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Parkinson's disease Diagnosis using Modified PCA-KNN Classifier

Sakina Imam and Prof. Sarwesh Site***

**M. Mech. Scholar, Department of Computer Science & Engineering, All Saints' College of Technology, Bhopal (Madhya Pradesh), India.*
***Assistant Professor, Department of Computer Science & Engineering, All Saints' College of Technology, Bhopal (Madhya Pradesh), India.*

(Corresponding author: Sakina Imam)
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ABSTRACT: Even though there is clinical demand for new technology that can accurately measure Parkinsonian tremors, automatic scoring of Parkinsonian tremors using machine-learning approaches has not yet been employed. This study aims to fill this gap by proposing machine-learning algorithms as a way to predict the Unified Parkinson's Disease Rating Scale (UPDRS), which are similar to how neurologists rate scores in actual clinical practice. Various data mining techniques have been used for the diagnosis of Parkinson disease such as BayesNet, decision tree, neural network etc. In this paper, we propose a modified PCA-KNN classifier methodology to diagnose the Parkinson disease. The simulation of propose methodology is perform on MATLAB2012a simulator toolbox which contain various data mining functions and the comparative analysis of the proposed method and existing method is performed using accuracy/ precision parameter. The simulation results of proposed methodology outperform than the existing method. It means that our proposed method if much more effective to diagnose the Parkinson disease (PD) than existing methods.

Index Terms: Data Mining, Medial Industry, Parkinson's disease, Naïve bayes, k-NN classifiers

I. INTRODUCTION

Despite the growing body of literature about tremor quantification for objective and quantitative diagnosis, automatic scoring of the Parkinsonian tremor severity using machine-learning algorithms for routine clinical assessments has yet to be investigated. Seeking to address this deficit in research, this paper expounds upon a machine-learning approach to objectively measure and accurately evaluate Parkinsonian tremors using the Unified Parkinson's Disease Rating Scale (UPDRS). The aim of this study is to connect the automatic scoring system and current clinical rating scale in a more natural manner in order to attain a more objective and sophisticated diagnosis and to provide clinical convenience.

A. Background

As PD is a movement disorder; its symptoms mainly show clinical abnormalities of movements including tremor bradykinesia, rigidity, and postural instability [1]. A Parkinsonian tremor is defined as an involuntary, rhythmic, oscillatory, and back-and-forth action [2]. It is certainly one of the most disabling symptoms of PD. In particular, the ability to perform functional upper-limb motor tasks is crucial for most activities in daily life, and consequently, patients with a Parkinsonian tremor experience difficulties on a daily basis, either physically or psychologically. Therefore, the evaluation of a tremor is crucial when seeking to diagnose, treat, and manage this disease. The assessment of a Parkinsonian tremor is usually accomplished by using rating scales. Various clinical rating scales have been used to quantify the symptoms of PD patients, of which the UPDRS is one of the best-known and most widely used methods [3]. The UPDRS provides comprehensive information about PD patients' disabilities for understanding the state of each patient. On the basis of the UPDRS, neurologists use digits to evaluate the severity of a total of 42 motor abilities by observing patients' conditions and their performance at various tasks [4].

Table 1: Unified Parkinson's Disease Rating Scale (UPDRS) for a tremor at rest (head, upper, and lower extremities).

Score	Guide
0	Absent
1	Slight and infrequently present
2	Mild in amplitude and persistent, or moderate in amplitude but only intermittently present
3	Moderate in amplitude and present most of the time
4	Marked in amplitude and present most of the time

The digits for assessment range from 0 to 4. Normal conditions without any symptoms are rated as 0, and the most severe conditions are awarded a score of 4. An example is provided in Table 1 for the resting tremor examination. Although this method is widespread, the results obtained by this approach depend on the observer's opinion. Ratings by trained observers and the patients' own ratings have been surprisingly low, but there may also be poor reliability between raters [5,6]. In addition, this approach is not suitable to follow up on patients' conditions in their daily lives since the clinical rating scales are employed only during routine clinical visits, despite PD being notorious for its fluctuations and its dependence on patients' conditions [7]. Therefore, clinical demand for the advent of new wearable technology that can objectively collect and quantitatively analyze data has arisen, and, by extension, has also arisen for long-term evaluations and the follow-up of PD abnormalities [7].

