International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-11, Feb 2019

Comparative Analysis of Multiclass SVM and Binary SVM for Epileptic Seizure Prediction using EEG signals

[1]Anjum Shaikh, [2] Mukta Dhopeshwarkar, [3]S.N.Helambe, [4] Ramesh Manza

[1, 3] Deogiri College Dept. of Computer Science and IT, Aurangabad, India

[1]anjumshaikhcs@gmail.com, [3]snhelambe@gmail.com

[2,4] Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India

[2]drmuktanaik@gmail.com, [4]manzaramesh@gmail.com

Abstract: In pattern recognition and data classification classifier play very important role. In data classification Selection of proper classifier and optimal classes of data to achieve the proper result is very important. The present studies represent the comparative study of performance of two classifiers that are Multiclass SVM (MC-SVM) and Binary SVM for epileptic seizure prediction using EEG signal. The database that used in present study consists of four classes of data. In first experiment we used all four classes of data for classification using MC-SVM and in second experiment we consider only two optimal classes data for classification using binary SVM. In this study Epilepsy is able to predict 25 minutes before its onset with the accuracy 92.67% and Sensitivity 94.15%.using Multiclass SVM and accuracy 95.89% and sensitivity 98.50%. using binary SVM.

Keywords: Epilepsy, EEG, MC-SVM, SVM

I. INTRODUCTION

Epilepsy is the neurological disorder of brain Electrical signal due to that the brain and body behave strangely. Near about 0.8 to 1% population all over the world were affected by epilepsy [1]. There are 80% research is on epilepsy detection but only 20% research is on Epilepsy prediction. In Epilepsy detection patient precedent endure the pain of epilepsy more than that patient suffers the pain of accident that happen throughout the epilepsy, so to minimize the risk during epilepsy the present study focus on epilepsy prediction using the proper analysis of EEG signal. This study used ASPPR [2] database of 24 hours Invasive EEG recording of 21 epilepsy patients [3]. After recording the EEG signal, signal were labeled with four different classes i.e. Inter-ictal (period between two seizures), pre-Ictal(period 300 sec befor the Seizure), Ictal(period during seizure) and Post-Ictal (period 300 sec after the seizure) [4]as shown in the figure 1. After recording the EEG signal the optimal features were selected by using SFS (Sequential Forward selection) algorithm [5]. After Feature subset selection feature is classified by using two different classifier that is MC_SVM in which all four classes data of EEG is used for classification and in another classifier only two classes that is pre-Ictal and Ictal data are used for classification.

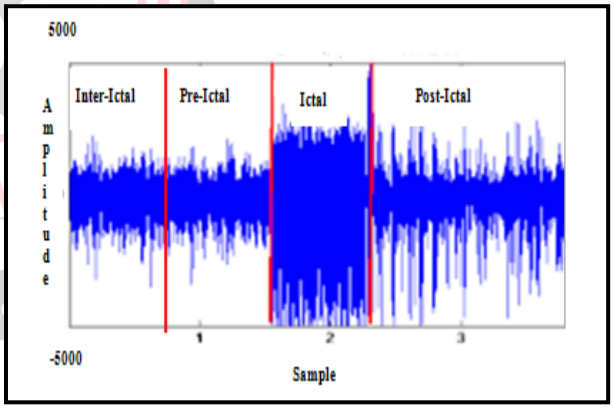

Figure 1. Epileptic EEG signal classification

Electroencephalography (EEG):

EEG is the medical diagnostic tool used to find the abnormalities related to the brain. In Epilepsy EEG is used to record the voltage fluctuation of brain signal.EEG signal is recorded by using two different method that is Non Invasive and Invasive method. In Non Invasive method the multiple electrodes are attached to the disc is placed over the scalp and signals are recorded. If non Invasive method gives insufficient information at that time Invasive method is used to record the brain signal. In Invasive method the electrode are placed over the substances of brain or inside the brain by surgically opening the skull. The figure 2 shows non invasive and invasive recording of EEG signal.

