Vidyayāmruthamashnuthe

BNM Institute of Technology

An Autonomous Institution under VTU

Department of Electronics & Communication Engineering

Technical Seminar

(18ECS84)

On

Intelligent Pen for diagnosing early stage symptoms of Parkinson's disease

SHISHEER S KAUSHIK

1BG18EC127

Project Guide:

Dr. Rekha P

(Assistant Professor, Dept of ECE, BNMIT)

What is Parkinson's Disease?

Parkinson's disease (PD) is a neurodegenerative disorder that affects multiple regions of the brain and autonomic nervous system

- Loss of dopamine-producing cells in the brain produces the most well-known symptoms of tremor, slowness, stiffness and problems with walking and balance
- Symptoms generally develop slowly over years
- Its cause remains largely unknown; although there is no cure, many highly effective symptomatic treatment options exist

move together to end parkinsons disease

Objective

- Capable of detecting standards and deviations on individuals' handwritings, such as tremors, orientation, and speed.
- Usage of an affordable and handier solution than others offered in the market, mainly for faraway places and undeveloped towns.

move together to end parkinson's disease

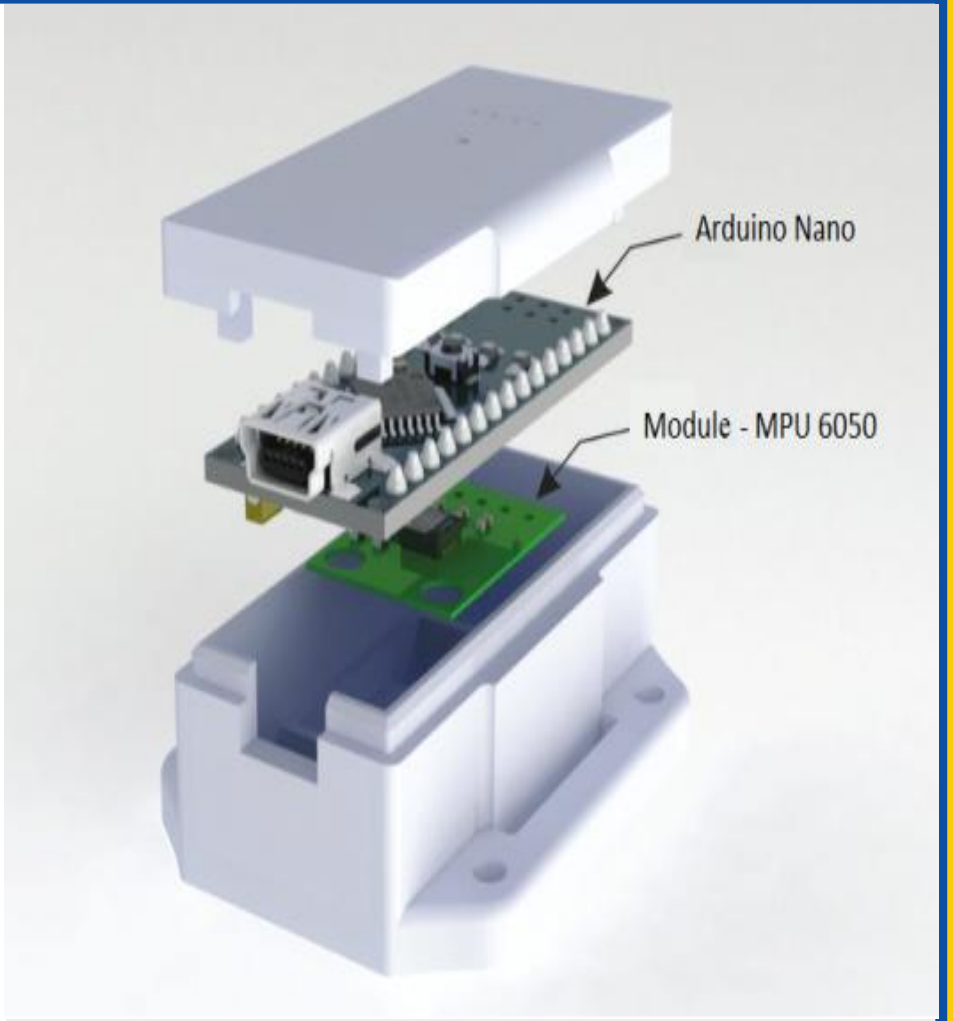
Literature survey

Title of the paper and year	Specifications & Methodology	Applications	Authors
[1] "Feature selection for classification based on fine motor signs of Parkinson's disease"	To classify the handwriting patterns of PD's patients by analyzing their biometric data	1. Biometric Data collection (PD) 2. Finger Pressure monitoring 3. Pen accelerations	1. Brewer, B.R. 2. Pradhan, S
[2] "Handwritten dynamics assessment through convolutional neural networks: An application to Parkinson's disease identification".	Biometric Smart Pen (BiSP), a smart biometric pen system for recording and analyzing handwriting, drawing, and gesture movements on a paper pad or free in space	1. Biometric Security Monitoring system 2. Forensic Handwriting Analysis	1. Silke A.T Weber 2. Pereira, D.R