Our study at hand is organized as follows: Section 2 presents related work. Section 3 provides the overview about the various data mining techniques to diagnose the Parkinson's disease. Finally, conclusions and future work is provided in the Section 4.

II. RELATED WORK

Benmalek *et al.* [4] propose to go further by multiclass classification with three classes of Parkinson stages and healthy control. So we have used 40 features dataset, all the features are analyzed and 9 features are selected to classify PWP subjects in four classes, based on unified Parkinson's disease Rating Scale (UPDRS). Various classifiers are used and their comparison is done to find out which one gives the best results. Results show that the subspace discriminant reach more than 93% overall classification accuracy. Tsiouris *et al.* [5] proposed a decision support system (DSS) for the conversion of Unified Parkinson's Disease Rating Scale (UPDRS) motor symptoms into a Hoehn & Yahr stage representation is proposed. Accurate estimation of a Parkinson's disease patient's Hoehn & Yahr stage is of great importance since this single value is enough to represent condition, severity of symptoms and localization and disease progression. For the first time data mining techniques are used to enhance Hoehn & Yahr stage estimation performance in a DSS. In its core a classification algorithm is trained using motor evaluation UPDRS data and new instances can then be automatically classified to provide suggestions and facilitate the final decision. Different classification methods and feature evaluation approaches are evaluated using public Initiative (PPMI). Overall, the Hoehn & Yahr stage classification accuracy reaches 87%. Chao Ma et al. [6] A novel hybrid method named SCFW-KELM, which integrates effective subtractive clustering features weighting and a fast classifier kernel-based extreme learning machine (KELM), has been introduced for the diagnosis of PD. In the proposed method, SCFW is used as a data preprocessing tool, which aims at decreasing the variance in features of the PD dataset, in order to further improve the diagnostic accuracy of the KELM classifier. The impact of the type of kernel functions on the performance of KELM has been investigated in detail. The efficiency and effectiveness of the proposed method have been rigorously evaluated against the PD dataset in terms of classification accuracy, sensitivity, specificity, area under the receiver operating characteristic (ROC) curve (AUC), f -measure, and kappa statistics value. Experimental results have demonstrated that the proposed SCFW-KELM significantly outperforms SVM-based, KNN-based, and ELM-based approaches and other methods in the literature and achieved highest classification results reported so far via 10-fold cross validation scheme, with the classification accuracy of 99.49%, the sensitivity of 100%, the specificity of 99.39%, AUC of 99.69%, the f -measure value of 0.9964, and kappa value of 0.9867. Promisingly, the proposed method might serve as a new candidate of powerful methods for the diagnosis of PD with excellent performance. Chen *et al.* [7] presented an effective and efficient diagnosis system using fuzzy k-nearest neighbor (FKNN) for Parkinson's disease (PD) diagnosis. The proposed FKNN-based system is compared with the support vector machines (SVM) based approaches. In order to further improve the diagnosis accuracy for detection of PD, the principle component analysis was employed to construct the most discriminative new feature sets on which the optimal FKNN model was constructed. The effectiveness of the proposed system has been rigorously estimated on a PD data set in terms of classification accuracy, sensitivity, specificity and the area under the receiver operating characteristic (ROC) curve (AUC). Experimental results have demonstrated that the FKNN-based system greatly outperforms SVM-based approaches and other methods in the literature. The best classification accuracy (96.07%) obtained by the FKNN based system using a 10-fold cross validation method can ensure a reliable diagnostic model for detection of PD. Promisingly, the proposed system might serve as a new candidate of powerful tools for diagnosing PD with excellent performance. Alam *et al.* [8] presented a study to differentiate PD patients from healthy controls, on the basis of features derived from plantar vertical ground reaction force (VGRF) data during walking at normal pace. The current work presents a comprehensive study highlighting the efficacy of different machine learning classifiers towards devising an accurate prediction system.

