Enhanced Optimal Feature Selection Techniques for Parkinson's disease Detection using Machine Learning Algorithms

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Abstract: Parkinson disease is a common mass measurement problem in public health. Machine-based learning is used to differentiate between the stable and Parkinson's disease people. This paper provides a comprehensive review of the Parkinson disease buying estimate using machine-based learning approaches. A brief introduction is given to various methods of artificial intelligence, focused on strategies used to predict Parkinson disease. This paper also offers a study of the results obtained by using MRMR feature selection algorithms with four classifications for Parkinson's disease detection using python

Keywords – Parkinson Disease(PD), Types of Parkinson's Disease, Stages, Symptoms, Causes, Risk Factor, Complications, Treatment, Prevention, Statistics, MRMR ,python.

I. INTRODUCTION

Parkinson disease is a developingirregularity of the nervous system which affects movement.It is a condition which affects the brain that controls how your body moves. It can get on so slowly that you don't even notice that first. But after some time,it starts with bit of hand shakiness that can have an impact on how you talk, walk, think and sleep.When you are 60 and older you are more likely to get it. It may also begin when you are younger, but it doesn't occur often.Parkinson disease is not cured but it canbe treated and get support tomanage the Parkinson disease symptoms.

II. TYPES OF PARKINSON DISEASE AND PARKINSONISM:

Parkinsonism is any condition that causes a combination of the movement irregularities found in the symptoms of Parkinson's type: tremor, muscle stiffness and movement slowness (bradykinesia).

A. Primary Parkinson:

Most patients diagnosed with Parkinson disease (approx. 80-85 percent) have what is termed primary parkinsonism or Parkinson idiopathic disease (meaning the disease has no known cause).

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This form appears to react good to the medicines that work by removing the brain's dopamine molecules.

B. Secondary Parkinson:

Parkinson's leftover types are called atypical parkinsonism or secondary parkinsonism or Parkinson Plus. The reason of the condition is known in these cases, and even though differentiating the secondary parkinsonism and parkinson disease is very difficult, a main difference is that patients who are affected by the secondary parkinsonism didn't react good to dopaminergic drugs like as levodopa.
Secondaryparkinsonism involves parkinsonism caused by medications,progressive supranuclear palsy (PSP) vascular parkinsonism, corticobasal degeneration (CBD), mild hydrocephalus pressure (NSA)and multiple system atrophy (MSA).

C. Druginduced parkinsonism :

Some drugs, like antipsychotics, can cause patient to develop symptoms of the Parkinson disease. Druginduced parkinsonism can be hard to differentiate from Parkinson disease, but tremor symptoms &postural instability will improve generally in weeks or months after the use of drugs has been stopped.

D. Vascular parkinsonism:

Sometimes called cerebro-vascular disease, mentioned form of parkinsonism is caused by the sequence of small strokes, leading to the death of brain parts, leading to the symptoms of the Parkinson disease. Often disorder shows symptoms only the lower half of the body (urinary incontinence and walking problems) and memory loss.Especially as it progresses, it appears to be less sensitive to the standard Parkinson's disease treatment. Vascular parkinsonism, mostly in people with diabetes, becomes more common with the era.

E. Natural pressure hydrocephalus :

The NSA symptoms are somewhat same to those in vascular parkinsonism. The disease can be treated as a long-term cure by withdrawing spinal fluid with in the short period or permanent removal of the spinal fluid by lumbar puncture.

F. Corticobasal degeneration:

Corticobasal degeneration is caused by the build-up proteinnamed tau which damages the body parts. The condition appears to begin one side of the body, and spread over time slowly to the other areas. That is the least common thing about atypical parkinsonism.

G. Progressive supranuclear palsy:

One of the most common forms of subparkinsonism is Progressive supranuclear palsy. With the idiopathic Parkinson disease, there is a late onset of progressive supranuclear palsy, but the signs tend to the progress much faster once they are appeared. But, as the disease progresses, dementia appears to have a later on start. The reason for the Progressive supranuclear palsy is a buildup of the tau protein, as in Corticobasal degeneration.

H. Multiple system atrophy:

Multiple system atrophy is caused by the overproductionof alphasynuclein protein in the brain which causes damage in multiple areas of brain. This results in symptoms similar to the Parkinson idiopathic condition but with a much quicker development.

