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Proposed Efficient Neural Network for Periodontal Disease

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ABSTRACT: Artificial Neural networks are used as a powerful discriminating classifier for tasks in medical diagnosis for early detection of diseases. The objective of this paper is to proposed convolutional neural network with five risk factors Monocytes, Neutrophils, Lymphocytes, Blood sugar level and Pregnancy. The aim of this work is to implement feature selection and convolutional neural network with accuracy, precision and recall.The data set used of 437 patients those are aggressive and chronic periodontal. In this efficient neural network is proposed for periodontal disease. CNN used in this work with two architecture layers. It is supervised technique and helpful in removing overlapping.

KEYWORDS: Periodontitist; Convolutional neural network; Feature selection; Information gain; Correlation; Disease

I. INTRODUCTION

Periodontitis is inflammatory condition of periodontal membrane. It is bacterial driven chronic disease of soft tissues. These soft tissues support the dental root. Periodontal disease occurs when bacteria affect the gingival and extend to the periodontal membrane. The disease continues propagate, if left untreated. In the end it can lead to tooth loss. In periodontitis there are some stages through which this disease is propagated and those stages are gingivitis, mild, moderate and severe periodontitis. Gingivitis is the earliest stage of gum disease, in this stage gums are red, swollen and bleed easily. In next stage gums begin to separate from teeth and forming pocket which fill with plaque .In moderate, deeper pockets form and then tissues are lost. In last stage teeth may lose because large amount of tissue have been lost. There is range which shows the affected people i.e. severe periodontitis affects 8.5% population where moderate 30% and mild in 9% of adults. Currently two types of periodontitis are there: Chronic periodontits and Aggressive periodontitis which are define below:

(a)Chronic Periodontitis: It is chronic inflammation of the periodontal tissues that is caused by plaque. The disease may be modified with systemic diseases. For example Blood sugar level and Pregnancy.

(b)Aggressive periodontitis: The involvement of multiple teeth and periodontal tissue loss; a high rate of disease progression.

There are some important risk factors in periodontitis like Monocytes, Neutrophils, Lymphoytes, blood sugar level and Pregnancy. Classification of periodontitis can be done on the behalf of these risk factors. Blood sugar level and Pregnancy are indirectly involved in this disease.

II. RELATED WORK

Armitage, Gary C. (1999) In this paper new classification and conditions are present. This is different from the classification system which is developed at 1989 World Workshop in Clinical Periodontics. In this analysis of rationale is given for each modification**Papantonopoulos, George H. (2004)** This paper shows that smoking is the risk factor of periodontal disease. In this clinically and radiographically comparison is done. Smoker and non-smokers patient had been treated for advance periodontal disease. They received maintenance therapy for minimum 5 years. There is no statistically difference between smoker and non smoker after 5 years. That difference showed in probing depth and bone loss measurement in radiography. In this, Analysis is done with the help of logistic regression.**Van Der Velden,**

