International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2019 IJSRCSEIT | Volume 5 | Issue 3 | ISSN : 2456-3307
DOI : https://doi.org/10.32628/CSEIT1953169

Predicting Chronic Disease by Monitoring Patients Updating Sensor Information with Big Health Application System

Arsheenath Beegam*, Ismail P. K.
Computer Science and Engineering, MEA Engineering College, Perinthalmanna, Kerala, India

ABSTRACT

Nowadays the advances in the computer technology have validated great development on healthcare technologies in numerous fields. However these new technologies have made also healthcare data not only much bigger but also much more difficult to handle and process. Currently the peoples are leading to death because of the proper distribution of medical resources over the world. Cloud and big data not only are important techniques but also are gradually becoming the trends in healthcare innovation. However these problems can be greatly solved by building a healthcare system with the help of these new technologies. But the greatest challenge of building a comprehensive healthcare system is in the handling of the heterogeneous healthcare data captured from multiple sources. In-order to provide a more convenient service and environment of healthcare, this paper proposes a big health application system based on the health internet of things and big data. The world is confronting issues, for example, uneven conveyance of restorative assets, the developing endless maladies, and the expanding restorative costs. Mixing the most recent data innovation into the human services framework will enormously alleviate the issues. So building huge well being application framework by adequately coordinating medicinal well being assets utilizing keen terminals, well being Internet of Things (IoT), enormous information and distributed computing is the significant method to unravel the above issues. Also in this work proposes a new convolutional neural network based multi-modal disease risk prediction (CNN-MDRP) algorithm using structured and unstructured data from hospital.

Keywords : Big Data, Internet of things(IoT), Cloud Computing, Big Health, Naïve Bayes, KNN, Decision Tree, CNN-UDRP, CNN-MDRP

I. INTRODUCTION

As of late, Big Data science has been an interesting issue in the logical, modern and the business universes. The human services and biomedical sciences have quickly progresses towards becoming information concentrated as examiners are producing and utilizing substantial, mind boggling, high dimensional, and differing space explicit datasets. Human suffers from the diseases of which one third could be completely prevented, one third could be detected early and one third could be done with aggressive treatment to improve quality of life. Major diseases could be controlled by strengthening the early detection. Everyone experiences the process from health to disease. In general, the status of health is from health to low-risk status, to high-risk status, to the occurrence of early lesions status, to clinical symptoms status and finally to the disease status. This process can be very long, often takes years to ten years, or even decades , which is highly correlated with genetic factors, peoples social and natural environmental factors, medical conditions and personal lifestyle[1].

Data Mining is the non-trivial extraction od implicit, previously unknown and potential useful information from the data. Data mining is the process of sorting through large data sets to identify patterns and establish relationships to solve problems through data analysis.

Data mining tools allow enterprises to predict future trends. The overall goal of the data mining process is to extract information from a data set and transform it into an understandable structure for further use.

Machine learning introduces various algorithms, those enable machines to understand the current situations and on the basis of that machines can take appropriate decisions. Machine learning works independently and takes decision at its own[2].

Innovation has been a key piece of medicinal services for hundreds, if not thousands of years. Today, however, the circumstance is evolving. As the Internet of Things (IoT) world view turns out to be progressively across the board, a large group of novel open doors have emerged. Innovations like scaled down wearable bio-sensors, alongside advances in Big Information particularly as to proficient treatment of enormous, multiscale, multimodal, circulated and heterogeneous informational collections have opened the conduits for e-Health what's more, m-Health administrations that are more customized and exact than any time in recent memory. The figure 1 shows the relation of bigdata in healthcare communities.

Figure 1 : Relation of Bigdata In Healthcare

In the ongoing years, cloud and huge information assume a significant job in the field of medicinal services because of approaching web of things (IoT). Hadoop is an opensource framework that allows to store and process big data in a distributed environment across clusters of computers using simple programming models. It is designed to scale up from singleservers to thousands of machines, each offering local computation and storage. Big data means really a big data, it is a collection of large datasets that cannot be processed using traditional computing techniques. Big data is not merely a data, rather it has become a complete subject, which involves various tools, techniques and frameworks. Big data is really critical to our life and its emerging as one of the most important technologies in modern world. Follow are just few benefits which are very much known to all of us. The term "big data" often refers simply to the use of predictive analytic, user behavior analytic, or certain other advanced data analytic methods that extract value from data, and seldom to a particular size of data set.