move together to end parkinsons disease

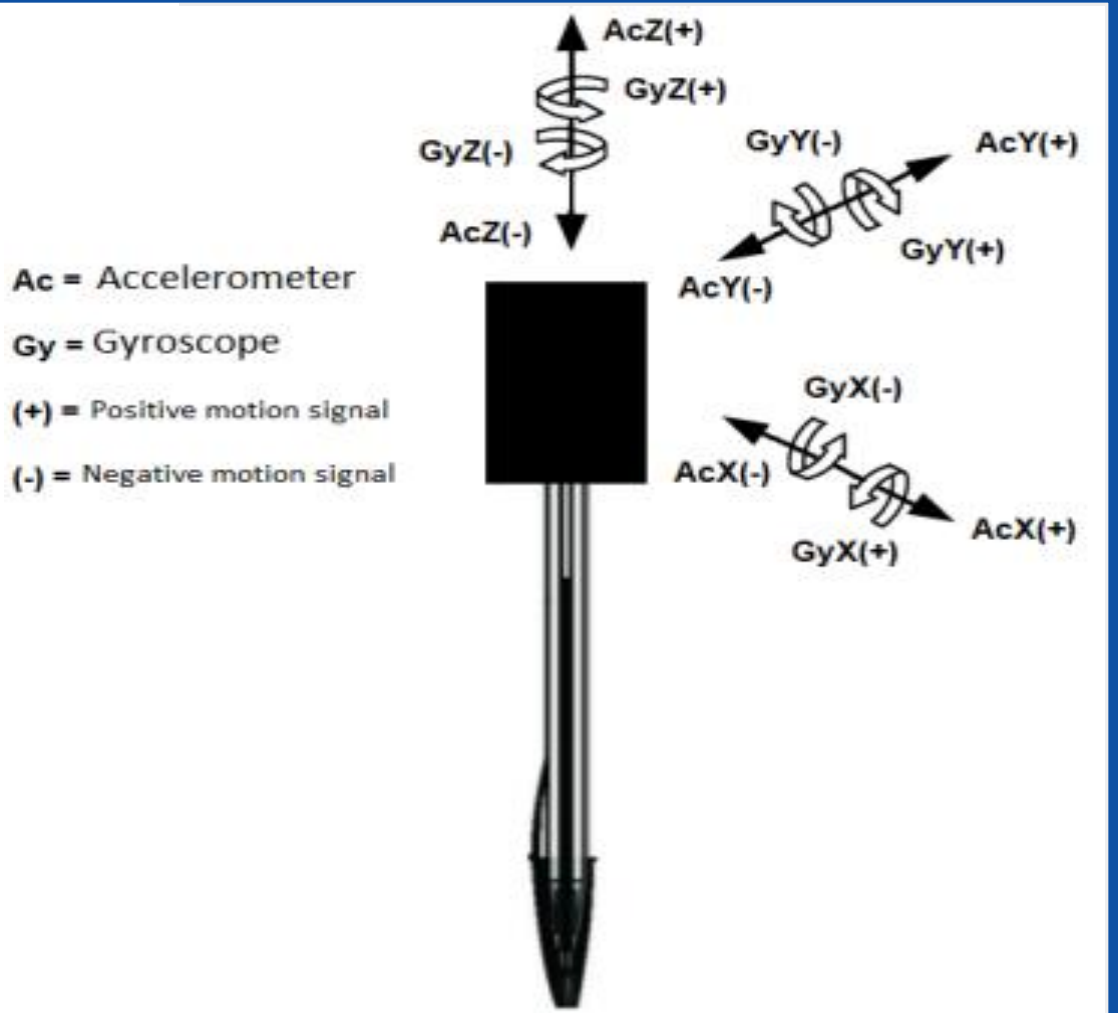
Title of the paper and year	Specification & Methodology	Application	Authors
[3] “A survey on computer-assisted Parkinson’s disease diagnosis”.	Image signal analysis and motor exams, such as handwriting tests	These tests have been the center of numerous research works that focus on applying ML techniques to improve and facilitate diagnosis’ results.	1. Pereira, C.R 2. de Albuquerque 3. Weber, S.A
[4] “Contribution of different handwriting modalities to differential diagnosis of Parkinson’s disease”.	Classification would consider the unique characteristics in hand motions of each person’s calligraphy, such as entropy, applied pressure when writing, and spent energy to realize their hand movements.	Using an ML algorithm called Support Vector Machines-Radial Basis Function (SVM-RBF), this classification correctly predicted 90% of the subjects’ diagnoses	1. Rektorová, I 2. Drotár, P 3. Mekyska, J

The Intelligent Pen Prototype
{Electronic Device}



move together to end parkinson's disease

Sensors positioning and degrees of freedom (DOF) of the electronic device



move together to end parkinson's disease

System Setup for test by Parkinson's victim

move together to end parkinson's disease

An example of the test applied {Data Collection Form}

Circle

Spiral

Meander

Diadochokinesis

FUNDAÇÃO EDSON QUEIROZ
UNIVERSIDADE DE FORTALEZA
ENSINANDO E APRENDENDO

POST GRADUATE PROGRAM IN APPLIED INFORMATICS
APPLIED INFORMATICS MASTERS

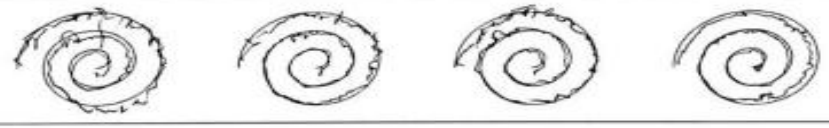
DATA COLLECT FORM

IDENTIFICATION: PDD23, AGE: 71, DOMINATING HAND: (X) right ( ) left, DATE: / /

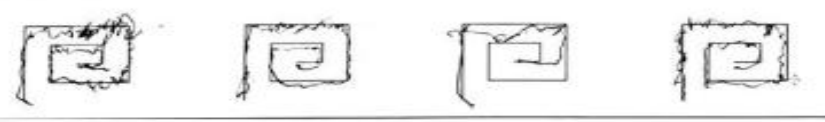
1 - Draw circle 10 times on the same spot non-stop