Table I: Types of Parkinson's Disease

S.no	Type	Description
1	Drug-induced parkinsonism	Caused due to usage of some medications like antipyschotic drugs.
2	Vascular parkinsonism	Caused due to several small Strokes, causing in the death or damage of brain parts.
3	Natural pressure hydrocephalus (NSA)	Symptoms are same to those of Vascular parkinsonism.It may be treated by the spinal fulid removing in the short period orpermanent removal of the spinal fluid by lumbar puncture.
4	Cortico-basal degeneration	Caused by the tau build-up protein,which damages brain parts.
5	Progressive supra-nuclear palsy	There is a late onset of progressive supranuclear palsy, but symptoms progress much faster once they are appeared. The cause of Progressive supra-nuclear palsy is a buildup of the tau protein , as in Cortico-basal degeneration .
6	Multiple-system atrophy	Multiple-system atrophy is caused by the over-production of the alpha-synuclein proteinin the brain,causing damage in multiple brain parts.

III. PARKINSON DISEASE STAGES

Parkinson disease is a chronic condition. This means the condition's symptoms usually intensify over time.The scale of Hoehn and Yahr is used by many physicians to describe the phases. The scale separates symptoms into five stages and helps health care providers understand how the signs and symptoms of the disease are progressed.

Table II: Parkinson Disease Stages

STAGES	SYMPTOMS SCALE	DAILY ACTIVITIES	DESCRIPTION	IMAGES
stage-1	Mild Symptoms	Do not Interfere	In one side of the body only tremor and other signs of movement occur. Changes in walking, posture and in the facial expressions will occur.	
Stage-2	Getting Worse	Difficult and Lengthy	Rigidity, tremor and the other signs of movement effect all the body sides. Problems with walking and bad balance can be noticeable.	
Stage-3	Mid-Stage	Impairing Activities like eating and dressing.	Balance loss&slow motion. Falls are more frequent	

| Stage-4 | Severe and Limiting | Person needs help with everyday life activities and can not live alone | Standing without help is possible, but movement can require a walker. | |
| Stage-5 | Most Advance and Degrading Stage | Person needs a wheelchair. All activities require nursing care round the clock. | Steadiness in the legs may makewalking or standing impossible. Persons can experience hallucinations and delusions (false beliefs). | |

IV. SYMPTOMS

The signs and symptoms of Parkinson disease maydiffer for each other. Earlier signs could be mild and stay unnoticed. Often symptoms start on one side of the body, and typically get worsen that side, even though symptoms start to affect both the body sides.

Parkinson signs and symptoms:

A. **Tremor:**Shaking or tremor,starts usually in your limb and with your hand or fingers often. You can rub back-and-forth your forefinger and thumb, called as a pill-rolling tremor. The handswill shiver when it is at rest.

B.**Slowed movement (bradykinesia):**Parkinson disease will restrict and slow down the movement over time making challenging simple tasks and consuming time. Your steps may get shorter as you walk. It can be hard to get out of a chair. You can get your feet dragged while trying to walk.

C. **Rigid muscles:** You may experiencestiffness in muscle in variousbody parts. The muscles stiffness may be painful and restrict the range of movement.

D. **Impaired posture and balance: Y**our posture will become stooped and may have problems with the balance as a result of Parkinson Disease.

E. **Loss of Automatic movements:** You may be able to perform involuntary gestures decreased, including, laughing,blinking, or shakingarms while walking.

F. **Speech Changes:** Before talking, you will speak softly, speedily, hesitate or slur . Speech could be more of a monotonous compared to thegeneral inflections.

G. **Writing Changes:** Writing can get difficult and your writing may seem low.

V. CAUSES

Researchers remain confused about what are the of causes of the Parkinsondisease. It happens when nerve cells die in the brain.

A. Low Dopamine Levels:

Scientists have shown low dopamine levels, a neurotransmitter, to Parkinson's disease. It occurs when dopamine-producing cells damage or die within the brain.

Dopamine is the one that plays a important role in sending messages that control movement and coordination to the part of the brain. Low levels of dopamine can make it more difficult to control their body movements.