There is little doubt that the quantities of data now available are indeed large, but that not the most relevant characteristic of this new data ecosystem.

The Internet of Things (IoT) is a network of physical devices and other items, embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. Its impact on medicine will be perhaps the most important, and personal, effect. The major issues encountered by the authors are in case of healthcare systems are inter-operability and security. All the health data are considered to be the personal private data and those data should need security. Like confidentiality, integrity, authority should be preserved in the case of medical data. IoT inter-operability issues are still not being considered a problem to develop a data transfer system connecting health care providers with patients. A number of technologies can reduce overall costs for the prevention or management of chronic illnesses. These include devices that constantly monitor health indicators, devices that auto-administer therapies, or devices that track real time health data when a patient self-administers a therapy. Because they have increased access to high-speed Internet and smartphones, many patients have started to use mobile applications (apps) to manage various health needs[7].

The problem of this work is that building a big health application system by effectively integrating medical health resources using intelligent terminals, health Internet of Things(IoT), is very complex. Hence we go for the application of the big health system which is disease prediction also leads to a problem. The IoT device collects and transfers health data : blood pressure, oxygen and blood sugar levels, weight, and ECGs. These data are stored in the cloud and can be shared with an authorized person, who could be a physician, your insurance company, a participating health firm or an external consultant, to allow them to look at the collected data regardless of their place, time, or device.

II. METHODS AND MATERIAL

Building big health application system by effectively integrating medical health resources using Intelligent terminals, Health Internet of Things (IoT), Big data and Cloud computing is very complex to implement with these resources. That is, it is not practical to implement by integrating these huge resources. Hence here go for the one of the application of big health system, disease prediction. Health care research brings together a wide range of disciplines and fields, as researchers in medicine, microbiology, bio-medical engineering, computer science, and big data analytics frequently find themselves working on related projects. Here discuss the 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.

As a result of having access to high-speed wireless Internet and smart phones, many patients have started to use mobile applications and monitoring health devices to manage various health needs and to provide real time health data. User devices and healthcare information systems and their components can be integrated by and communicated via the Internet of Things (IoT). As a result of such integration huge volume of data will be produced by health and healthcare information systems at a remarkable rate. One objective of this study is to explore the opportunities of using big data analytics in healthcare information system to significantly improve the decision making process, enhance capability to offer services to patients and resolve major national challenges in healthcare such as predicting epidemics, patients follow up, etc. The method here presents a predictive model for chronic disease by monitoring the patients sensor information by finding all users behavior with the help of bigdata and cloud computing. For the prediction of chronic disease, here we use machine learning algorithms and computational methods. The method has undergone through four modules:

1. Dataset Loading
2. Map and Reduce
3. Classification
4. Disease Prediction.

Lets have a look on these modules. The figure 2 shows an overview of these
modules.

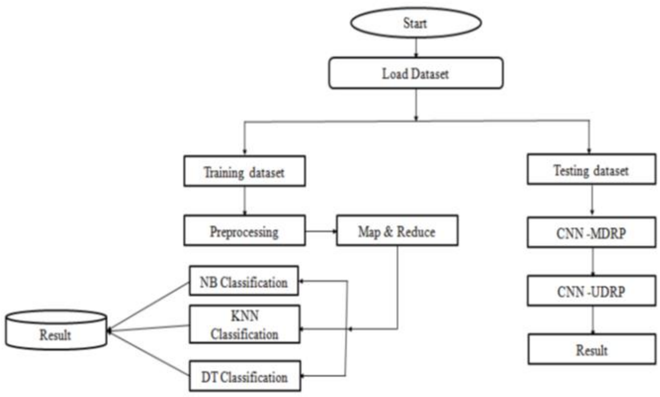

Figure 2 : Model for Disease Prediction

DATASET LOADING

The datasets are the key contribution for each and every project. In this module, load healthcare dataset to process. And then insert the dataset on database dynamically. Dataset should be loaded after preprocessing automatically and also inserted into database newely whenever run the process. Here also two types of dataset will be loaded into the given database. Both dataset is loaded and after data is partitioned and then finding results.