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Ubele. (2005) This paper deals with the purpose and the problem of periodontal disease classification. Classification means distribution into different groups. In this, periodontal condition is characterized by three symptoms i.e. loss of connective tissue, loss of alveolar bone, inflamed pockets. Various forms of disease is classify with nominalistic concept. This concept is simple to apply.**Page, Roy C., and Paul I. Eke (2007)** This paper presents the case study. In this survey is done on the behalf of measuresing probing depth (PD), clinical attachment level (CAL), radiography and alveolar bone loss, gingival inflammation measured as bleeding on probing, or a combination of these measures. Other risk factors are also consider like age which can affect the PD and CAL. case definitions for periodontitis are based on measurements, and small changes in the values of result can do large changes in disease prevalence.**Youssif, Aliaa AA, Abeer Saad Gawish, and Mohammed Elsaid Moussa (2012)** In this paper, for classification of periodontal disease an automated system have been developed. Feature extraction has been done with the help of H&E stained images. In the system image processing techniques has been used which is color deconvolution, morphological operations, and transforms for epithelium & connective tissue segmentation, nuclear segmentation and extraction of the features of nucleus, dilated blood vessels & collagen fibbers[14]. Classification is done with the help of feed forward Back propagation artificial neural network. Results are more accurate with the mixed feature classification.**Eke PI, Dye BAet al (2012**) This paper presented the prevalence of periodontitis in adults of U.S. Data collection is done from National Health & Nutrition Examination Survey.The severity of mild, moderate, and severe periodontitis was 8.7%, 30.0%, and 8.5%, respectively. Periodontitic ranged from 24.4% in adults 30 to 34 yrs to 70.1% in adults aged 65 yrs and older.**Aimetti, Mario, et al (2012)** This paper deals withmetabonomic analysis of saliva that shows the generalised chronic periodontitis. Metabonomic profiling of saliva samples provide a signature of the disease. Nuclear Magnetic Resonance (NMR) used for analysing the saliva samples. In this clustering and Support vector machine (SVM) used. Accuracy of Metabolic Profile is 84.1% of GCP patients. Metabonomic analysis is valid approach for identification of PD.**Kebschull, M., et al. (2013)** In this molecular profiling is done to differentiate the CP and AgP. They use supervised classification with machine-learning algorithms and internal validation .They use Gene expression profiles. Small differences between gene expression and in highly variable classifier performance give the limited dissimilarities between AgP and CP.**Papantonopoulos G,Takahashi K et al. (2013)** In this, author used theCellular automata to understand the non linear dynamics of periodontal disease. Biological systems can be model by Cellular automata (CA) which is time and space discrete dynamical systems. In this simulation is done by CA experimentswhich shows that how the disease is propagated. There are three groups of CA rules i.e. spreading, remaining constant or receding the disease. Periodontitis is a nonlinear dynamical process which is recommended by this study through mathematical model.**Azhagusundari, B., and Antony Selvadoss Thanamani (2013**)In this paper attribute reduction is done. In this most of the features present are redundant and affect the classification. To improve the efficiency of classification these redundant features eliminated. And then, selected the best discriminate features with discernibility matrix and information gain is presented. The classification with selected features shows better results.**Papantonopoulos G, Takahashi K et al. (2014)** This paper presents the artificial neural network (ANN) and immunologic parameters which is trained to diagnose the Aggressive Periodontitis. In this ANN used to classify Agp and CP patients and it trained by cross entropy (CE) values. To estimate the probability of derived dataset kernel density estimation (KDE) proposed.Accuracy of ANN 90%–98% to classify the AgP or CP patients.**Arevalo, John, et al (2016)**this paper presents the learning frame-work for breast cancer diagnosis in mammography that integrates deep learning technique. Clinical medical images are used as data set. In this, deep learning based framework automatically addresses classification of breast mass lesions in mammography.

III.MEDICAL DATA

The data set of periodontal disease is purely real data set. The data set used in this work collected from medical laboratories. In this work 437 patients data has been used i.e. 437 instances and has 5 attributes. These attributes are actually risk factors of periodontal disease on the behalf of convolutional neural Network trained. The attribute taken for classification are neutrophils, monocytes, lymphocytes, blood sugar level and pregnancy.The dataset is divided into two classes i.e. Agp and CP. These features are helpful in the classification of periodontal disease. These features in table1 specify their range through which classification is done. In **Table1**there are features along with their range.

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Table 1: Sample of dataset for periodontal disease

S.No.	Features	Normal Range
1	Neutrophils	50-80%
2	Monocytes	2-10%
3	Lymphocytes	25-50%
4	Blood sugar level	70-130 mg/dl
5	Pregnancy	1-9 months

IV. PROPOSED WORK

The proposed system consist of two steps i.e. feature selection and convolutional neural network. This section presents the detail description of methodology. The above data set is used as input in this work. There are two labels i.e. Agp and CP in the sample data. Agp and CP consider as "1" and "0" respectively for input. This process is supervised that's why labels are also considered as an input with attributes value.