Selection of meaningful feature based on sequential forward feature selection, the swing time, stride time variability, and center of pressure features facilitated successful classification of control and PD gaits. Abdullah et al. [9] presented a Parkinson disease diagnosis is realized by using the speech impairments, which is one of the earliest indicators for Parkinson disease. For this purpose, a deep neural network classifier, which contains a stacked autoencoder and a softmax classifier, is proposed. The several simulations are performed over two databases to demonstrate the effectiveness of the deep neural network classifier. The results of the proposed classifier are compared with the results of the state-of-art classification method. The experimental results and statistical analyses are showed that the deep neural network classifier is very efficient classifier for Parkinson disease diagnosis. Bourouhouet *et al.* [10] compared classification method for detecting Parkinson's. Its chronical neurological degenerate disease and three classifiers are used to it they are KNN, Naïve Bayes and support machine. From 20 healthy patient and 20 dis patient features extracted like frequency, amplitude, pitch, pulse for this KNN is used. Naïve Bayes identify the performance detection of PD. SVM is used for detection of PD and the final result of comparisons is SVM is effective. Hu¨seyin Guruler *et al.* [11] Proposed approach that involves a combination of the k-means clustering-based feature weighting (KMCFW) method and a complex-valued artificial neural network (CVANN). A Parkinson dataset comprising the features obtained from speech and sound samples were used for the diagnosis of PD. PD attributes are weighted through the use of the KMCFW method. New features obtained are converted into a complex number format. These feature values are presented as an input to the CVANN. The efficiency and effectiveness of the proposed system have been rigorously evaluated against the PD dataset in terms of five different evaluation methods. Experimental results have demonstrated that the proposed hybrid system, entitled KMCFW– CVANN, significantly outperforms the other methods detailed in the literature and achieves the highest classification results reported so far, with a classification accuracy of 99.52 %. Therefore, the proposed system appears to be promising in terms of a more accurate diagnosis of PD. Also, the application confirms the conclusion that the reliability of the classification ability of a complex-valued algorithm with regard to a real-valued dataset is high

PROPOSED METHODOLOGIES

In this novel system, we plan to decide determine pattern by various classification algorithm. To the preparation dataset, the classification algorithm is connected. Gigantic classification algorithm is worked in which Principle Component Analysis is discovered a decent element therefore. Feature extraction, selection and classification are the fundamental advances. Data fraction is additionally utilized as a part of proposed novel technique and is connected to the preparation set. On the off chance that the dataset isn't grouped effectively, at that point it is increase prepared to information part. By and by different advances and calculations have been connected in the territory of Parkinson Disease, including information mining calculation like K-NN, PCA, Random Forest, Deep Belief Network, and Neural Network. It additionally reached a conclusion that K-NN has better exactness results and given datasets or properties are effectively arranged.

A. K-NN (k- Nearest Neighbours) Classifier

Most generally well known supervised classification algorithm utilized as a part of the novel philosophy is K-NN. KNN the term implies k-Nearest Neighbors Classifier. KNN Classifier is thinking about being a powerful classification algorithm and is the main data mining algorithm in display time.

The point of the KNN is that it secures every single accessible case and orders new cases in view of a similarity measures that is separate capacities. It is viewed as, the data is in an feature space. K-NN Classifier demonstrates k focuses, which are close to an information point. The estimation of "k" is taken deliberately in light of the fact that if it's not taken painstakingly, finished fitting may happen if the picked estimation of k is low and on the off chance that the chosen value is high then the information won't have the capacity to be arranged precisely. Thus, the picked estimation of k must be neither too high nor too low. The K-NN characterization procedure is connected on the consistent properties and is by and large delicate to the local structure of the data.

k-Nearest Neighbour
Classify (X,Y, *x*)// **X**: training data, **Y**: class labels of **X**, *x*: unknown sample
for *i*=1 **to** *m* **do**
  Compute distance *d*(**Xi**, *x*)
end for
Compute set *I* containing indices for the *k* smallest distances *d* (**Xi**, *x*).
return majority label for {Yi where i∈I}

B. PCA (Principal Component Analysis)

To diminish dimensionality in feature extraction methods certain algorithms have been utilized, for example, PCA (Principal Component Analysis), KPSA (Kernel based Principal Component Analysis) and ICA (Independent Component Analysis). Important Component Analysis is a standardized straight mix of the first indicators in an informational collection.