MAP AND REDUCE

MapReduce is a parallel programming model for Big Data with high scalability and fault tolerance. The elegant design of MapReduce has prompted the implementation of MapReduce in different computing architectures, including multi-core clusters, clouds, Cubie boardsand GPUs. MapReduce also has become a primary choice for cloud providers to deliver data analytical services. Many traditional algorithms and data processing in a single machine environment are transferred to the MapReduce platform. Figure 4.3 illustrates the flow process for map and reduce work.

CLASSIFICATION

The Classification fill be done on the Training dataset. Various data mining techniques such as Naive Bayes, KNN algorithm, Decision tree, Nueral Network are used to predict the risk of heart disease. The KNN algorithm uses the K user defined value to find the values of the factors of heart disease. Decision tree algorithm is used to provide the classified report for the heart disease. The Naive Bayes method is used to predict the heart disease through probability. For the classification, here use three datamining algorithms.

1. Naive Bayes Algorithm
2. KNN Algorithm
3. Decision Algorithm

Naive Bayes Classifier

In machine learning, naive Bayes classifiers are a family of simple "probabilistic classifiers "based on applying Bayes' theorem with strong (naive) independence assumptions between the features.

Naive Bayes has been studied extensively since the 1950s. It was introduced under a different name into the text retrieval community in the early 1960s, and remains a popular (baseline) method for text categorization, the problem of judging documents as belonging to one category or the other (such as spam or legitimate, sports or politics, etc.) with word frequencies as the features. With appropriate pre-processing, it is competitive in this domain with more advanced methods including support vector machines. It also finds application in automatic medical diagnosis [3]. Naive Bayes classifiers are highly scalable, requiring a number of parameters linear in the number of variables (features/predictors) in a learning problem. Maximum-likelihood training can be done by evaluating a closed-form expression, which takes linear time, rather than by expensive iterative approximation as used for many other types of classifiers. In the statistics and computer science literature, naive Bayes models are known under a variety of names, including simple Bayes and independence Bayes. All these names reference the use of Bayes' theorem in the classifier's decision rule, but naive Bayes is not (necessarily) a Bayesian method.

It is a classification technique based on Bayes' Theorem with an assumption of independence among predictors. In simple terms, a Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature. For example, a fruit may be considered to be an apple if it is red, round, and about 3 inches in diameter. Even if these features depend on each other or upon the existence of the other features, all of these properties independently contribute to the probability that this fruit is an apple and that is why it is known as 'Naive'.

Naive Bayes model is easy to build and particularly useful for very large data sets. Along with simplicity, Naive Bayes is known to outperform even highly sophisticated classification methods. Below is the formula for calculating the conditional probability.

$P(H|E) = (P(E|H) – P(H)) / P(E)$

where

- P(H) is the probability of hypothesis H being true. This is known as the prior probability.
- P(E) is the probability of the evidence(regardless of the hypothesis).
- P(E |H) is the probability of the evidence given that hypothesis is true.
- P(H |E) is the probability of the hypothesis given that the evidence is there.

Algorithm 1 Naive Bayes Classifier Algorithm

Input

• The dataset.

Output

• The class with the highest posterior probability.

Method

1. Convert the data set into a frequency table.
2. Predict classes using the naive bayes model.
3. Now, use Naive Bayesian equation to calculate the posterior probability for each class.

The class with the highest posterior probability is the outcome of prediction.