- Draw circle in the air 10 times non-stop

2 - Draw spiral from the inside out



3 - Draw meander from the inside out



4 - Diadochokinesis - Right hand for 10 seconds

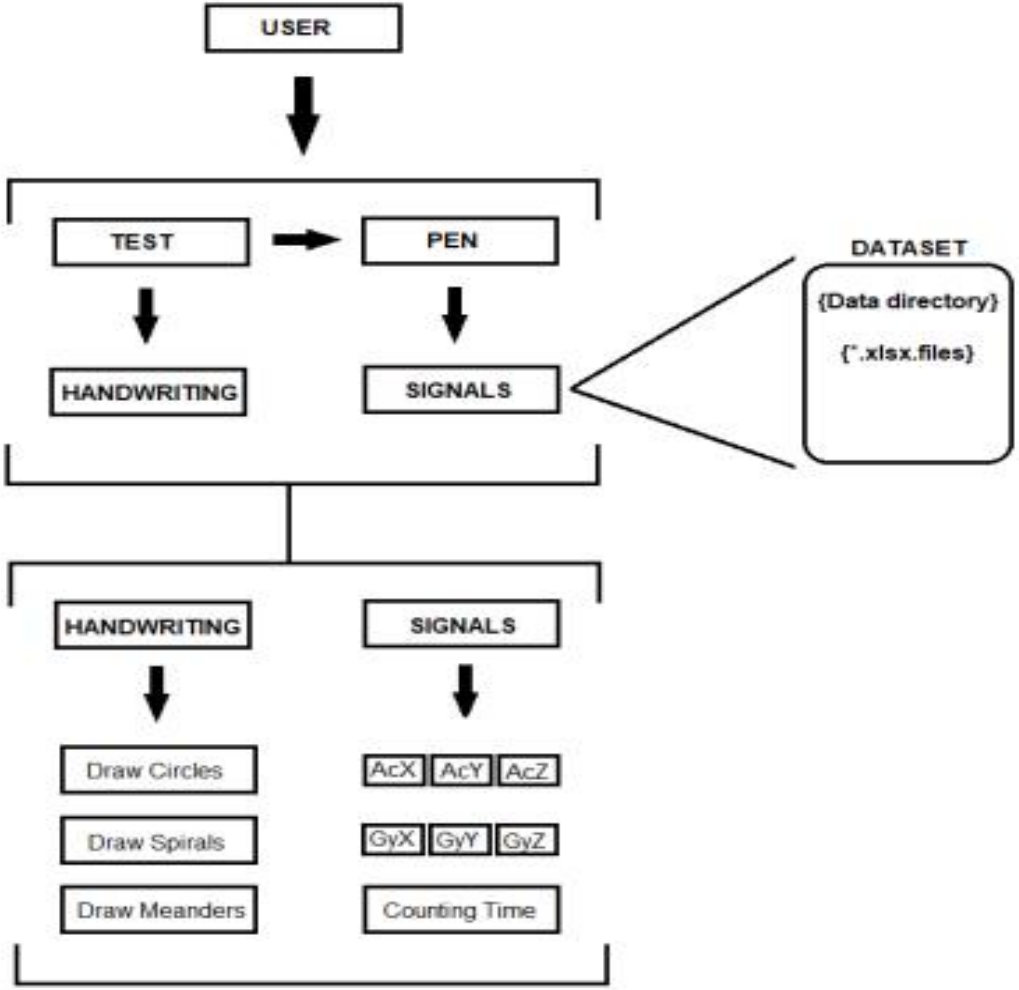
5 - Diadochokinesis - Left hand for 10 seconds

observations:

Medicação às 9:10; Teste às 09:35 (05:40 e

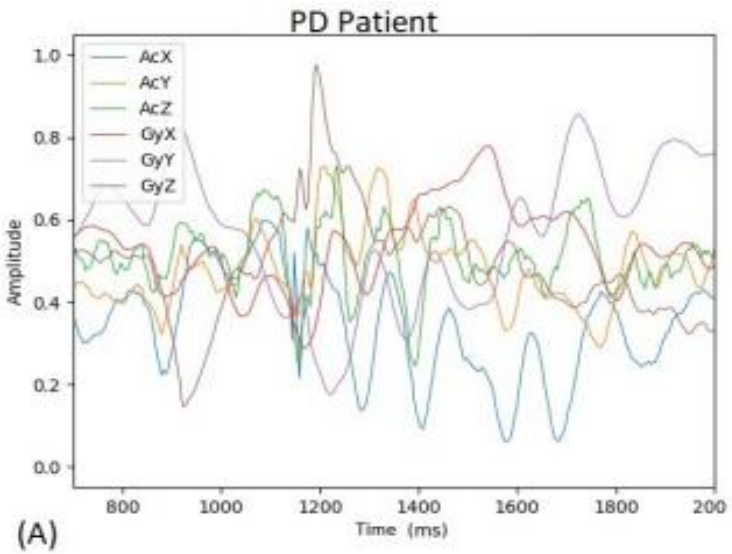
move together to end parkinson's disease