The new factors, called Principal Component (PC) are for the most part uncorrelated and requested by the portion of the aggregate data that each holds. The Principal Components are given the standardized adaptation of genuine indicators.

PCA is a dimensionality lessening process that diminishes a multivariate dataset to a few classifications of developed factors putting away however much data or variance as could be expected. These factors known as part examination are linear segments of the data factors. Data refers to the varieties introduce in the example gave by the connections between unique factors. PCA extricates fundamental factors in type of parts from expansive classification of factors introduce in the dataset.

Aside from extraction of factors, PCA overcomes with the statistical technique issues for instances, factor analysis. PCA is for the most part executed on symmetric correlation or grid of covariance, which implies that the network should be numeric and forces institutionalized information. Consequently, Principal Component Analysis is normally reasonable for managing at least three dimensional information, as representation happens to end up plainly significantly more important with less factors.

C. Proposed Methodology

The proposed methodology section describes about how the classification strategies have been connected on the properties, class of characteristic, for example, strings, numeric and null value. The section additionally clarifies about the working of the K-NN classifier. At the point when KNN is actualized for the classification purpose, yield can be resolved as class with highest frequency from the K – most comparative cases. Besides, there are no suppositions about the matter of utilitarian type of the issue being settled, rather separated from characterization, KNN can likewise be connected to determine the relapse issues, which implies that expectations can be founded on mean or can be founded on the middle of k - most comparative cases. KNN can be utilized for entering the missing estimations of straight out and ceaseless factors by utilizing diverse separation measures, for example, Manhattan Distance, Euclidean Distance and Hamming Distance. If there should arise an occurrence of constant factors, both Manhattan Distance and also Euclidean Distance can be utilized. Furthermore, if there should be an occurrence of all out factor, Hamming Distance can be utilized. In setting of calculation on test time and prepare time, KNN calculation figures more on test time than prepare time as the preparation period of the calculation comprises just of safeguarding the element vectors and class names of the preparation tests.

In the proposed strategy, the Euclidean separation is utilized as it is a standout amongst the most generally known separation measure and to figure out which of the k examples in preparing dataset are most like another information, a separation measure is vital to utilize. Also, in the proposed work, Euclidean separation is utilized to figure the separation between the question record and all the preparation tests.

The element determination is executed to keep only the terms relating to the K biggest Eigen value which implies that component choice was required to recognize the fitting highlights or wipe out loud highlights with the goal that some potential corruption in prescient power can be maintained a strategic distance from.

Proposed Algorithm Steps: Read dataset through xlsread function in Matlab, and then assign read data into an unsigned variable x1.

Set a learning algorithm to individual pattern into selected dataset.

Suppose $x_1, x_2, \dots x_M$ are N$x1$vectors

Step 1: $\overline{x} = \frac{1}{M}\sum_{i=1}^{M} x_i$

Step 2: Subtract the mean: $\Phi_i = x_{i-}\overline{x}$

Step 3: From the matrix $A = [\Phi_1 \Phi_2 \dots \Phi_M]$(N *M matrix), then compute:

$$C = \frac{1}{M}\sum_{N=1}^{M} \Phi_n \, \Phi_n = \mathrm{AA}^{\mathrm{T}}$$

(Sample covariance matrix, N*N, characterizes the scatter of the data)

Step 4: Compute the Eigen values of $C: \lambda_1 > \lambda_2 > \dots > \lambda_N$

Step 5: Compute the eigenvectors of $C: u_1, u_2, \dots u_N$

Since C is symmetric, $u_1, u_2, \dots u_N$ form a basis, (i.e., any vector x or actually$(x - \overline{x})$, can be written as a linear combination of the eigenvectors):

$$(x - \overline{x}) = b_1 u_1 + b_2 u_2 + \cdots + b_N u_N = \sum_{i=1}^{N} b_i \, u_i$$