K-Nearest Neighbour Classifier(KNN)

In pattern recognition, theK-NearestNeighbors algorithm (KNN) is a non-parametric method used for classification and regression. In both cases, the input consists of the K closest training examples in the feature space. This is a type of instance-based learning, or lazy learning, where the function is only approximated locally and all computation is deferred until classification. This algorithm is among the simplest of all machine learning algorithms. Both for classification and regression, a useful technique can be to assign weight to the contributions of the neighbors, so that the nearer neighbors contribute more to the average than the more distant ones. For example, a common weighting scheme consists in giving each neighbor a weight of 1/d, where d is the distance to the neighbor. The neighbors are taken from a set of objects for which the class (for KNN classification) or the object property value (for KNN regression) is known. This can be thought of as the training set for the algorithm, though no explicit training step is required [4]. A peculiarity of the algorithm is that it is sensitive to the local structure of the data. The algorithm is not to be confused with k-means, another popular machine learning technique. KNN makes predictions using the training dataset directly. Predictions are made for a new instance (x) by searching through the entire training set for the K most similar instances (the neighbors) and summarizing the output variable for those K instances. For regression this might be the mean output variable, in classification this might be the mode (or most common) class value.

To determine which of the K instances in the training dataset are most similar to a new input a distance measure is used. For real-valued input variables, the most popular distance measure is Euclidean distance. Euclidean distance is calculated as the square root of the sum of the squared differences between a new point (x) and an existing point (xi) across all input attributes j.

Euclidean Distance

$$EuclideanDistance(x, xi) = \sqrt{(x_j - x_{ij})^2}$$

Other popular distance measures include:

- Hamming Distance: Calculate the distance between binary vectors.
- Manhattan Distance: Calculate the distance between real vectors using the sum of their absolute difference. Also called City Block Distance.

You can choose the best distance metric based on the properties of your data. If you are unsure, you can experiment with different distance metrics and different values of K together and see which mix results in the most accurate models

Euclidean is a good distance measure to use if the input variables are similar in type (e.g. all measured widths and heights). Manhattan distance is a good measure to use if the input variables are not similar in type (such as age, gender, height, etc.). The value for K can be found by algorithm tuning. It is a good idea to try many different values for K (e.g. values from 1 to 21) and see what works best for your problem. The computational complexity of K-nearest neighbour increases with the size of the training dataset. For very large training sets, K-nearest neighbour can be made stochastic by taking a sample from the training dataset from which to calculate the K-most similar instances. The K-nearest neighbour has been around for a long time and has been very well studied.

Decision Tree Classifier

Decision Trees are a type of Supervised Machine Learning (that is you explain what the input is and what the corresponding output is in the training data) where the data is continuously split according to a certain parameter. The tree can be explained by two entities, namely decision nodes and leaves. The leaves are the decisions or the final outcomes. And the decision nodes are where the data is split. Tree models where the target variable can take a discrete set of values are called classification trees; in these tree structures, leaves represent class labels and branches represent conjunctions of features that lead to those class labels. Decision trees where the target variable can take continuous values (typically real numbers) are called regression trees. In decision analysis, a decision tree can be used to visually and explicitly represent tdecisions and decision making. In data mining, a decision tree describes data (but the resulting classification tree can be an input for decision making). Decision tree learning is a method commonly used in data mining. The goal is to create a model that predicts the value of a target variable based on several input variables. An example is shown in the diagram at right. Each interior node corresponds to one of the input variables; there are edges to children for each of the possible values of that input variable. Each leaf represents a value of the target variable given the values of the input variables represented by the path from the root to the leaf[5].

DISEASE PREDICTION

Here prediction will done on testing dataset. The Neural Network provides the
minimized error of the prediction of chronic disease. In prediction, here use two algorithm

1. CNN MDRP
2. CNN UDRP

CNN MDRP and CNN UDRP

Chen, M., Hao, Y., Hwang, K.,Wang, L.,Wang, L. says that combine the structured and unstructured data in healthcare field to assess the risk of disease. First, use a latent factor model to reconstruct the missing data from the medical records collected from a hospital in central China. Second, by using statistical knowledge, we could determine the major chronic diseases in the region. Third, to handle structured data, consult with hospital experts to extract useful features. For unstructured text data, select the features automatically using CNN algorithm. Finally, propose a novel CNN-based multimodal disease risk prediction (CNN-MDRP) algorithm for structured and unstructured data. The disease risk model is obtained by the combination of structured and unstructured features[6].

