Analysis for Heart Related Issues using comprehensive Approaches: A Review

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www.ijcseonline.org

Abstract— **Nowadays the heart problems are like one of the common things that are happening throughout the world. There are various reasons that lead to heart diseases problems, and the most common among is the change in lifestyle. For doctors it becomes quite tedious task to identify and rectify disease as there are thousands of symptoms that are held responsible for it. Comprehensive study of various machine learning approaches like various supervised and unsupervised algorithm like neural network, Genetic algorithm as well as Data mining approaches are covered in this paper which are helpful in early prediction of heart diseases so that many lives could be saved. Other approaches are also discussed in this paper that help in early prediction of heart disease e.g. with the help of speech analysis and also with the help of Big Data.**

Keywords— **Data Mining, Big Data, ECG, Machine Learning.**

1. Introduction

Heart disease is the primary reason of demise among all three level generation people, i.e. in adults, in old age people and in children. In the United States, 50% of heart diseases occur and one person dies every 35 seconds because of the reason of cardiovascular diseases so, it becomes necessary to detect heart attack as early as possible to increase the survival rate of people.

1.1 Diagnosis by Human vs. Machine Diagnosis

Detection of heart disease based on the previous symptoms and various other factors contributing to the heart disease is quite a complex task. So, here is a brief comparison in human expertise diagnosis and machine diagnosis.

Human diagnosis is based on the:
- history of the patient
- observations
- individual doctor's knowledge
- treatment based on expert's perception

Problems confined by Human diagnosis
- difficulty in establishing a relation between multi symptoms
- restricted knowledge of doctors
- time reliant information
- copying of experts not probable

Machine diagnosis is based on the:
- diagnosis based the pattern analyzed from the large linear or non linear database by the machine
- not time dependent
- results based on information database

1.2 Symptoms of Heart Diseases

There are various reasons that lead to heart diseases problems. Symptoms of heart diseases collected from various hospital websites includes like anxiety, gastric problems, high cholesterol, chest pressure, smoking, chest pain, high blood pressure, Nauseas, swelling of eyes or face etc. these symptoms doesn't guarantee that a person suffers from heart disease problem, although these are necessary to educate oneself and adhere from severe heart attack problems.

1.3 Types of Heart Diseases

There are various kinds of heart diseases and all these types of heart diseases have some common traits or attributes. These all diseases are collectively termed as Coronary Heart Disease (CHD). According to these attributes, various types of heart diseases are as follows:-

Angina: - This type of disease causes pain in the chest, which sounds like squeezing or indigestion. In these arteries get stiffen and narrow.

Congestive Heart Failure: Such types of abnormalities profoundly occur in the old age people. Doctors give it another name "losing Pumping capacity". Symptoms include Breathlessness, weight gain, dizziness, swelling in legs and abdomen e.tc. Treatment of such kind of diseases involves medications and if the disease level is severe then its treatment includes surgery too.

Congenital Heart Diseases: These are also known as heart abnormalities that are present at the birth when the foetus is in the uterus. The main reason may be viral infections, alcohol or some other unknown causes. The following symptoms could cause such diseases like fatigueness, Breathlessness, rapid heartbeat etc. The treatment of such diseases typically involves surgery but most of the time it depends on the severity of the disease.

Congenital Micro vascular Disease: This type of disease usually causes damage to the linings of artery walls, thus causing heart failure. Symptoms of such disease include chest pain, Breathlessness, etc. These types of diseases are less severe as compared to Congestive Heart Failure, Congenital Heart Diseases, and Angina hence treatment could be handled only by medication. These types of diseases are also famous as MVD, small vessel disease

Organic Heart Diseases: -These types of diseases are due to physiological problems. These are not as severe as above mentioned diseases. These could be solved using normal daily routine and by changing thought process.

Inflammatory Heart Disease: -These diseases are caused by inflammation of heart muscles and surrounding tissues. Various Symptoms of these types of heart diseases include fatigueness, short breath to the patient, and swollen feet. The people who have birth injury or defect or the frequent drug users are more prone to inflammatory heart disease. Treatment includes medication or surgery depending on the severity level of disease.