Whenlevels of Dopamine are decreasing in the Parkinson disease affected person, their symptoms are slowly getting worse.

B. Low Norepinephrine Levels:

Another Norepinephrine, neurotransmitteris essential for regulating many of the automatic functions of the body, like blood circulation.

The nerve endings which this neurotransmitter produces die in Parkinson's disease. This will explain why Parkinson diseased people not only experience mobility issues but also orthostatic hypotension, constipation, and exhaustionwhen the pressure in blood changes as they stand up, contributing to the light headedness.

C. Lewy Bodies:

Parkinson diseased person may have protein clumps known as the Lewy bodies in their brain. Lewy body's dementia is another disorder but it has similarities to Parkinson disease.

D. Genetic Factors:

Parkinson disease sometimes seems to run in the families, but it isn't always inherited. Scientists are putting efforts to identify certain genetic factors that can contribute to Parkinson disease, but not only one, a number of factors appear to be reasonable.

For that reason, scientists believe that the disease may result from a combination of genetic and environmental factors.

Possible number of environmental factors may include exposure to chemicals, like solvents, pesticides, metals, and other contaminants.

E. Auto-Immune Factors:

In 2017, JAMA confirmed that scientists have found possible evidence of genetic link between autoimmune conditions and Parkinson's disease, like rheumatoid arthritis.

Researchers in Taiwan(2018) studying health records found that autoimmune rheumatic diseased person also had a 1.37% higher risk of Parkinson's disease than those who are without autoimmune rheumatic disease.

VI. RISK FACTORS

A. Age:

Younger adults suffer occasionally from Parkinson disease. This usually starts in the middle (or) late of the life, and risks rise with the age. Usually people aged 60 or older develop the disease.

B. Heredity:

Close friend of Parkinson disease may increases your chance of developing the condition.

The chances, however, are still low until and unless you have multiple relatives with the Parkinson disease within your family.

C. Sex:

Males have high chance to develop Parkinson disease than women.

D. Exposure of Toxins:

Continued exposure to the pesticides and herbicides may increase your risk of Parkinson disease slightly.

Table III: Risk Factors of Parkinson Disease

S.no	Risk Factors	Male	Female	Overall
1	Exposure of Pesticide	68	42	110(29.5%)
2	Heavy metal exposure	33	12	45(12.09%)
3	Head Injury	15	2	17(4.56%)
4	Smoking	96	22	118(31.72%)
5	Caffeine	46	25	71(19.08%)
6	Alcohol	78	14	92(24.73%)
7	Tea	124	85	209(56.18%)
8	Obesity	32	26	58(15.59%)
9	Milk	110	54	164(44.08%)
10	Uric acid	120	81	201(54.03%)

VII. COMPLICATIONS

A. Difficulties in Thinking:

You willhave cognitive issues called dementia and trouble thinking. Those typically occur in the last stages of Parkinson disease. These cognitive issues are not very prone to drugs**.**

B. Depression and Emotional changes:

Often depression may occur in stating stages. The treatment for depression will make the other problems of Parkinson disease easier to handle.
The subjects will experience other changes in their feelings, like anxiety, fear or lack of the motivation. Physicians can prescribe the medicines used for treatingsuch symptoms.

C. Swallowing Problems:

The Subject can experience difficulty swallowing as the condition progresses. Due to slow swallowing, saliva can accumulate in your mouth which leads to the drooling.

D. Chewing and Eating Problems:

Last-stage Parkinson disease affects the muscles of mouth, resulting in chewing problems. This will result in poor nutrition and choking.

E. Sleeping Problems and Sleeping Disorders:

Individuals with Parkinson disease arefrequentlyaffected with sleeping problems,regular waking up in the night, falling asleep in the day and waking up early.

Individuals will experience sleeping behavioral condition with rapid eye movement, which includes acting out the dreams. Medicines will help with your sleeping problems.

F. Problems in Bladder:

Parkinson's disease can cause problems with the bladder, including being unable to regulate urine or having trouble urinating.

G. Constipation Problem:

Most of the Parkinson diseased subjects experience constipation, leading to sluggish digestive tract in particular.

H. Changes in Blood Pressure:

orthostatic hypotension which is a sudden drop in blood pressure will cause you to feel dizzy or lightheaded when you stand.