(i) Disease Risk Prediction

The goal of this study is to predict whether a patient is amongst the cerebral infarction high-risk population according to their medical history. More formally, and regard the risk prediction model for cerebral infarction as the supervised learning methods of machine learning, i.e., the input value is the attribute value of the patient, X = (x1, x2, ... ,xn) which includes the patient's personal information such as age, gender, the prevalence of symptoms, and living habits (smoking or not) and other structured data and unstructured data.

The output value is C, which indicates whether the patient is amongst the cerebral infarction high-risk population. C = (C0, C1) , where, C0 indicates the patient is at highrisk of stroke, C1 indicates the patient is at low risk of stroke. For dataset, according to the different characteristics of the patient and the discussion with doctors, we will focus on the following three datasets to reach a conclusion.

• Structured data (S-data): use the patient's structured data to predict whether the patient is at high-risk of cerebral infarction.

• Text data (T-data): use the patient's unstructured text data to predict whether the patient is at high-risk of cerebral infarction.

• Structured and text data (ST-data): use the S-data and T-data above to multi-dimensionally fuse the structured data and unstructured text data to predict whether the patient is at highrisk of cerebral infarction.

Introduces a machine learning and deep learning algorithms used in this work briefly. For S-data, use three conventional machine learning algorithms, i.e., Naive Bayesian (NB), K-nearest Neighbour (KNN), and Decision Tree (DT) algorithm to predict the risk of cerebral infarction disease. This is because these three machine learning methods are widely used . For T-data, we propose CNN-based Unimodal Disease Risk Prediction (CNN-UDRP) algorithm to predict the risk of cerebral infarction disease. In the remaining of the study, let CNN-UDRP(T-data) denote the CNN-UDRP algorithm used for T-data. For ST data, we predict the risk of cerebral infarction disease by the use of CNN-MDRP algorithm, which is denoted by CNN-MDRP(ST-data) for the sake of simplicity. Figure 3 illustrates the model for CNN MDRP.

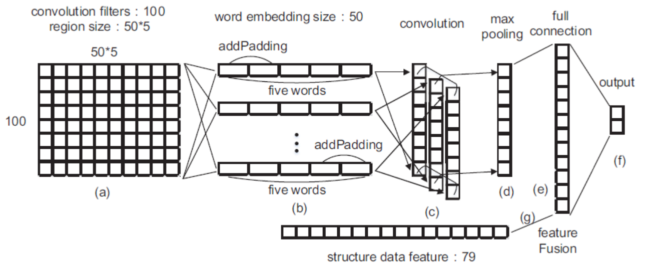

Figure 3 : CNN-based multimodal disease risk prediction algorithm

This paper proposes a new Convolutional Neural Network based Multimodal Disease Risk Prediction (CNN-MDRP) algorithm using structured and unstructured data from hospital. To the best of my 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 percentage with a convergence speed which is faster than that of the CNN-based Unimodal Disease Risk Prediction (CNNUDRP) algorithm. Here find out the results like Accuracy, precision, Recall and F measure. The main purpose of this work is to propose the best technique for early prediction of disease and to reduce the diagnosis time and improve the efficiency and accuracy. Enormous Data has difficulties in restorative applications and social insurance. With the advancement of enormous information examination innovation, more consideration has been paid to illness forecast from the point of view of enormous information investigation, different investigates have been directed by choosing the qualities consequently from countless information to improve the exactness of hazard characterization. Numerous calculations have demonstrated great outcomes since they distinguish the trait precisely. From past investigation, it is seen that for the anticipated of Chronic illness, CNN-MDRP gives improved more exactness. Unending illness hazard anticipated is precisely by Naive Bayes. It offers the most elevated grouping precision. For interminable infection expectation, more precision is accomplished by CNN-MDRP calculation.

