Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

Alzheimer's disease Detection through Machine Learning

Savita[1], S.vijayalakshmi[2], Munish Sabharwal[3]
[1]Research Scholar, School of computing science & engineering, Galgotias University
[2]Professor, School of computing science & engineering, Galgotias University
[3]Professor, School of computing science & engineering, Galgotias University
dsavita89@gmail.com[1], svijisuji@gmail.com[2],mscheckmail@yahoo.com[3]

Abstract

A neurological disease Alzheimer's disease (AD) that occurs most commonly in older adults and is a common reason for dementia. The accurate and timely diagnosis of Alzheimer's disease is important to prevent it from spreading at an irreversible level. This paper concentrates on a machine learning method used to identify Alzheimer's from magnetic resonance images. The proposed approach will focus on the purposeful area of the hippocampus ROI boundary. The HC ROIBR features such as entropy, variance, contrast, energy, and correlation are computed. Our proposed method for classification of AD into stages such as normal, mild, moderate, and severe, use neural network and support vector machine.

Keywords: Dementia, Alzheimer's disease, Hippocampus, Region of Interest, Boundary, neural network, support vector machine.

Introduction

A disorder of the brain that causes gradual and irreversible memory loss is known as Alzheimer's disease (AD). AD is the most common type of brain deterioration that is caused by the build-up of beta amyloid plaques in the brain. Fungus causes the hair to become very tangled. As the number of plaques and tangles increase, the healthy neurons which are able to communicate and survive begin to function less efficiently and eventually begin losing their capacity to communicate to operate, which results in overall shrinkage of the brain tissues. Over time, it was doing the same to your brain cells. This disease affects the way your thoughts act, your memory, and how you act. Because the signs develop slowly and at a gradual pace, it is often difficult to recognize the early stages of Alzheimer's disease. There is no medical cure available in the world[1]. The Alzheimer's association claims that AD is the sixth leading cause of death in United States. As time goes on, the yearly number of newly diagnosed patients with Alzheimer's disease goes up by ten to fifteen percent. Although genetics, environmental factors and other lifestyle factors may influence it, this disease is the leading cause of its type. Alzheimer disease is typically categorized into 3 phases:

1. Mild
2. Moderate
3. Severe

Having a mild level of Alzheimer's disease can be a sign of what will happen in later stages

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

of the disease. The patients in this phase might experience difficulty with familiar tasks, difficulty telling the time, not understanding people‘s words, or problems participating in conversations. The phase two of moderate Alzheimer disease is clearly mild symptoms of memory loss. In the earlier stage of this disease, the symptoms would be that the patient might begin to experience problems with mood, mood swings, can cause depression, can cause anxiety, can cause an increase irritability, can cause an increase in restlessness, can affect the ability to communicate by words, going through the last stage, in the last stage, the symptoms would shift and become worse. Face to groaning, grunting, and moaning. It is necessary to identify the disease and treat it as soon as possible before irreversible harm is done. Clinicians might use traditional methods such as the Medical Dementia Rating Scale (CDR), Mini-Mental State Investigation (MMSE) and Positron Emission (PET) and also some imaging techniques like Magnetic Resonance (MRI), Single-Photon Emission Ct Scan (SPECT) and Positron Emission Tomography (PET) to look at changes in the brain and diagnose the Alzheimer's. In this we are using MRI (Magnetic resonance image) to see the structure and functions of the brain and also for AD indentification. MRI uses to acquire brain images. Screening for persons at risk for Alzheimer's (AD) at early preclinical stages may aid in early detection of AD disease pathology. The recent biomarker of Alzheimer's disease (AD) requires the collecting of specimen or imaging data. But at the other side, electronic medical records do not require extra work or time for gathering. Machine learning is a perfect choice for analyzing groups of records in medical administrative dataset sets millions of identifiers from thousands of hundreds of individuals. Machine learning was one of the major artificial intelligence concepts that has come out of academia (A.I.). The machine learning technique is also called "training data" or "preliminary evaluation data," and has a baselines of its experience. It focuses on the development of abilities needed in the program to use and access the information[2]. Machine learning is commonly employed to analyze and interpret data. Furthermore, the software can organize patterns and model data. It really permits finished decisions to be made for which a routine procedure is not useful and at this time sparing time and effort. Machine learning algorithms have been comprehensively used for medical image and data mining and extraction with broad variety of different applications including in brain disease diagnosis. We increase the number of options to choose from. You will know which type of Alzheimer disease you have by using Machine Learning. This will tell you how to manage your Alzheimer disease because this will decrease your brain capacity. As time goes on, your thinking efficiency will decrease.