I. Smell Dysfunctions:

With your sense of smell, you will run into problems. The subjectswill have trouble recognizing certain odors and differentiating the odors.

J. Fatigue:

Some persons suffering from Parkinson disease may lose energy and feel exhaustion, particularlyevening times.The reason of this is not always understood.

K. Pain:

Most of the people suffering from Parkinson disease feel pain, either in the entire body or some specific parts

L. Sexual Dysfunctions:

Most of the people with Parkinson disease experience a decline in performance or desire of sex.

VIII. TREATMENT

Though there is no particular cure for Parkinson disease, certain symptoms can often be relieved by medications, surgical treatment and other therapies.

A. Levodopa:

The most common treatment for Parkinson is levodopa. It helps in replenishing dopamine.
Approximately 75% of cases do respond to the levodopa, but all the symptoms are not improved. In general, it is treated with carbidopa.
Carbidopa slows down degradation of levodopa, and at the same time increases levodopa's presence near the blood brain barrier.

B. Dopamine Agonists:

They can display dopamine activity in the brain. These are less effective than levodopa but when levodopa is less effective, these can be useful as bridge medicines.
This class of drugs includes bromocriptine, pramipexole, and ropinirole.

C. Anticholinergics:

We use these to suppress the parasympathetic nerve system. They can use rigidity to aid us.

The anticholinergics used to treat Parkinson are benztropine (Cogentin) and trihexyphenidyl.

D. Amantadine (Symmetrel):

Amantadine (Symmetrel) and carbidopa-levodopa may also be used. It is a drug which blocks glutamate (NMDA).
This provides a limited time relief for dyskinesia which can be one of the side effects of levodopa.

E. COMT Inhibitors:

The levodopa activity is enhanced by catechol O-methyltransferase (COMT) inhibitors. Types of COMT inhibitors include Entacapone (Comtan), and tolcapone (Tasmar).
The tolcapone can cause damage to the liver. It is usually reserved for people who are not reacting to other therapies.
The ectacapone does not cause damage to the liver.
Stalevo is a drug in one pill which mixes ectacapone and carbidopa.

F. MAO B inhibitors:

MAO B antagonists block monoamine oxidase B enzymes. The enzyme breaks down the brain's dopamine. Two of them are selegiline (Eldepryl) and rasagiline (Azilect).
Talk to your doctor about MAO B inhibitors before taking any other medicines.
They can interact with a wide number of drugs:
- Ciprofloxacin
- Antidepressants
- St. John's wort
- And some narcotics

The Success of Parkinson medicines will decrease over time. The side effects of some medicines can outweigh the benefits of late-stage Parkinson. These may however still provide sufficient symptom management.

IX. PREVENTIONS

Parkinson disease cannot be avoided but different studies have shown that certain lifestyle changes can help reduce the risk.

A. Turmeric:

It includes curcumin, an element which is antioxidant. It helps to stop the flogging of proteins that are involved in this disease, according to one lab study.

B. Flavonoids:

According to study, eating another form of antioxidant — flavonoids — could reduce the chance of developing this disease. There are flavonoids in csrtain fruits and vegetables like berries, apples, some potatoes, tea, and red grapes.

C. Avoiding Reheated Cooking Oils:

Researchers have linked aldehydes, to Parkinson, Heating certain oils to a certain temperature will help the aldehydes to come about in those oils, and then using them again.

D. Avoiding Toxins:

Exposure to toxins increases the risk of nerve system diseases. People should be cautious, for example people should use protective materials, when using these kinds of drug.

X. STATISTICS

Parkinson disease is the second most occurring nerve system disorder linked to age. An estimate shows about 10 million people worldwide suffer from this disease.
In the fourth decade of life, the prevalence of the disease spans from 41 people for every 100,000 to larger than 1,900 people for every 100,000 for those who are 80 and older.
Generally speaking, prevalence of this disease, or the incidence of newly diagnosed cases, goes up with age, even though it can surpass in people over 80. An approximate 4 per cent of this people are diagnosed by age 50.
Due to high medical bills associated with the disease, the disease takes a toll on the quality of life of patients, making socialising more difficult, and causes a huge financial burden.
Population based studies on the occurrence of Parkinson are critical for scientists for ' understanding the history of the disease, its development and the risk factors associated. Data on the prevalence of various groups of different ages and genders will help the healthcare professionals to devise approaches to encounter the needs of patients.