III.RESULTS AND DISCUSSION

A. Dataset loading

A big healthcare system is designed as the homepage for the work in progress. First the datset will be loaded to the system. The dataset consist of both testing and training data which are collected from one of the hospital data taken from the kaggle website. Both the training and testing data attributes will be considered for the process. The training dataset have the Patient physical information and the Testing dataset have the detail about chronic disease Information.

The training data will be firstly trained and executed for the dataset loading, which is the first module that is done for the work process. Dataset loading will be done randomly from the healthcare data as the training and testing data. After loading both training and testing dataset to the database, the next process has been carried out, that is the preprocessing step.

Preprocessing is done for removing the unwanted values such as null values, whitespace and empty records. After the preprocessing is successfully finished, the records will be readily inserted to the healthcare system.

B. Map and reduce

Map Reduce is a programming model and an associated implementation for processing and generating big data sets with a parallel, distributed algorithm on a cluster. The model is a specialization of the split-apply-combine strategy for data analysis. Here Hadoop platform with implemented the certain process as finding overall data with mapping and how much data will be reduced. The term Map Reduce actually refers to two separate and distinct tasks that Hadoop programs perform. The first is the map job, which takes a set of data and converts it into another set of data, where individual elements are broken down into tuples.

C. Classification

For organized and unstructured information, here utilizing customary AI calculations, i.e., Naive Bayes(NB), K-Nearest Neighbour(KNN) and Decision Tree(DT) calculation to foresee the danger of stroke.

Innocent Bayes characterization is a straightforward probabilistic classifier. It requires to ascertain the likelihood of highlight characteristics. Here utilize contingent likelihood recipe to gauge discrete component ascribes and Gaussian appropriation to evaluate constant element characteristics. The K-Nearest Neighbor order is given a preparation information set, and the nearest K occasion in the preparation informational index is found.

For K-Nearest Neighbor, it is required to decide the estimation of separation and the choice of K esteem. In the analyze, the information is standardized at first. At that point we utilize the Euclidean separation to gauge the remove. With respect to the determination of parameter K, we find that the model is the best when K = 1. Accordingly, we pick K = 1. We pick grouping (C4.5) calculation among a few choice tree DT) calculations.

D. Prediction

Tremendous Data experiences issues in remedial applications and social protection. With the headway of tremendous data examination advancement, more thought has been paid to ailment figure from the perspective of colossal data examination, extraordinary examines have been coordinated by picking the characteristics thus from endless data to improve the precision of danger portrayal. Various estimations have shown extraordinary results since they recognize the attribute decisively. From past examination, it is seen that for the foreseen of Chronic sickness, CNN-MDRP gives improved more precision. Unending sickness danger foreseen is decisively by Naive Bayes. It offers the most raised gathering exactness. For endless disease desire, more accuracy is achieved by CNN-MDRP figuring precisely by Naive Bayes. It offers the most elevated grouping precision. For constant malady expectation, more exactness is accomplished by CNN-MDRP calculation.

The results of the work gives a predictive model for chronic disease by continuous monitoring patients update sensor information following with the screenshots.

First load the training and testing dataset in to the system. The dataset will bebrowsed and go for the data preprocessing step. The figure 4 and figure 5 shows the loading of training dataset from the database. After loading the dataset for the system, the preprocessing is done for the removal of unwanted data. Training is done with the training dataset of patient physical information. The data loaded files are in csv files. This will help to get the files in the readable form. After the loading, the data are compressed with the preprocessing step and the preprocessing is successfully finished and check in the UR file.

Figure 4 : Result for Dataset Loading

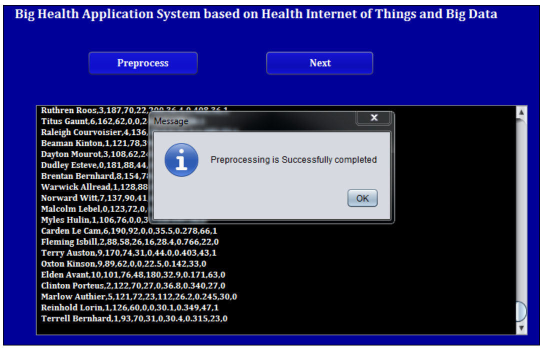

Figure 5 : Results for Preprocessing

After preprocessing the preprocessed data willbe inserted to the system. The data will be stored in Hadoop server. The figure 6 shows the result of map and reduce. The attributes are stored in the table format so that the readers can find clearly the attributes taken for testing of the patient.