Machine learning

“It is a strategy used to collect and analyze data that automates the construction of analytical solutions. It is based on the idea that, with little human intervention, machines can analyze data, find patterns, and form assessments:. Supervised and unsupervised are two class of machine learning that can be used to indentify Alzheimer’s disease at early stage[3].

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

Supervised learning is one that makes use of labeled data. Supervised learning needs supervision to train the model, which is similar to as a student who learns things in the presence of a teacher.

Supervised learning in medical imaging can be applied to identify the disease and then do the classification according to the result. In this first we need to train the model according to image texture, shape, size. When the training is completed then we input image in to supervise model so that it can identify the image and according to algorithm it can predict the output.

Unsupervised learning is also another type of learning algorithm. Unsupervised learning will help us find structure and patterns in the data. Unsupervised learning does not require any rules to be followed. The machine determines patterns in the data by their own.

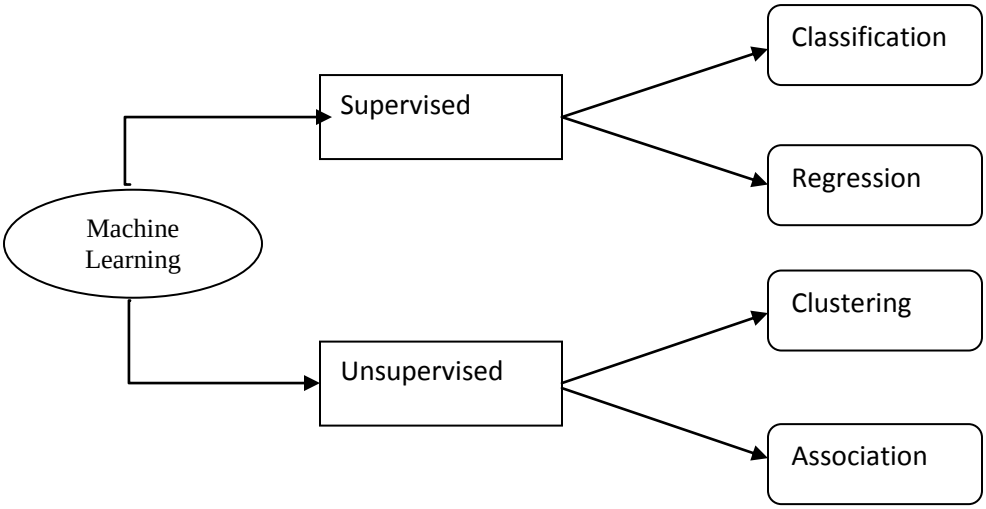


Figure 1: Machine Learning

Motivation

In current situation, such decisions are hard to be made. That is one reason why we must have computational and unconventional methods, such as machine learning. The growing trend of using machine learning as part of health care involves predictions and visualizations of diseases. This information will aid doctors and health-care analysts to make treatment and illness management decisions. It is not the cause of aging; it is the result of a malfunctioning brain. Because the human brain deteriorates with age, a weakness in the brain may lead to the creation of the disease of the brain. In addition, some patients with this disease may experience changes in personality, mood and abilities [1].

A doctor who views an MRI scan would have a biased perception for a certain disease. This could possibly lead to missing a very serious disease or it could actually make the physician

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

diagnose the wrong disease causing the patient severe harm. It will lead to thinking about only a small subset of elements as a result. In [2], C S Lee stated that . Radiology, which is the study of the body from an ultrasound or magnetic resonance imaging point of view, accounts for 75 percent of all the medical errors that occur. The workload is increased, the stress and fatigue are high, cognitive errors are common, and the system itself has some holes in it. In this situation, high-powered diagnostic systems provide clinicians with a safe and effective clinical support.

Problems Statement

By the existing model, it is very difficult to identify a person who is in the early stages of Alzheimer's disease. It can only be done if the patient reveals their entire medical history and if a genetic testing has shown that they have a defective protein. Sometimes it is the case that prescription will not be observed when the doctor has diagnosed a disease. According to the survey of patients with Alzheimer's disease, worldwide there are as many as 50 million people with dementia with 7 million new cases annually. Alzheimer's disease has the highest prevalence of any type of dementia, and may be present in 60 to 70 percent of cases [3]. The early recognition of Alzheimer's disease is vital for early stages of the disease.

Related works on Alzheimer's Detection

In [4] proposed a feature selection based algorithm for diagnosis of Alzheimer's Disease. This solution combines the wrapper and filter analysis techniques. The features were extracted based on the top-k features. The support vector machine (SVM) was used for the classification task. The paper argues that proposed method exhibits improved accuracy and computational cost, which is greater than other methods.