Ischaemic Heart Disease: -Such types of disease are also recognized as Coronary Artery Disease (CAD).The dictionary meaning of the word "ischemic" is "reduced blood supply." Hence, such kind of heart problems leads to reduction in blood supply to the heart which subsequently results in the less supply of oxygen to the other parts of the body. Symptoms includes narrowing of arteries, atherosclerosis etc.

Structural Heart Disease:-These types of diseases affects the structure of the heart itself and are profoundly termed as hereditary heart defects, also it includes other abnormality in the heart vessels which extend soon after in life due to aging.

Cyanotic Heart Disease: -Such kinds of heart disease results in low blood and oxygen supply throughout the body parts. Reasons are many like wrong medication during pregnancy, syndrome in the left heart. Symptoms of this type disease are bluish colour of skin, swelled eyes or face. Treatment of such diseases includes surgery.

2. Comprehensive Techniques
2.1 Data Mining Techniques
Data mining algorithms is based on the method of knowledge discovery, extracting out hidden patterns from the large database. There are many Data mining algorithms that are used for heart disease classification and prediction.

Why to use Data mining techniques in the medical field:
- Data mining techniques follow automation system

- It is an important method of knowledge discovery
- It has the capability of extracting hidden patterns and its relationships from the large unstructured or structured database
- Because of its accuracy and efficiency

Following are few methods of data mining and machine learning algorithms that we have covered:-

Naive Bayes
It is a statistical classifier which is based on Bayes theorem which uses conditional independence, means an attribute value on a given class is independent of the values of other attributes.

Work related to Heart disease classification and prediction using Naive Bayes

Using Naive Bayes algorithm, a decision support system for prediction of heart disease was developed to uncover the association of variables, and implemented as a web based questionnaire [1].This developed DSHDPS (Decision support in heart disease prediction system) can aid as training tool also for the nurses and doctors for better treatment results In another study [2], a method has been proposed for the heart disease classification. Attributes which are used to predict heart disease are the symptoms of patient. Further, they introduced a hybrid approach for attribute selection that is Cfs and Bayes theorem.

Decision Trees
Decision tree is the prominent classifier as it doesn't require any domain knowledge. There are subsequent decision trees algorithms that have been used in the classification and prediction of a disease are CART C4.5, ID3, J48, CHAID etc. The main concept behind drawing a tree is providing the flexibility and accuracy.

Genetic algorithm
Genetic Algorithms follow the idea of SURVIVAL OF THE FITTEST- Better and better solutions evolve from previous generations until a near optimal solution is obtained. The paper named as "Heart Disease Classification Ensemble Optimization Using Genetic Algorithm", focused the work on optimization of genetic algorithm. Four different data sets are used in this, firstly Support vector machine algorithm with different kernel functions is used as base classifier then further genetic algorithm is applied on the base classifiers for the optimization of results.

Association Classification
This technique to classify and foretell, basically these are classifiers which fit to the applications where maximum accuracy is required for predicting something. Association and classification are two different functionalities of Data mining approaches where association is an unsupervised learning where no class

rule is used to find associations or correlations among the item sets whereas classification is a supervised learning approach where class attribute is involved in the construction of the classifiers, which is used to classify the data based on the give data sets.

Work related to Heart disease classification and prediction using Association rules
In the study [4] the constrained association rules for heart disease prediction. In this research the preliminary data taken was the medical record of people having heart diseases. The attributes that are taken for assessment are heart perfusion measurements and artery narrowing, risk factors. With the help of these attributes, numbers of patterns are decreased, they are divided in two groups and several experiments are conducted on them. To imply whether a patient consist of heart disease or not and thereafter data mining methods are taken into consideration for the prediction of heart disease. An intelligent heart disease Prediction System was designed by [5] ,employing a method of weighted associative classifiers using Java (front end) and Ms access(backend) as implementation tool, classified whether a patient has heart disease or not.

Fuzzy
The concept of Fuzzy Logic (FL) was conceived by Lotfi Zadeh, the fuzzy logic starts and builds on a set of user-supplied human language rules into a mathematical correspondent, and this simplifies the job of the designer and computer, and results in accuracy and flexibility of data in a real world. Fuzzy has its many advantages, it can solve the problems with imprecise and incomplete data and also it can model non linear functions of random complexity.