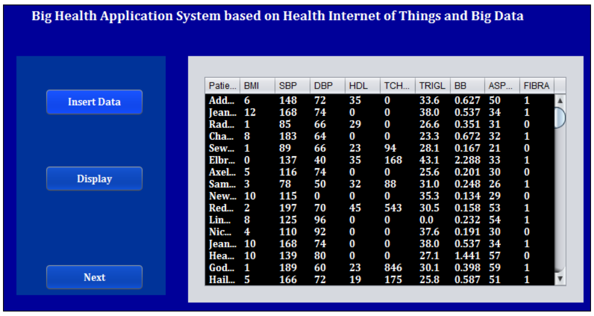

Figure 6 : Result for Map and Reduce

The classification is done with the help of three datamining algorithms namely Naïve Bayes, KNN algorithm and Decision tree. Unending illness hazard anticipated is precisely by Naive Bayes algorithm. Figure 7, figure 8 and figure 9 illustrates the results for these three algorithms.

The comparison results of the three algorithm is shown with the parameters namely accuracy, recall, f-measure and precision.

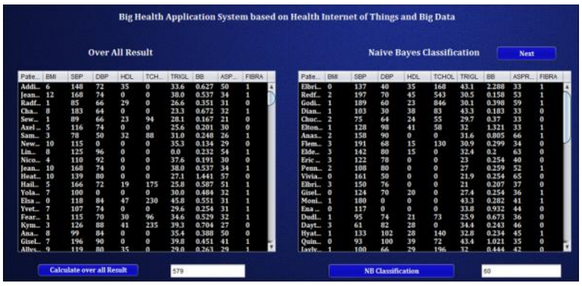

Figure 7 : Result for Naive Bayes Algorithm

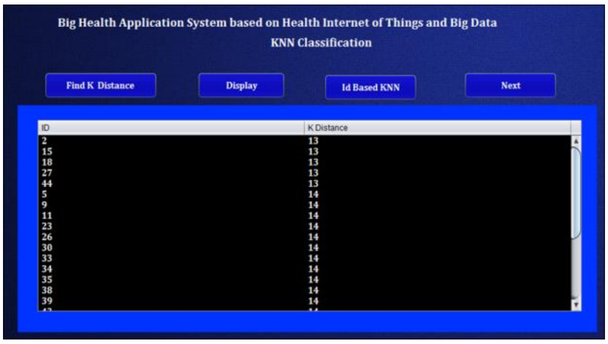

Figure 8 : Results for KNN Algorithm

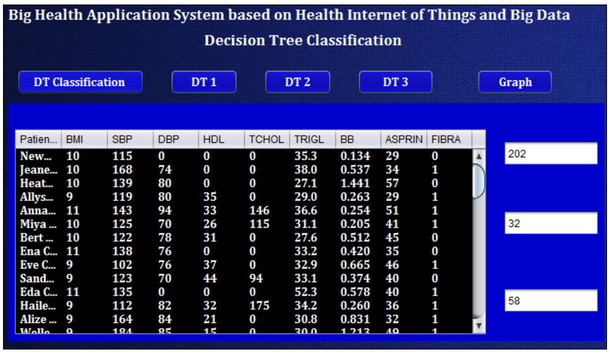

Figure 9 : Results for Decision Tree

The comparison graph shown in figure 10 represents the classification results of three algorithm with certain parameters. The graph explains that naïve bayes algorithm gives more accuracy compared to other algorithms.