FEATURE SELECTION

Feature selection is done for effective features. In this attribute reduction is done which is the key process for knowledge acquisition. Some data set is larger in size. If that data set is used for classification it may occupy more resources especially in terms of time. Most of the features present are redundant and inconsistent and affect the classification [9]. In order to improve the efficiency of classification these redundancy and inconsistency features must be eliminated by feature selection. It has two methods which are followed:

INFORMATION GAIN

Information gain (IG) is the amount of information in bits about the class prediction, if the only information available is the presence of a feature and the corresponding class distribution. It measures the expected reduction in entropy [21]. Information gain is that in which an Attribute has a high information gain, because it will uniquely identify.

In this work,there are some values which are genratting from features. That value will predict the label i.e. Agp or CP, if this can be done effecently it means it has more information. Otherwise it will show entropy, if this is fail to predict. In this work information gain is done with following formula:

*logVal(ithEle)=(subLen/totLen)*log2(subLen/totLen);*

CORRELATION

The Correlation Feature Selection (CFS); contain features which is highly correlated with the classification, yet uncorrelated to each other. Correlation based feature selection does not depend on any particular data transformation; it is done by measuring the correlation between any two variables. So, the technique may be applied to a variety of supervised classification problems, including those in which the class the variable to be predicted [27].Correlation is done with the help of command in this work. That command shown below:

R1=Corrcoef(features)

CONVOLUTIONAL NEURAL NETWORK

Convolutional neural network is a type of feed-forward artificial neural network. It helps us train deep. It is many-layer networks, which is very good at classification. It is a neural network with specialized connectivity structure. In this, Classification layer at the end.

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In this work, if we see features label on the behalf of 2D it will overlap. To remove overlapping CNN separate it by given weights.CNN selects the weight with the help of overlapping. In CNN, weights are given according to feature's values and reduce overlapping between the features. In the next step, input is given to neural network. At last neural network trained.CNN selects the adaptive weights. In the CNN training error and testing error reduced on the behalf of overlapping weights.
The methodology for periodontal disease using CNN involves following steps:
Training module
Step1: Collecting data set
Step2: Feature selection
Step3: Feature selection with label
Step4: Convolutional neural network classifier
Testing module
Step1: Feature selection
Step2: Features without label
Step3: Classifier model

Performance evaluation parameters:

These elements are used in supervised machine learning algorithm which helps in evaluating the performance of any specified algorithm. Terms used for classification are "True Positive (TP)", "False Negative (FN)", "True Negative (TN)", and "False Positive (FP)" .True positive are positive reviews and are also classified as positive by the classifier, whereas on the other hand false positive shows positive reviews but classifier does not classify it as positive. Likewise , True Negative constitute the reviews which are negative and are also classified as negative by the classifier, whereas False Negative are negative reviews but classifier does not classify it as negative. On the basis of the values found from confusion matrix, additional parameters such as "accuracy", "recall", and "Precision" are evaluated to find the performance of classifier.

Accuracy: It is defined as the number of correctly classified reviews to the total number of reviews.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

Precision: It is the ratio of number of reviews correctly identified as positive to the total number of reviews identified positive by the classification algorithm.

$$Precision = \frac{TP}{TP + FP}$$

Recall: It is defined as the ratio of total number of positive reviews to the total reviews which are truly positive.

$$Recall = \frac{TP}{TP + FP}$$

V.SIMULATION RESULTS

In this section, feature selection and convolutional neural network is implemented on the 437 instance.**Figure3** shows that feature selection is implemented on the 437 instance i.e. information gain and correlation. Ranking is done on the behalf of priority. In below there is CORR and IG:

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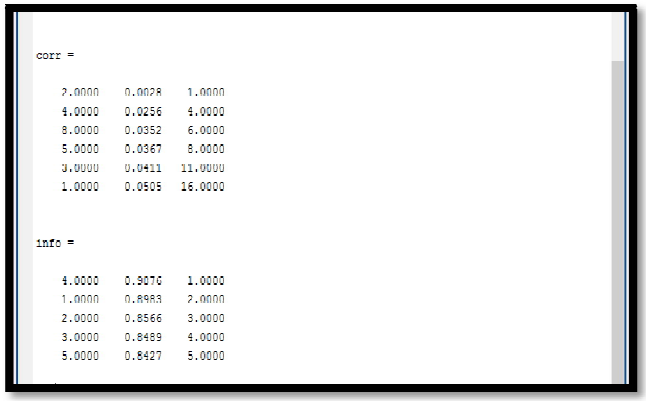

Fig.3: Feature selection by correlation and information gain

Figuer4 shows the three parameters Accuracy, precision and recall with convolutional neural network. In this, Convolution neural network implemented on 437 instances.