Table IV: Statistics of Parkinson Disease

INTERNATIONAL	NATIONAL(India)
United States-Every year tens of thousands of Americans seek Parkinson's diagnosis	**Kashmir-** Prevalence rate of 14.1 per 100,000 of the population of 63,645 in rural Kashmir in northern India was recorded.
Canada-There are more than 100,000 people of Canada are affected with Parkinson's disease today, with about 6,600 new cases of Parkinson's disease coming up in Canada every year.	**Bangalore-**A low prevalence rate of 27/100,000 was reported from Bangalore, in the southern part of India.
United Kingdom-Parkinson's prevalence in the UK. Nearly one in 500 people, with nearly 127,000 living with the disease.	**Mumbai -** Prevalence rate of 328.3/100,000 among a population of 14,010 Parsis residing in colonies in Mumbai, Western India was recorded.
Finland-More than 15,000 people from Finland are living with the disease, with symptoms ranging from slight tremors to loss of voice,depression and physical incapacitation.	**BENGAL-**16.1/100,000 from rural Bengal are noticed in the eastern part of India.

Brescia in Italy has prevalence of 407 people per 100,000 population.	Kolkata has the prevalence of 45.82 per 100,000 population.

Table V: Top Ten Death Rate of Parkinson Disease

S.no	Rank	Country	Rate
1	1	Finland	5.28
2	2	Ireland	5.13
3	3	United States	4.76
4	4	United Kingdom	4.53
5	5	Australia	4.52
6	6	Belgium	4.49
7	7	Malta	4.46
8	8	Iceland	4.44
9	9	Netherlands	4.33
10	10	Switzerland	4.31

XI. LITERATURE REVIEW

An essential factor is the early detection of any type of illness. This helps the patient be well ahead of treatment. We aimed at designing a system in this research paper that would assist physicians in medical diagnosis. This paper introduces a diagnostic fuzzy cluster means and pattern recognition methods to use a series of speech signals to help diagnose this disease. The paper aims to check the validity of the Parkinson Dataset implementation of these classifiers. This dataset consists of 11 attributes of different range of values. ANN's have become very common in all kinds of predictive problems in the past few years. Multiple feed-forward ANNs with different configurations are being used in the prediction of tested individuals ' PD, based on extracted characteristic from 26 voice samples for every single person. Data mining offers a great potential for advancement in medicine related to the prediction, detection and therapy of diseases.

PD is one of the most feared diseases which affect the old people who demonstrate a very rare response to therapy at a more advanced stage of the disorder. Early detection of this disease will help in arresting this rising ailment, thus giving many ailing minds hope.

In this article, we discussed the synergies for the first time between the effects of motor and non-motor. To do this, we have supervised classification and   sub-set selection features to estimate two severity indices, HY and CISI-PD, in terms of symptoms that are only non-motor.

A lot of recent research has been done on the link between PD and speech   loss. Recently, a wide range of speech signal processing alg orithms (dysphonia measures) were developed with the goal of predicting severity of PD symptoms using speech signals.

The standard clinical reference score quantifying the symptom   severity   of   a   normal   PD is the Disease Rating Scale (UPDRS) of the Unified Parkinson. UPDRS is currently being deterred by the subjective clinical evaluation of the patient's abil ity to cope with a range of tasks appropriately.

In this article, using the Extreme Learning Machine (ELM), an effective approach to creating an accurate predictive model for tele-monitoring PD was suggested. This procedure can classify PD subjects with 81.55 percent accuracy.

Identifying and classifying pathologic voice is still a very challenging area for the speech processing research. The acoustic characteristics of speech are primarily used for distinguish of regular voices and abnormal voices. This paper explores and compares different classification methods in order to find the ability of acoustic parameters to distinguish regular voices from affected voices.

Using the method mentioned, classification of postural balance data for subjects with dyskinesia and history of Parkinson's disease falls may be achieved. It is noted that the percentage of classification increases dramatically (from 66 to 77 percent) when the data is segregated for dyskinesia subjects

PD is the second most occurring nerve system disorder that affects billions of people worldwide. The primary goal in PD's detection practice is to achieve a single differential diagnosis to find the best treatment for each individual.