 DOI : 10.18231/2454-9150.2019.0078

Figure 2:a) Non Invasive EEG recording

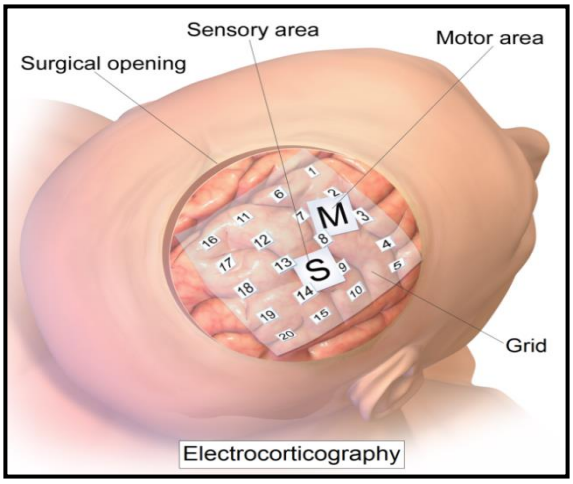

Figure 2:b) Invasive EEG recording

II. METHODOLOGY

2.1 Feature Subset Selection:

The EEG Database used in the present study is in the form of feature vector of 204 features were extracted from the 6 electrodes that is 34 different features from each of the electrode. The more optimal features from the feature vector were selected by using SFS (Sequetial Forward Selection) algorithm. SFS algorithm start optimal feature selection with the vacant set and then sequentially add the feature into the vacant set by analyzing the performance of classifier, if performance of classifier increases after adding the new feature into the set then that feature is permanently added into subset otherwise that feature was discarded [8]. By using this iterative process SFS finally gives the subset of optimal selected features that are different in size and type for different patient. By applying this method on EEG database of 21 different patient separately finally dataset were prepared for prediction before 25 min before seizure onset and passé this prepared dataset to classifier to learn the predictive model. The work flow of predictive model illustrate in Figure 3.

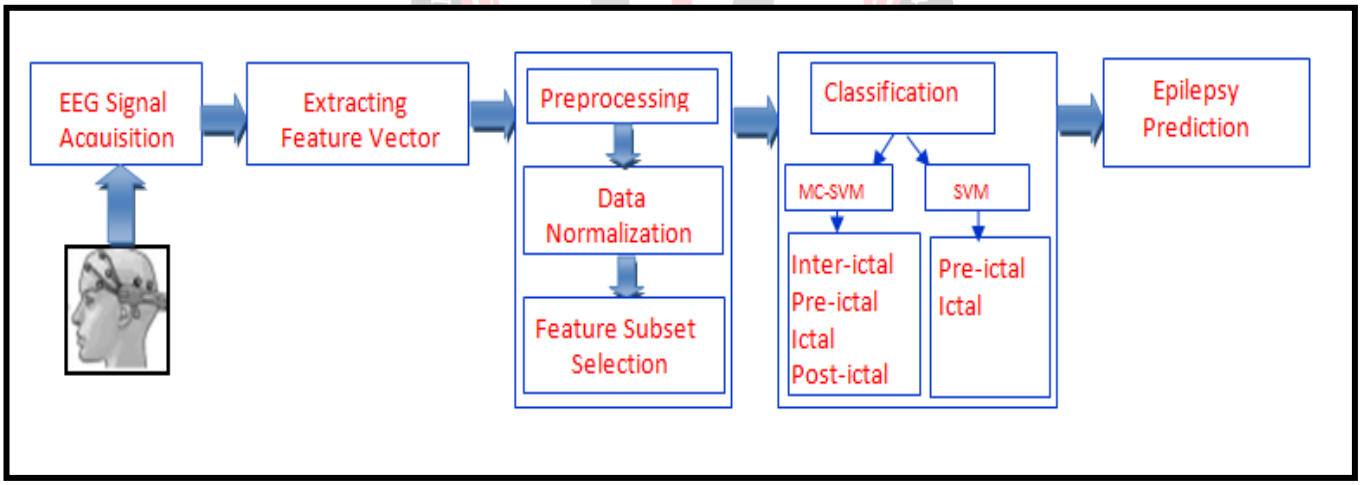

Figure 3: Workflow using MC-SVM and SVM

2.2 Multiclass SVM(MC-SVM):

The first classifier used in present work was MC-SVM [9] using one-against-one approach. The one-against-one [10] strategy uses the concept of binary SVM classifier by creating a binary pair for each of different class label and apply soft margin SVM. This approach constructs C(C-1)/2 number of binary classifiers where C is the number of classes. Database that were used in this study has 4 classes that are Inter-Ictal,Pre-Ictal,Ictal and Post-ictal ,all four classes data were used for classification so it make 6 pair of binary classifiers i.e.(C1,C2), (C1,C3), (C1,C4),(C2,C3), (C2,C4) and (C3,C4). The collection of these binary pair classifiers are trained using the voting strategy, the class prediction is counts as a vote and the predicted class is that class which receives the maximum votes [11].The 21 different predictive models were learn for each of the patient separately.

2.3 Support Vector Machine (SVM):

The second classifier used in present work was the SVM . The SVM separates all data objects in a feature space into two classes .The data objects must have features {x1 ... xn} and a class label, yi. SVM treats each data object as a

 DOI : 10.18231/2454-9150.2019.0078

point in feature space such that the object belongs to one class or the other. Specifically, a data object (characterized by its feature vector) either belongs to a class, in which case the class label is yi = 1, or it does not belong to the class(implying that it belongs to the other class) in which case the class label is yi = -1. Therefore, the definition for the data is

$$Data = \{(x_i, y_i) \mid x_i \in R^p, y_i \in (-1,1)\}_{i=1}^{n}$$

Where p is the dimension of the feature vector and n is the number of data points. During training, the SVM classifier finds a decision boundary in the feature space that separates the data objects into the two classes [12]. As the SVM classifier used for binary class so only two class are used for classification that i.e. Pre-ictal and Ictal class data are used for classification .Pre-Ictal data is more important for prediction because medically it is prove that seizure activity start one hours before seizure. In this study 25 min data before seizure were used as Pre-Ictal data to learn the predictive model.