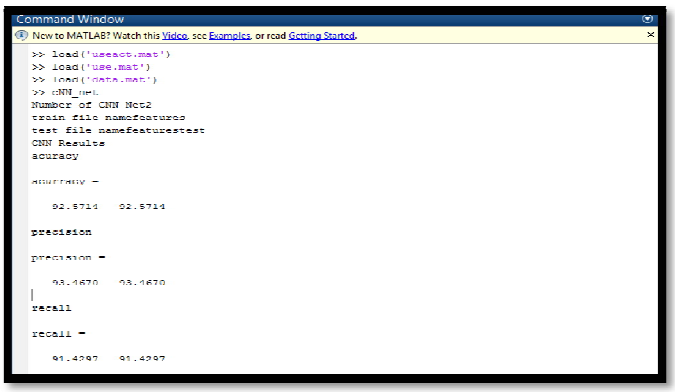

Fig.4: Parameters with Convolutional neural network (CNN)

In next, Figure5 shows the training and testing error of convolutional neural network. There are red and blue dots which show the overlapping of two classes.

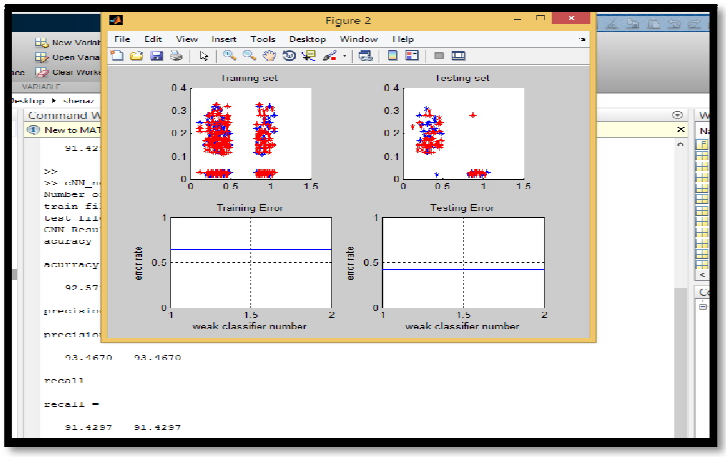

Fig.5: Training and testing error of CNN

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In this, Figure6 shows the parameters with correlation method and convolutional neural network.

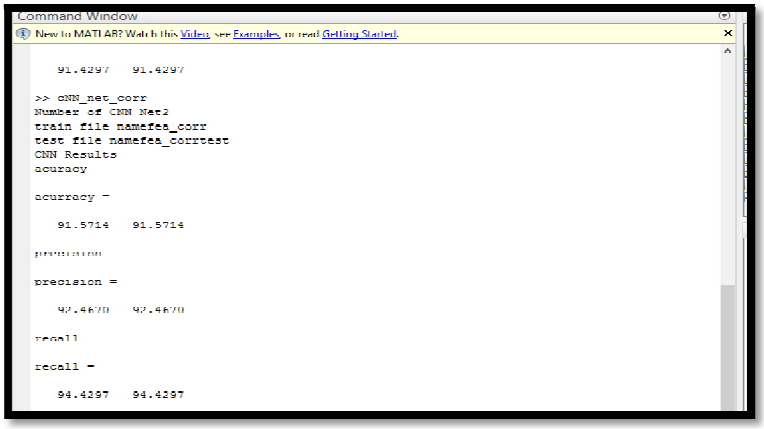

Fig.6: Parameters with correlation and CNN

In this, Figure7 shows the training and testing error of correlation with convolutional neural network.