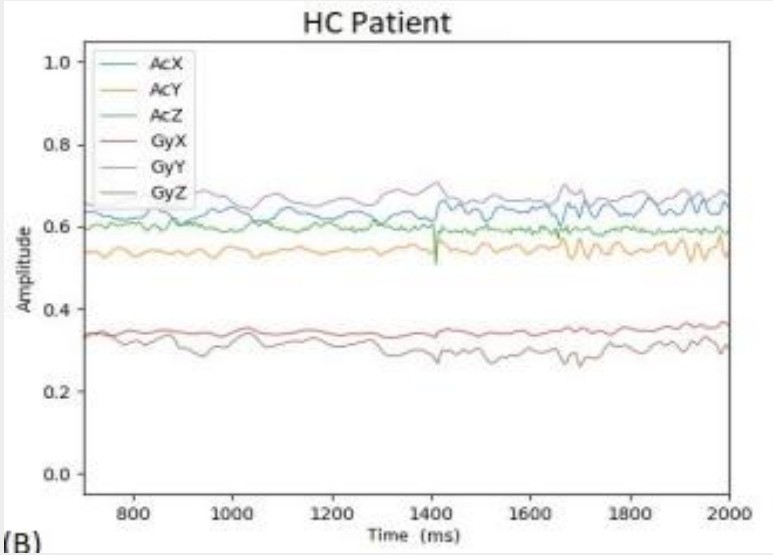
The architecture of the modeled system



move together to end parkinsons disease

Comparison signal acquired from the sensors of {PD & HC} patient





move together to end parkinsons disease

Data Pre-Processing and ML

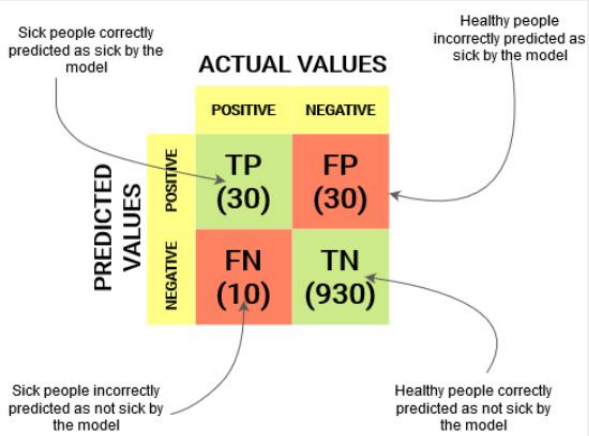
Classification task

1) Linear Discriminant Analysis (LDA)
2) Logistic Regression (LR)
3) Classification and regression Trees (CART)
4) K-Nearest Neighbours (KNN)
5) Support Vector Machines (SVM)
6) Naive Bayes (NB)

Evaluation method

1) Accuracy
2) Precision
3) Recall
4) F1-Score

Confusion Matrix {Syntax}



move together to end parkinsons disease

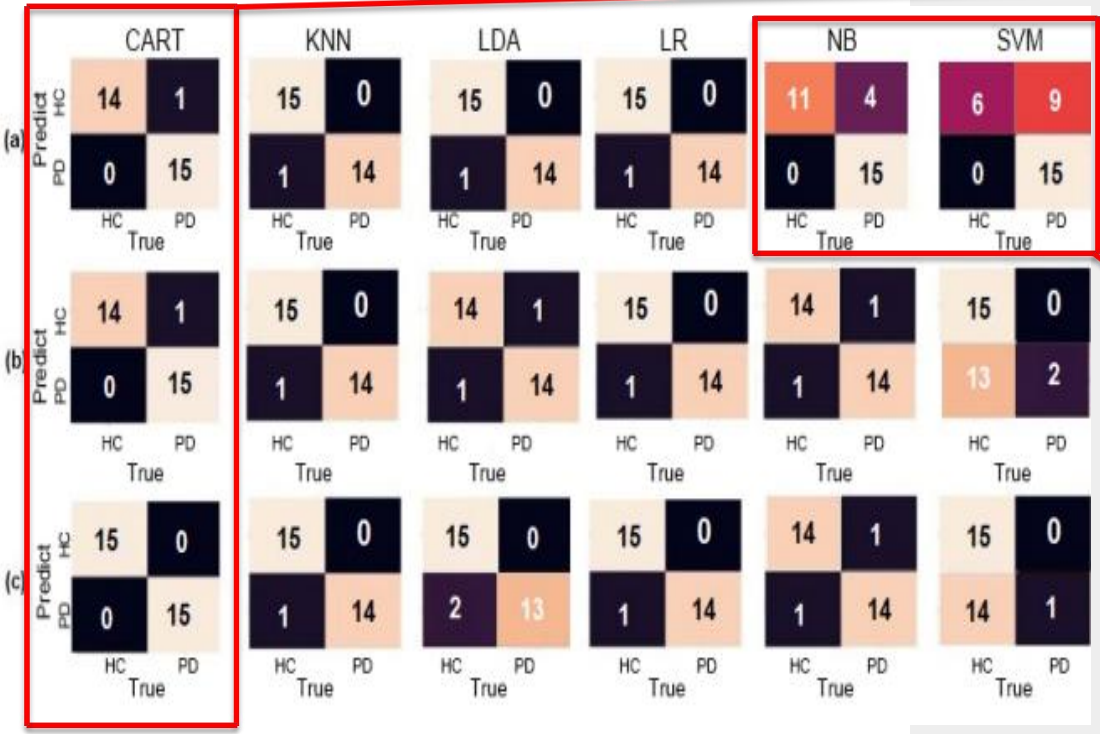
Results were analyzed individually, as new datasets, for each performed task

