of cardiac disorders of low-cost and a non-invasive in nature. The condition of heart can be reflected in the shape of ECG waveform and variability in heart rate. The proper analysis of ECG can provide the useful information regarding various cardiac diseases. Clinical observation of ECG signal is a time taking and very tedious process. The manual analysis may miss some vital information hence computer-aided diagnosis is very helpful in classifying cardiac diseases. Various techniques have been reported in literature regarding heartbeat detection and classification of ECG signals. The time or frequency domain features from ECG waveforms are useful in beats detection of different classes. Due to large variation in morphology information of ECG waveforms, the automatic ECG analysis system is a challenging task.

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