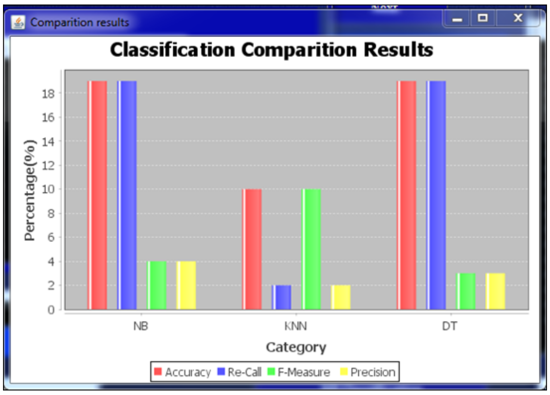

Figure 10 : Comparison Results of Three Classification algorithms

The prediction will be carried out by two convolutional nueral network namely CNN MDRP and CNN UDRP. The disease is predicted with the help of monitoring patients updated sensor information. The result will shows that the prediction is accurate with CNN MDRP algorithm. The figures 11and figure 12 shows the prediction results.

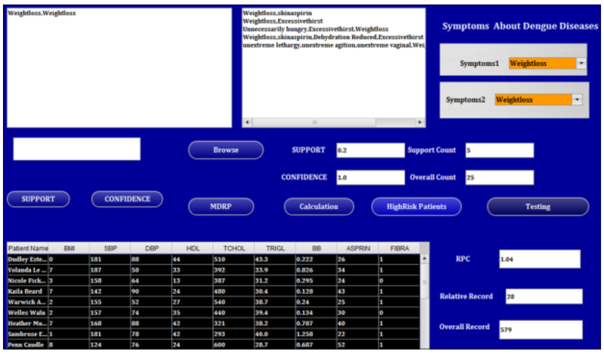

Figure 11 :Result for CNN - MDRP

Figure 12 : Results for CNN – UDRP

Comparison graph of prediction algorithms are shown in figure13. From the graph it can noticed that CNN – MDRP gives more accurate prediction result for the system.

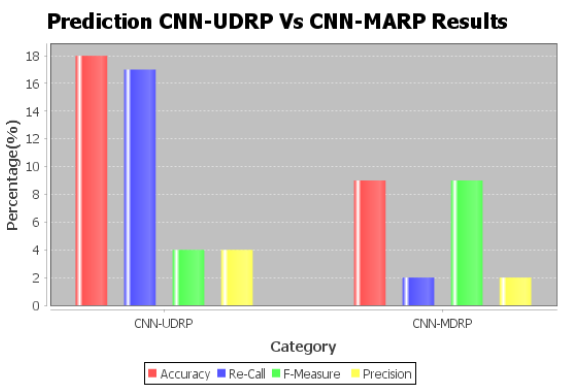

Figure 13: Comparison Results of Two prediction algorithms

IV.CONCLUSION

The intent of this research paper is to develop flexible and scalable intelligent framework architecture based on IoT and big data. Since the latest information technologies have been collaborated each other, the shortage of medical resources can be solved. For this reason, this paper proposes a big health application system based on internet of things(IoT) and bigdata.

The most recent data advances can be utilized into medicinal services field to beat overall medical issues, for example, uneven dissemination of restorative assets, the becoming unending illnesses, and the expanding restorative costs. Blending the latest information technology into the healthcare system will greatly mitigate the problems. This work presents the big health application system based on the health Internet of Things and big data. Due to the complexity of building a health application system, here go for a application of big health system that is disease prediction.

In this work, propose a new convolutional neural net-work based multi-modal disease risk prediction (CNN -MDRP)algorithm using structured and unstructured data from 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 percent with a convergence speed which is faster than that of the CNN-based uni-modal disease risk prediction (CNN - UDRP) algorithm. Thus the model helps to predict the chronic disease case earlier and reduce the mortality rate.

Since the model will not gives a hundred percent accuracy, in the future, we will consider more reference methods to fulfill the accuracy. Experiments and analysis confirm the effectiveness of our schemes and design.

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Cite this article as :

Arsheenath Beegam, Ismail P. K., "Predicting Chronic Disease by Monitoring Patients Updating Sensor Information with Big Health Application System", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 5 Issue 3, pp. 613-624, May-June 2019. Available at doi : https://doi.org/10.32628/CSEIT1953169
Journal URL : http://ijsrcseit.com/CSEIT1953169