1) Circle dataset
2) Air-Circle dataset
3) Spiral dataset
4) Meander dataset
5) Diadochokinesis dataset

All datasets were split into two categories, i.e., training and testing, being 75% and 25% for the first and second, respectively

move together to end parkinson's disease

Circle Dataset



CART classifier {best(a+g)}

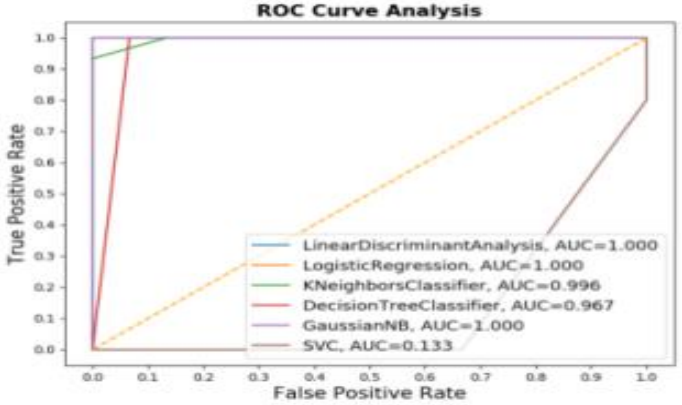
Accuracy: 100% for both groups
Precision: 100% for both groups
Recall: 100% for both groups
F1-Score: 100% for both groups

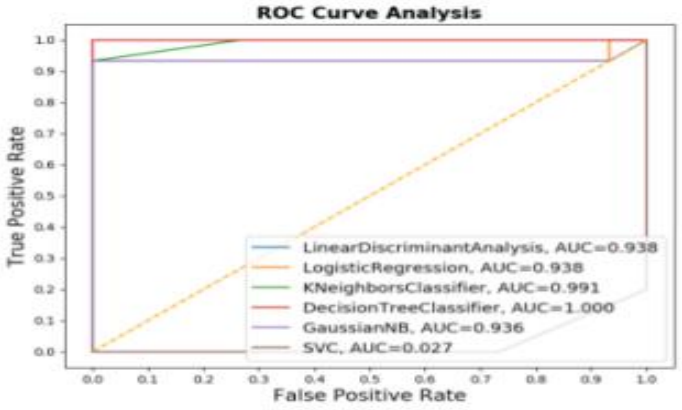
SVM Classifier {worst(ao)}

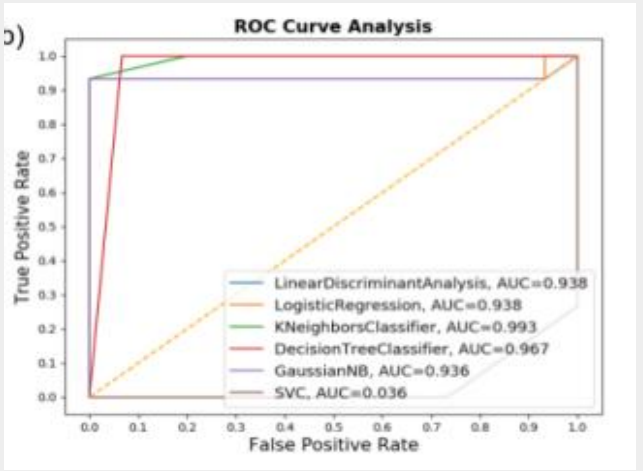
Accuracy: 53.33%
F1-Score: 12.50%

move together to end parkinsons disease

Receiver Operating Characteristic (Circle-dataset)