The goal of this paper is to check the efficacy of applying SVM and GA to a Parkinson disease-related medical dataset. This kind of a dataset requires several different attributes, with different ranges of values, making the use of many ML techniques challenging.

A novel modified version of the natural inspired optimization technique for feature selection called Optimized Cuttlefish was proposed in this work. It was suggested that the Opti-mized Cuttlefish algorithm obtain deduced set of features and evaluate comparative accu-racy and computat-ional time without reducing the model's perfor-mances.

This work provided a good review of PD prediction, using methods focused on machine learning. This brief overview of various computational intelligence techniques based methods used to predict Parkinson's diseases is discussed. Also presented is the description of outputs obtained by different literature researchers to predict PD.

In this research we tried to differentiate within early stages of PD between safe speakers and speakers. We also suggested a method for classifying Parkinson's disease based on a neural network with back propagation along with a scheme for majority voting. The emphasis was on static committee machine structure, known as boosting by filtering, and use was made of the total seven committee machines.

Detection of PWP based on vocal samples was a promising area of research. Finding a way for differentiating PD patients from healthy people based on various voice tests was less accurate since a single classifier treated all vocal terms. The proposed method dealt separately with each voice test and used major vote to overcome any confusion. Results from this research displayed that more precise PD detection can be achieved based on multiple voice tests.

In this paper the use of cepstral analysis has been qualitatively checked for the clinical assessment of voice function. This defined the mathematical transformations involved in the analysis, as well as the suitability of the analysis for this application.

For early PD diagnosis, there is a need for cheap scalable diagnostic techniques. Hence this system provides analysis of vocal recordings of a patient by providing a decision support for detection and medical professionals to know if the patient is suffering from PD as it is very hard to detect and is easily mistaken for other movement disorders and to make early prediction so that proper clinical monitoring of the patient can be done.

PD is one of the nerve system's degenerative diseases, characterized by a huge group of nerve conditions called motor system disorders due to the loss of brain cells containing dopamine

Non-motor behaviors such as olfactory impairment and REM sleep activity disorder predate the onset of first clinical symptoms in PD by years or even decades. More analyzes and diagnostic tools focused on machine learning techniques have enormous potential that can assist with early diagnosis of PD.

Treatment of PD manifestation depends on the experience of the neurologist, UPDRS and measurements of the scale of Hoehn and Yahr to approximate the stage of PD.

Table VI: Related Work

S. no	Author's Name	Machine Learning Methods	Data Description	Performance
1	Indira R. (2014)	fuzzy C- means	Speech signal dataset	68.04% accuracy, 75.34% sensitivity and 45.83% specificity
2	Lucijano Berus(2019)	ANN	Speech and Vocal Data set	86.47% accuracy
3	R. Geeta (2012)	R. Geeta (2012)	Speech dataset as high or low	Random tree classification 100% accuracy
4	Rubén A. (2013)	Wrapper feature selection	non-motor symptoms	72% to 92% accuracy
5	A.Tsanas (2011)	SVM	Speech signal dataset	98.6% accuracy
6	A.Tsans (2011)	Regression & Classification	Speech signal dataset	5–95 percentile
7	Aarushi Agarwal(2016)	Back-Propagation learning algorithm	UCI repository	90.76% accuracy
8	Sellam V. (2014)	Radial Basis Functional Neural Network (RBFNN)	Voice and unvoiced speech signals	91% accuracy
9	Amit S. (2013)	Using nonlinear dynamic and SVM	Dyskinesia Data	66% to 77% accuracy
10	Salvatore (2014)	SVM	Magnetic resonance imaging (MRI)	> 90% accuracy ,sensitivity and specificity
11	Hanguang Xiao(2012)	Genetic algorithm,SVM and KNN	Speech signal dataset	99.0% accuracy
12	Deepak Gupta(2018)	optimized cuttlefish algorithm and KNN	Speech signal dataset	94% accuracy
13	Arvind Kumar Tiwari(2015)	ANN and SVM	Vocal data set	90.3% accuracy
14	Indira R. (2014)	ANN	Speech signal dataset	Recognition rate of 92 %.
15	Mahnaz Behroozi(2016)	Mutual information-based selection algorithm	Speech signal dataset	92.75% accuracy
16	Sharma A(2014)	SVM	Speech signal dataset	90.76% accuracy
17	SONU S R(2017)	data mining algorIithm decision tree (CART)	Vocal data set	85.29% accuracy
18	Ma, C.(2014)	SVM	recorded the speech signals	99.49% accuracy, 100% sensitivity and 99.39% specificity
19	Prashanth (2014)	SVM and classification tree	de-novo PD	89.39% accuracy
20	PrzybysZ. (2014)	Reflexive saccades measurements	Magnetic resonance imaging (MRI)	70% accuracy