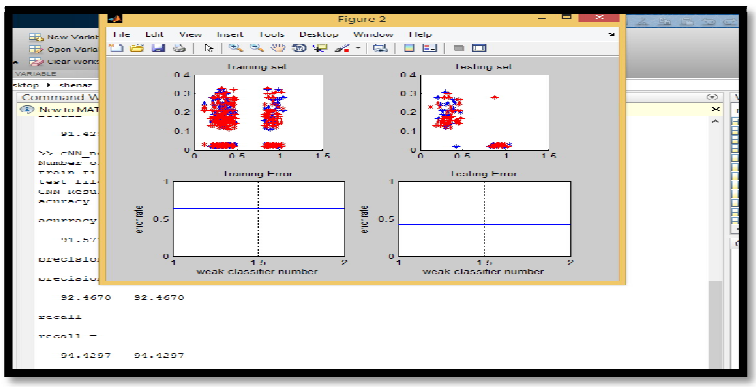

Fig.7: Training and testing error of correlation with CNN

In next, Figure8 shows the result of parameters after implemented the information gain and convolutional neural network. It has highest accuracy which is 93.5714% as compare to multilayer perceptron.

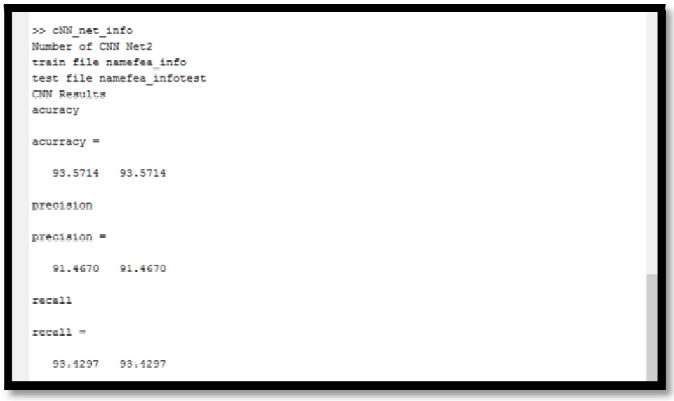

Fig.8: Parameters with information gain and CNN

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In below, Figure9 shows the training and testing error of information gain and convolutional neural network.

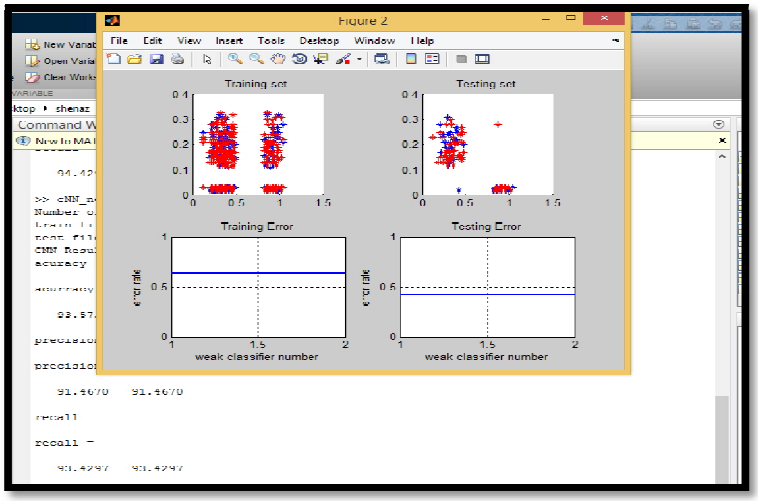

Fig.9: Training and testing error of information gain with CNN

VI. CONCLUSION

In this, we purpose the efficient neural network for periodontal disease. That efficient neural network is convolutional with five risk factors i.e. Monocytes, Neutrophils, Lymphocytes, Blood sugar level and Pregnancy. The proposed system achieved an accuracy of 93.5714%. Thus it may be concluded that the results of this system are reliable for the system to be substitute to the medical experts.

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