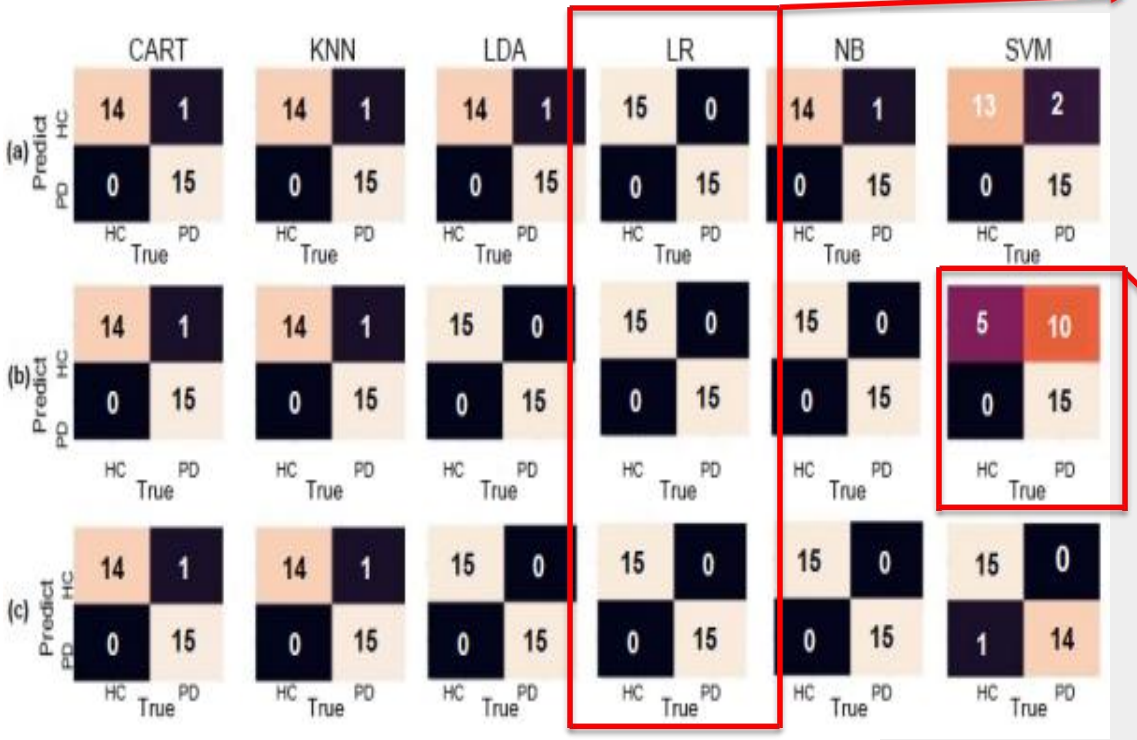




AUC values above 0.9

move together to end parkinson's disease

Air-Circle Dataset



LR classifier {best(all)}

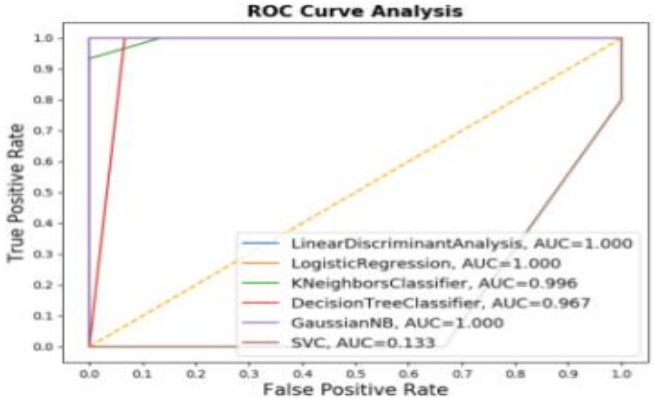
Accuracy: 100% for both groups
Precision: 100% for both groups
Recall: 100% for both groups
F1-Score: 100% for both groups

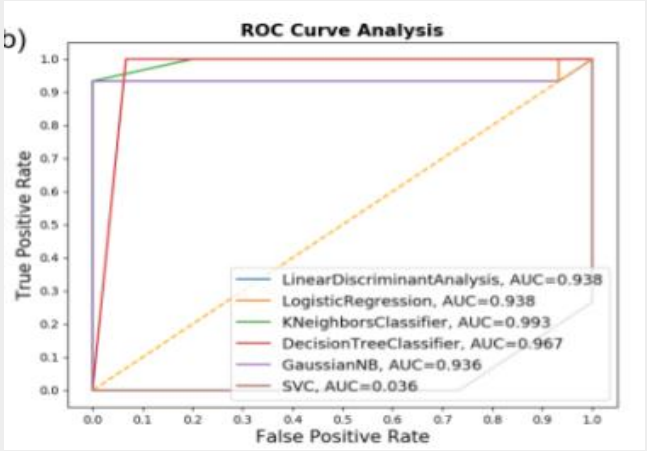
SVM Classifier {worst(go)}

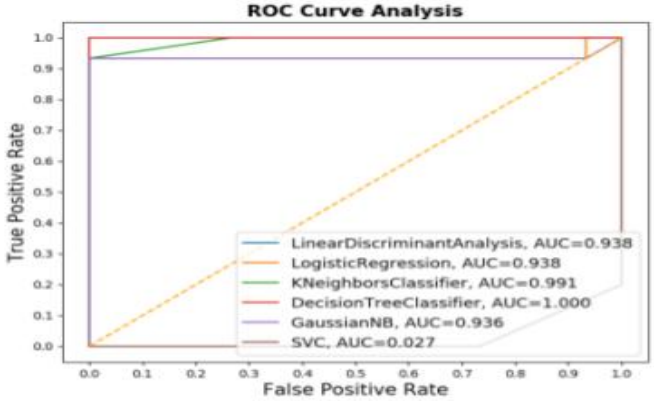
Accuracy: 66.67%
F1-Score: 75.0%

move together to end parkinsons disease

Receiver Operating Characteristic (Air-Circle-dataset)