XII. METHODOLOGY

Minimum Redundancy Maximum Relevance technique is employed for feature selection which has high correlation with the class and low correlation with other features in the dataset. The selected features are then classified using the following algorithms: KNN, K- means clustering, Logistic Regression, Support Vector Machine. Figure 1 shows the System Architecture Diagram.
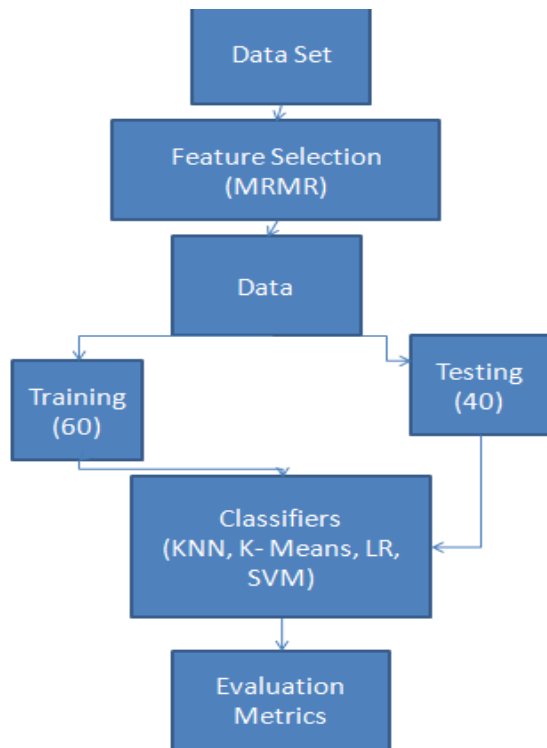
Enhanced Optimal Feature Selection Techniques for Parkinson's disease Detection using Machine Learning Algorithms

Fig 1: System Architecture

XIII. RESULT ANALYSIS

The performance of the proposed work is analyzed using the following metrics: accuracy, precision, recall and F-score.

Table VII: Comparison results of classifiers with regard to Accuracy

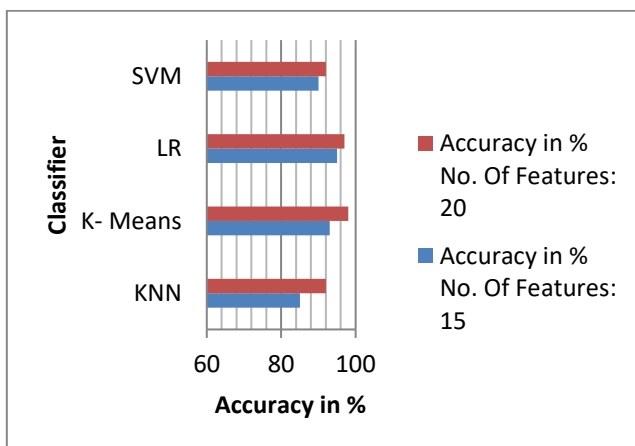| Accuracy in %		
Classifier	No. Of Features: 15	No. Of Features: 20
KNN	85	92
K- Means	93	98
LR	95	97
SVM	90	92