Work related to Heart disease classification and prediction using Fuzzy
In a proposed diagnosis [6] method of fuzzy expert system using fuzzy logic using crisp values as fuzzified as an input to get fuzzy values as output. Later on the output value is defuzzified to get a crisp value for heart disease diagnosis.

2.3 Hybrid Approaches in diagnosing of heart diseases
The usefulness of scheming and applying hybrid methodologies to various medical applications. The main basis for this accomplishment seems to be the computational intelligent components, such as machine learning, fuzzy logic, neural networks, genetic algorithms, or other intelligent heuristics. This portion will depict some hybrid approaches that have been used so far in the diagnosis and prediction of heart diseases.

One of the most famous and successful hybrid approaches "Neuro-fuzzy approach" was proposed by J.S.R. Jang, which is the hybridization of two approaches. This approach combined the features of fuzzy system that have the capability of human-like thinking [7] and neural network carrying learning capability. Its main strength

lies while concentrating on interpretability and accuracy with the facility to implore interpretable IF-THEN rules.

2.4 Heart disease diagnosis using heart sounds
Different heart sounds are utilized in predicting and classifying various heart diseases, and this process of interpreting heart sounds is called as heart auscultation [8]. In the prediction process the timing and tone of a murmur plays a significant role. Main components of heart sounds called as lub(first heart sound s1) and dub(second heart sound s2) [9], systole and diastole(Fabio de Lima Hedayioglu). The electronic stethoscope only indicates whether sounds are present or not, so an innovative approach has been developed in the paper named as "Automated Diagnosis of Cardiac Abnormalities using Heart Sounds [10]. In this, the work focuses on production of software which is used to predict heart irregularities.

2.5 Heart disease diagnosis using speech analysis
Speech sounds are the most common and natural form of human communication that convey expression, accent, gender, age, intonation, intention and state of health of the speaker [11][12] [13].

2.6 Heart disease diagnosis using Cloud decision support system
Cloud computing, is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable resources which includes servers, networks, applications and services with minimum effort and less service provider interaction. In a work [14] the authors develop a fuzzy expert system, which is used to self assess the risk severity of heart disease using the cloud service platform by utilizing the artificial intelligence and cloud computing technology. In this, firstly data is collected from the UCI sources, then factorial ANOVA is used for filtering, subsequently a fuzzy expert system developed to assess the risk factor.

2.7 Heart disease diagnosis using ECG
ECG: ECG is a test that depicts the electrical activity going in the heart over a period of time. These recorded impulses are transformed into wave form, which provides measures for the heartbeat rate [15]. It is used to test the irregularities of the heart functions. Ischemia, one of the common heart diseases represented by the variation in the ST part of the ECG signal. Based on ECG signal, Ischemia disease automatic diagnosis involves classification and then detection [16].

2.8 Role of Big Data Solutions in prediction of Heart Disease
Big Data is large amount of data sources, is captured at a rapid rate, and is structured or unstructured, or some combination of the above. These factors make Big Data difficult to capture, mine, and manage using traditional methods.
Why to use Big Data in Medical?

Risk prediction involves medical as well as social factors, which makes the prediction task quite difficult or complex. Hence, these all factors need to be combined together from independent sources, so there arrives a requirement of big data. In this paper, named as "Role of Big Data Solutions in Prediction of Heart Disease", the researcher studied big data driven solutions to forecast 30 day risk for congestive heart failure occurrences [17]. For it, first of all useful factors have been extracted from National impatient Dataset and then it is augmented with the patients of Multicare Health System. Then developed Data mining models to predict risk of readmission using the dataset, and then the effectiveness of results from various algorithms is compared.

3. Challenges in Cardiovascular Diseases

There may be many challenges that can occur, we are going to discuss few yet the most important ones. Predicting the heart disease on the basis of perception and occurrence rather than facts based on rich data concealed in the database causes:

- superfluous biases
- Errors
- unnecessary price tag
- Low quality of examination to patient

4. Conclusion

The comprehensive studies of various heart diseases including their symptoms are covered under this review paper. Various machine learning as well as data mining approaches with their relevant work is included. Further implementation can be done using any one of the data mining or machine learning approach.

Acknowledgment

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