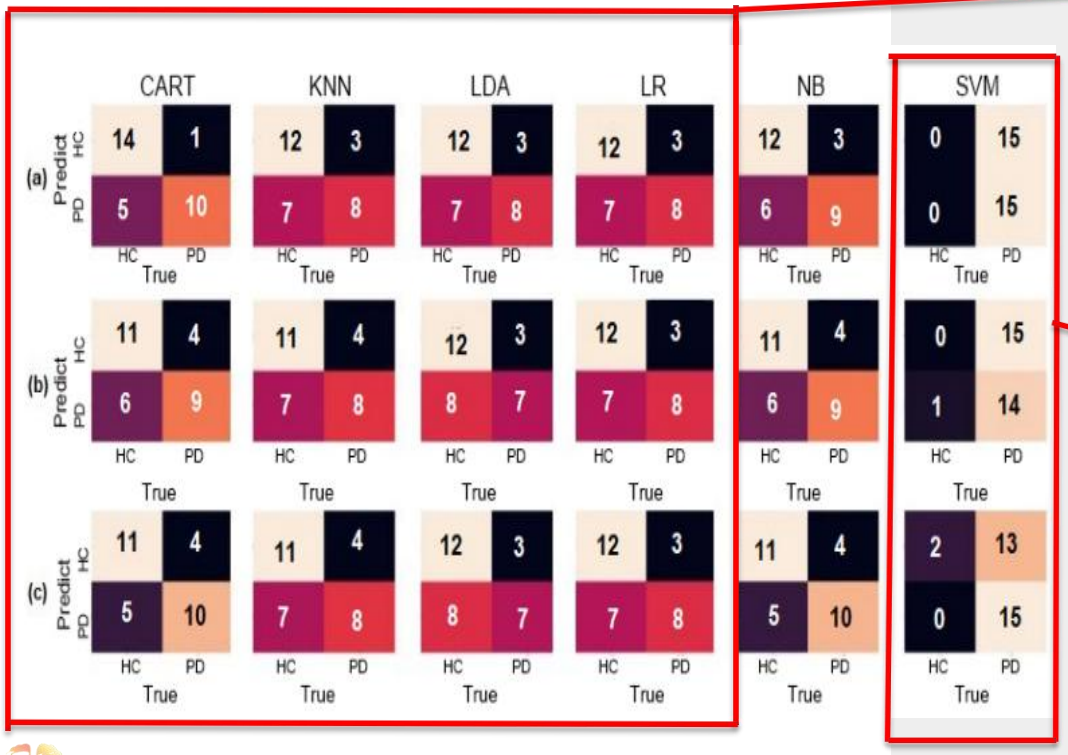




AUC values above 0.9

move together to end parkinsons disease

Spiral Dataset



CART classifier {best(ao)}

Accuracy: 80% for both groups

Precision: 90.90% for PD and 73.68% for HC

Recall: 66.67% for PD and 93.33% for HC

F1-Score: 76.92% for PD and 82.23% for HC

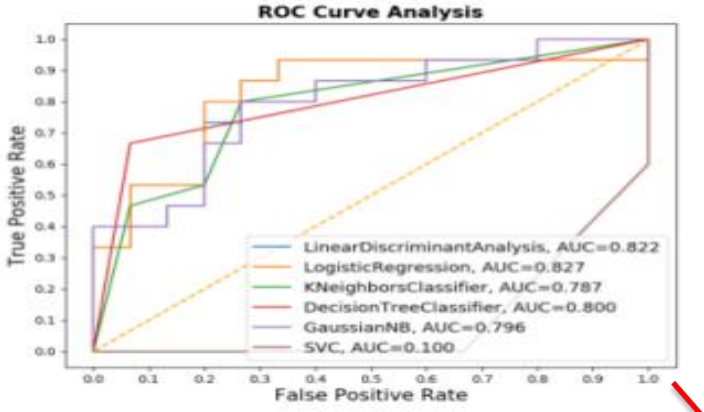
SVM Classifier {worst(a+g)}

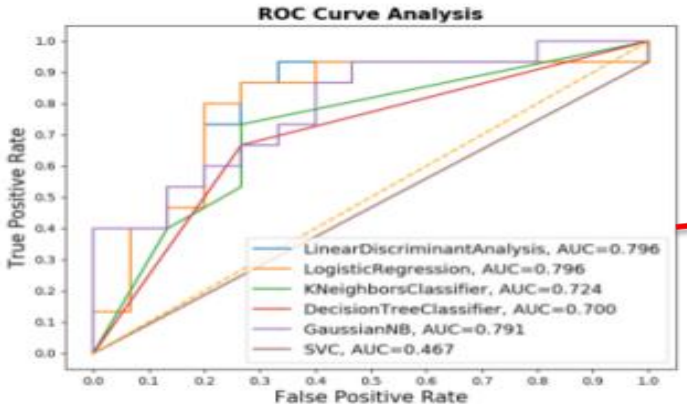
Accuracy: 46.67%

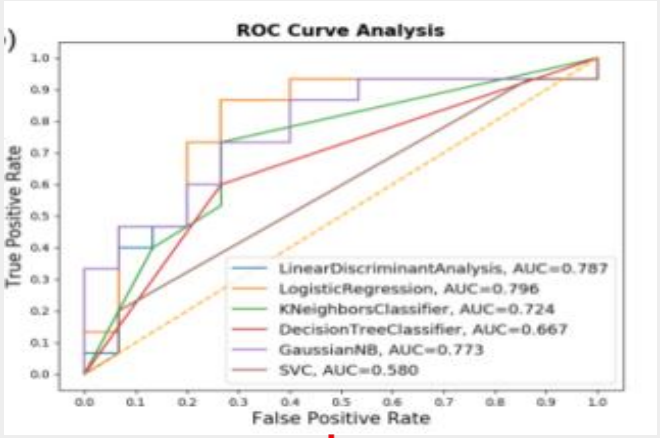
F1-Score: 23.53%

move together to end parkinsons disease

Receiver Operating Characteristic (Spiral-dataset)