Fig. 2 Comparison results of classifiers with regard to Accuracy

Table VIII: Comparison results of classifiers with regard to Precision

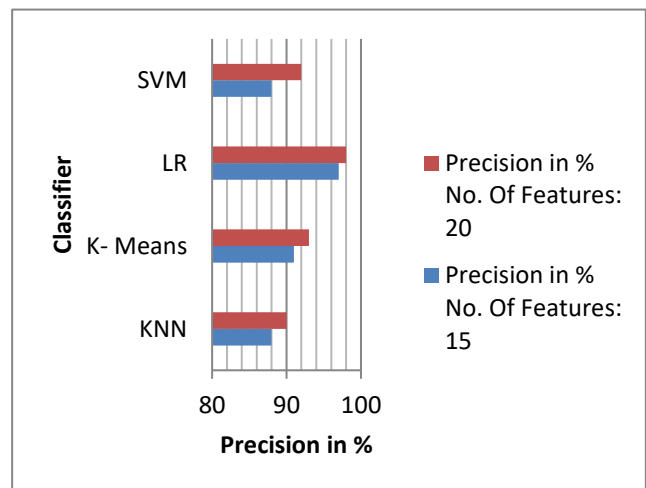| Precision in %		
Classifier	No. Of Features: 15	No. Of Features: 20
KNN	88	90
K- Means	91	93
LR	97	98
SVM	88	92

Fig. 3 Comparison results of classifiers with regard to Precision

Table VII: Comparison results of classifiers with regard to Sensitivity

Sensitivity in %		
Classifier	No. Of Features: 15	No. Of Features: 20
KNN	83	89
K- Means	86	90
LR	93	96
SVM	86	93

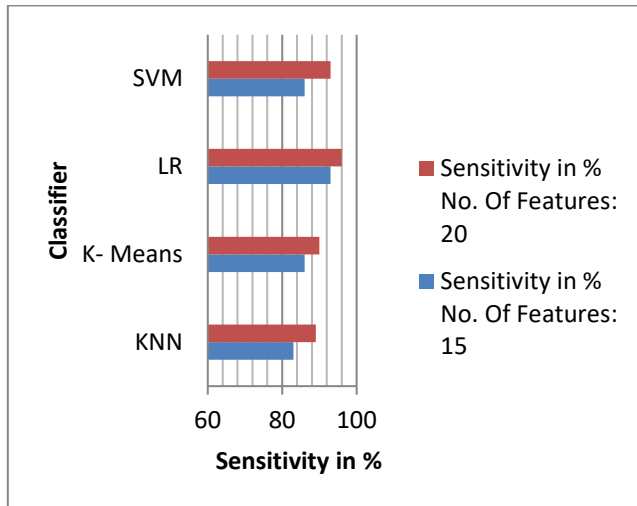**Fig. 4 Comparison results of classifiers with regard to Sensitivity**

Table VII: Comparison results of classifiers with regard to F- Score

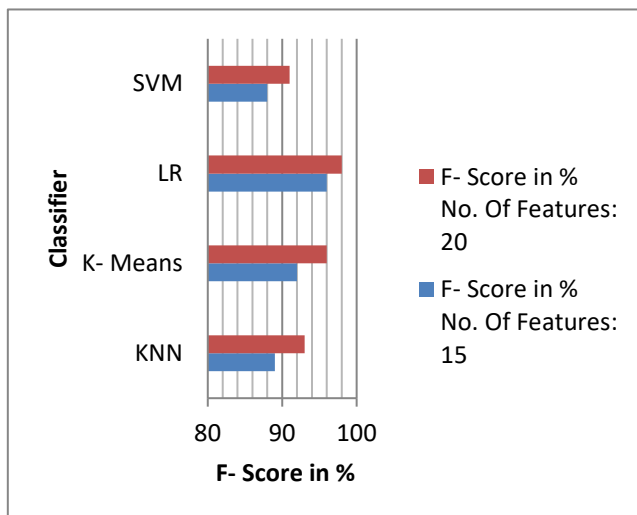| F- Score in %		
Classifier	No. Of Features: 15	No. Of Features: 20
KNN	89	93
K- Means	92	96
LR	96	98
SVM	88	91

Fig. 5 Comparison results of classifiers with regard to F- Score

XIV. CONCLUSIONS

Thus the paper examines the Parkinson's disease Detection using MRMR Feature Selection Algorithm on four different classifiers, with Logistic Regression having a high F-Score (98), Sensitivity (96), Precision (98), and Accuracy (97).

Logistic regression has got the maximum metrics percentage for MRMR Feature selection algorithm.

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