Step 6: (feature selection step) keep merely the terms corresponding to the *K* largest Eigen values:

$$x - \overline{x} = \sum_{i=1}^{K} b_i \, u_i$$

To prefer *K*, use the following criterion

$\frac{\sum_{i=1}^{K} \lambda_i}{\sum_{i=1}^{N} \lambda_i}$> Threshold (e.g., 0.9 or 0.95)

Step 7: Determine parameter K = 7 number of nearest neighbours //let K=7

Step 8: Here apply Euclidean distance

Distance functions

Euclidean $$\sqrt{\sum_{i=1}^{k}(x_i - y_i)^2}$$ Calculate the distance between the query record and all the training samples

Step 9: Sort determined data as per the distance and determine nearest neighbours based on the K^{th} minimum distance

Step 10: For each normalized sample the query instance is (att_i, m X n), instead of calculating the distance using step 9

Step 11: Sort the distance Step 10

Step 12: Rank minimum distance

Step 13: It will be included n-Nearest neighbours

Step 14: If the rank of K > 7 then that attribute value will not be included into the classified result.

Step 15: ELSE

Step 16: Use majority of the same category of nearest neighbours predicted value of the query instance

Step 17: We have on the same classes classification had done on X1 feature selected data set.

Step 18: Finally result measurement is as follows: accuracy

Proposed Block Diagram. Here block diagram shows that the working of proposed approach, where at initial state health care dataset is selected for the processing, then into next stage entire dataset is logically separate for the moment due to it is containing string fields as well as numeric fields, so in the designing approach they developed separate approach for string and numeric data.

Pre-preparing: It changes over the information which is more solid for unsupervised taking in by expelling the marks from the dataset.

- **Feature selection:** It changes the dimensionality of information by choosing only a subset of measured highlights to deliver a model.
- **Data fraction:** Pre-handled information are utilized to parcel into preparing and testing sets tests.
- **Detection of Normal:** in this progression typical information is isolated from the preparation information test, here preparing process is finished via preparing and standardize utilizing minmax.
-

And if the normal class has been easily detected then its goes to the separately normal class otherwise if not detected then it will go to the KNN-PCA classifier.

And in this process each class has been accurately predicted with their own identity, after successful prediction the result analysis approach follows for the detected intrusions.

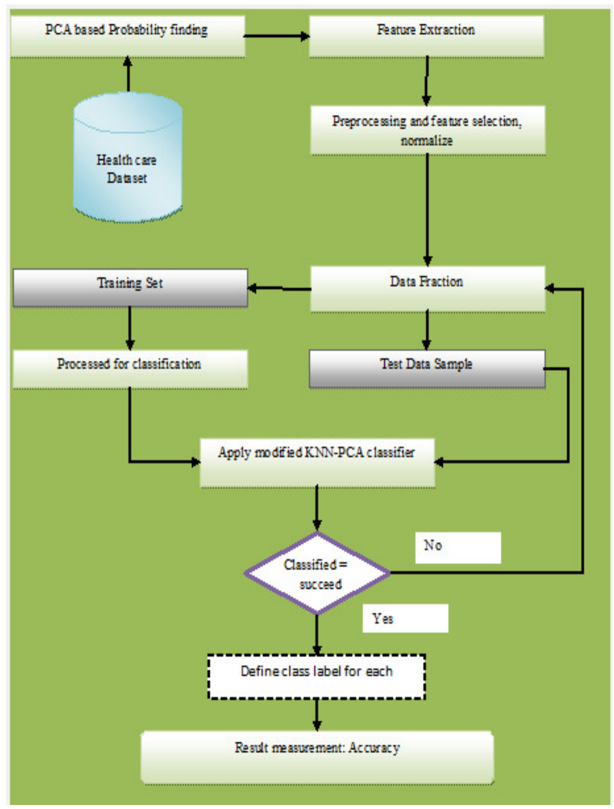

Fig. 1. Proposed Block Diagram.

EXPERIMENTAL RESULTS

In this section, we present the results from our extensive experiments to compare the performance of M.KNN, DBN method on real health care data. All experiments are conducted on the MATLAB platform, which includes three Intel 3.4 GHz machines, each running 4 GB RAM.