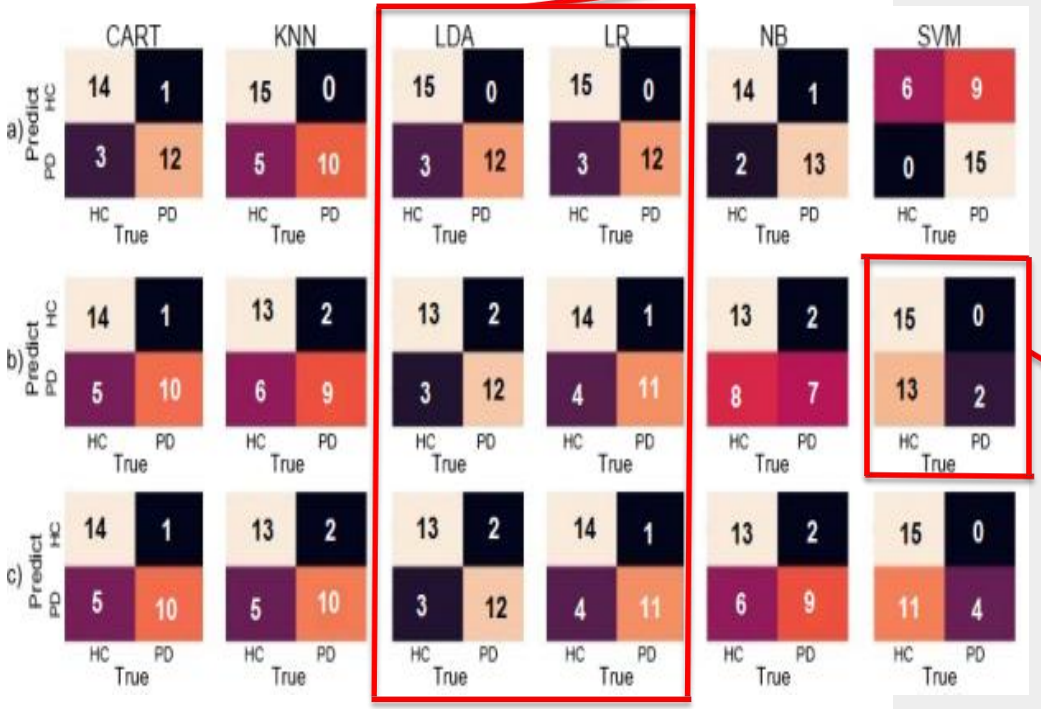


AUC values below 0.8

AUC above 0.9 {paired CART}

move together to end parkinsons disease

Meander Dataset



LDA & LR classifier {best(ao)}

Accuracy: 90% for both groups

Precision: 100% for PD and 83.33% for HC

Recall: 80% for PD and 100% for HC

F1-Score: : 88.89% for PD and 90.91% for HC

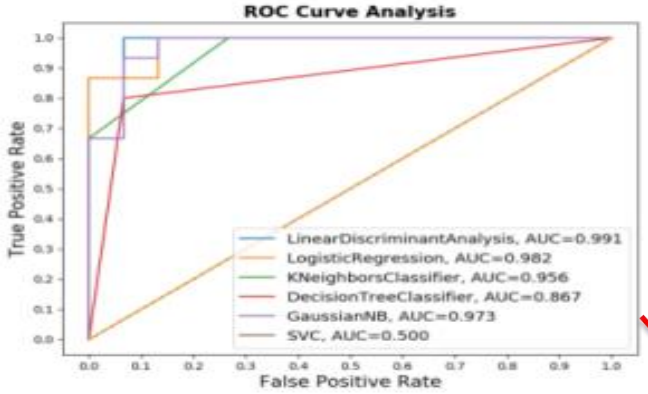
SVM Classifier {worst(go)}

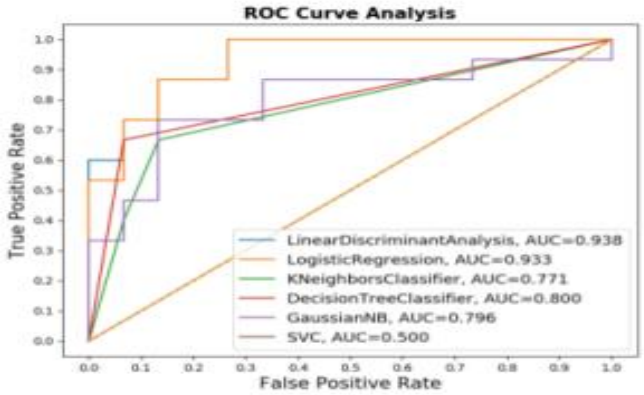
Accuracy: 56.67%

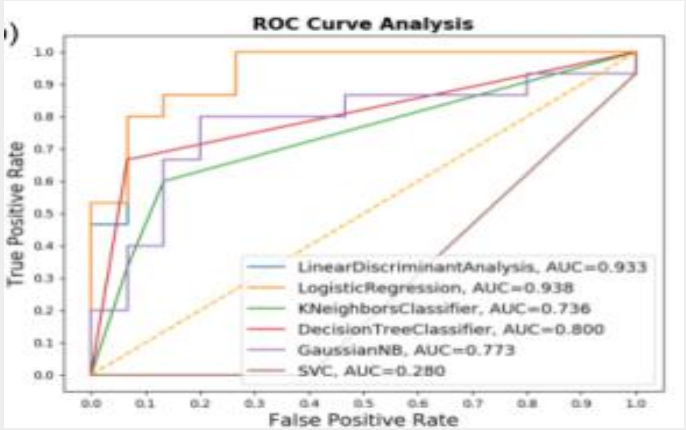
F1-Score: 23.53%

move together to end parkinsons disease

Receiver Operating Characteristic (Meander-dataset)







AUC values above 0.99

{ao}

move together to end parkinsons disease

Conclusion and Future Work

- Capable of detecting standards and deviations on individuals' handwritings, such as tremors, orientation, and speed.
- Some limitations, i.e., the sensor's disposition, were responsible for 'noisy' data and higher deviation in specific tasks than others.
- Usage of an affordable and handier solution than others offered in the market, mainly for faraway places and undeveloped towns.
- As future works, the device can be further developed to process the diagnoses and classification by its own, using built-in hardware, as well as allowing the interconnection between multiple devices and the internet for IoT related purposes.

THANK YOU

Vidyayāmruthamashnuthe

B.N.M. Institute of Technology