III. RESULTS

In the present Study by performing the two different experiments epilepsy is able to predict 25 min before its onset. In first experiment classify data using MC-SVM in which all four classes of EEG data were used for classification and noted the evaluation measures for each of the patient separately and find the average classification accuracy 92.67% and average Sensitivity 94.15%. In second experiment data are classified using binary SVM in which only two classes of data that is Pre-Ictal and Ictal were used for classification and noted the average evaluation measure accuracy 95.89% and sensitivity 98.50%.The result of both experiment as shown in Table 1. and Figure 4 shows the graphical representation of performance of MC-SVM and SVM classifier

Sr.no.	Classifier	Accuracy	Sensitivity
1	MC-SVM	92.67%	94.15%
2	SVM	95.89%	98.50%

Table 1. Experimental Results

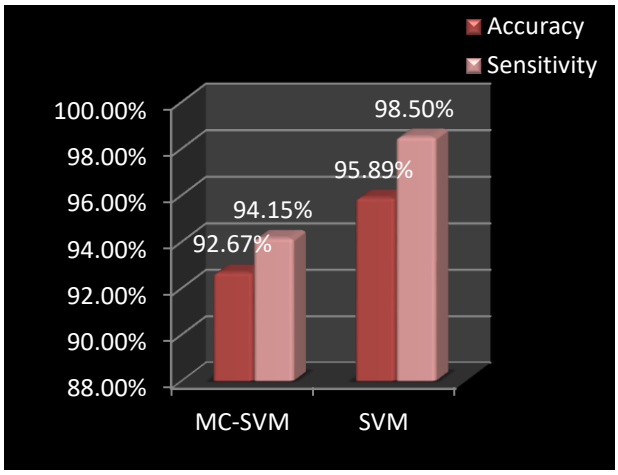

Figure 4.Graphical representation of Results

IV. CONCLUSION

The present study analyzes the performance of two classifiers by performing the two experiments for epileptic seizure prediction 25 min before onset. In first experiment using MC-SVM noted the average evaluation measures accuracy 92.67% and sensitivity 94.15% and in second experiment using binary class SVM noted the average evaluation measures accuracy 95.89% and sensitivity 98.50%, so in experiment two got improved result than experiment one. This study concludes that SVM classifier performs well than the MC-SVM always used optimal class data for .classification.

REFERENCES

[1] Shaikh A., Dhopeshwarkar M. (2019) Development of Early Prediction Model for Epileptic Seizures. In: Mishra D., Yang XS., Unal A. (eds) Data Science and Big Data Analytics. Lecture Notes on Data Engineering and Communications Technologies, vol 16. Springer, Singapore.

[2] Moghim N, Corne DW (2014) Predicting Epileptic Seizures in Advance. PLoS ONE 9(6):e99334. doi:10.1371/journal.pone.0099334

[3] Epilepsy.uni-freiburg.de (2007) EEG Database Seizure Prediction Project.

[4]Costa RP, Oliveira P, Rodrigues G, Leita˜o B, Dourado A (2008) Epileptic seizu classification using neural networks with 14 features: 281–288.

[5] Mohamad KHALIL, Joelle AL HAGE, Khaled KHALIL" Feature Selection Algorithm Used to Classify Faults in Turbine Bearings" International Journal of Computer Science and Application, Vol. 4, No. 1—April 2015 12324-7037/15/01001-08

doi:10.12783/ijcsa.2015.0401.01

[6]https://wantoncreation.files.wordpress.com/2013/08/eeg-cap.jpg

 DOI : 10.18231/2454-9150.2019.0078

[7]http://learn.neurotechedu.com/images/introtobci/ecog.png

[8]. Santosh Singh Rathore, Atul Gupta A Comparative Study of Feature-Ranking and Feature-Subset Selection Techniquefor Improved Fault Prediction, Conference Paper February 2014 DOI: 10.1145/2590748.2590755

[9] LIBSVM (2013) LIBSVM — A Library for Support Vector Machines.Available: http://www.csie.ntu.edu.tw/,cjlin/libsvm/.

Accessed 2014 May 18.

[10] T. Hamamura, H. Mizutani, and B. Irie, "A multiclass classification method based on multiple pairwise classifiers", International Conference on Document Analysis and Recognition, pp. 809-813, Edinburgh, Scotland, August 3-6, 2003.

[11] Falah Chamasemani, Fereshteh & Singh, Yashwant. (2011). Multi-class Support Vector Machine (SVM) Classifiers -- An Application in Hypothyroid Detection and Classification. The 2011 Sixth International Conference on Bio-Inspired Computing. 351-356. 10.1109/BIC-TA.2011.51.

[12]https://www.ugpti.org/smartse/resources/downloads/support-vector-machines.pdf

 DOI : 10.18231/2454-9150.2019.0078