A. GUI Environment

This section shows the main GUI environment of the proposed methodology and probability entropy process of it.

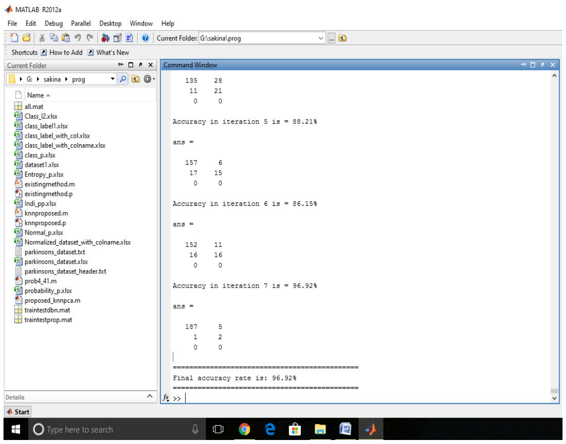

Fig. 2. Main GUI of the Proposed Methodology.

B. Result Analysis

The result analysis of the proposed work is performed using the accuracy parameter.

Accuracy Analysis. For this parameter the comparison between different existing, Modified PCA-KNN method is perform in which it is found that the accuracy rate of existing method is about 94%, and our proposed method is about 96.92% which means our method generates better accuracy rate than the existing method.

Table 1: Comparison of accuracy between the proposed methodology with previous methods applying in the same dataset.

Article	Method	Accuracy
[9]	DMNeural	84.3
	Decision Tree	84.3
	Regression	88.6
	NN	92.9
[14]	Bayes Net	80
	Logistic	83.66
	Simple Logistic	84.61
	Kstar	89.74
	ADTree	86.15
	J48	80.51
	LMT	86.15
	Random Forest	86.15
[1]	DBN	94.00
Proposed Method	MKNNPCA	96.92

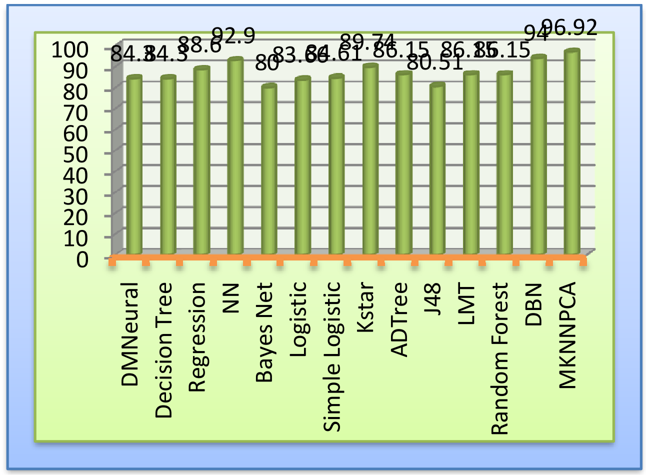

Fig. 3. Accuracy graph between exiting method and proposed PCA-k-NN Method.

V. CONCLUSION

Parkinson disease happens when certain groups of brain cells can't produce dopamine which is expected to manage the quantity of the motor and non-motor movement of the human body. Furthermore, adding to speech, visual, development, urinary issues, Parkinson malady likewise expands the disturbances of sleep, uneasiness, and fits of anxiety, aggravations of rest. Parkinson disease diagnosis through appropriate translation of the vocal and speech data is an imperative classification problem. In this paper, a Parkinson disease diagnosis is acknowledged by realizing the PCA-KNN, which is one of the most earliest indicator for Parkinson disease.. For this reason, a PCA-KNN classifier, which contains a stacked auto encoder and a softmax classifier, is proposed. The few simulations are performed more than two databases to show the adequacy of the PCA-KNN classifier. The consequences of the proposed classifier are contrasted and the aftereffects of the state-of-art classification technique. The trial comes about and factual examinations are demonstrated that the PCA-KNN classifier is exceptionally productive classifier for Parkinson disease analysis which is around 2-3 % more effective than the existing strategy.

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