In [5] author's introduced an 'Efficient K-Nearest Neighbor Classifier With Different Numbers of Nearest Neighbors'. in this paper will use public data from UCI repository, in this paper will say to store costs of Ktree method are same to traditional KNN method. It gives much higher sorting accuracy. It stores training samples in the leaves of the k-tree.

In [6][11][12] present a Random forest algorithm for regression analysis N of neuroimaging Data in Alzheimer's disease. It is one of the latest and most innovative method in medicine data analysis. Popula's ability to handle highly nonlinear data. He wanted to use magnetic resonance imaging, diffusion tensor imaging and positron emission tomography (PET) data.

In [7][13][14] present the the technique and also do the WEKA and SVM-light comparison based on help vector machines in the classification of the disease of Alzheimer's using the structural features of the brain MR imaging the model using software WEKA tools and an SVM algorithm.

In [8][15] proposed The theory of early cognitive losses in the hippocampal texture has been checked. They used three separate data sets for classification training, consisting of

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

Australian Imaging Biomarkers and a Lifestyle Flagship Ageing Study (AIBL), ADNI and Metropolitan 1953. In this study hippocampal texture was found to be better than reducing hippocampal volume to forecast conversion from MCI to AD to ADNI. The texture of the hippocampus was shown to be superior to the volumetric changes in the hippocampus zone, to the distinction between stable MCI and MCI conversion. The results of their studies have confirmed the hypothesis that hippocampus textural information is more sensitive than volume and can be used in the early phase to detect AD.

In [9] M.Evanchalin et al. introduced An Artificial-intelligence-based Particle Swarm Optimization (PSO) and Decision Tree classifier was developed for Alzheimer's disease detection. The solution suggested standardizes the pictures processed and uses the random Markov filter to eliminate noise. Functions are derived using the moments and the key component analysis from normalized images. Swarm optimisation of particles is carried out using the Decision Tree Classifier for the reduction of extracted characteristics and the classification. The authors note that their method for similar work is 92.07% accurate in SPECT and 86.71% in PET pictures.

Objective

Our main objective is here to make the diagnosis of the Alzheimer's disease easier, also to detect the AD disease in its early stages and use the machine algorithm approach for entire process.

Proposed Method

Material

We have used OASIS (Open Access Series of Imaging Studies) data set. It provides whole brain structural MRI neuro imaging demographic datasets, which is open to the scientific community. This data set contains 436 neurological scan and the range of age is between18-96 out of them 100 subjects are clinical diagnosed with different AD and 135 are normal control subjects stages like mild and moderate. Form this data set we have download 235 MRI scan with Alzheimer's [10]. For the selected subjects the demographic information is according to Clinical Dementia Rating is shown in table I and its analysis is shown in Figure.2.

CDR=0 (No AD)

CDR=0.5 (Very mild)

CDR=1(mild)

CDR=2 (moderate)

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

Table I : Clinical Dementia Rating

	Normal control (CDR=0)	**Alzheimer's (CDR=0.5/1/2)**
Subjects	135	100
Gender	97 female/38 male	59female/41 male
Age (mean± S.D)	69.07±13.82	76.76±7.08

Methods

The process of work is as follows:

1. Input dataset
2. Preprocessing
   - ROI Bounding Rectangle (BR) Identification
   - ROI BR extraction
   - ROI BR Enhancement
3. Feature Extraction
4. Classification

1. Data Collection

Dataset for proposed experiment is collected from OASIS project [11].

2. Preprocessing

Preprocessing is one of the necessary steps to make the AD detection process simple and easy. ROI BR, ROI BR extraction and enhancement are some process that is performed at preprocessing step.

- **ROI Boundary Rectangle Identification** (HC ROIBR):- the first step is the identification of hippocampus region of interest in brain MRI. HC ROI Boundary is identifying by doing the historical analysis of MRI scan. And it was found that the coordinate values for the Hippocampus boundary are Row min = 88, Row column= 128, Column min= 68 and column max= 188 encloses the hippo camp.
- **ROIBR extraction**: - After identification oh hippocampus boundary rectangle we extract only the Hippocampus ROI BR to make the process simple. Because it is only the place in Brain MRI that is first affected by Alzheimer's disease so we not need to process the entire image.
- **ROI BR Enhancement**

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

In this step, Hippocampus ROI BR is enhanced to make the HC more clearly for further processing. Contrast enhancement is done.

3. Feature Extraction

Now the HC ROIBR is enhanced so for Alzheimer's disease detection some texture and shape features are computed. For enhanced ROIBR features like entropy, contrast, mean, standard deviation, and variance are extracted by using Grey level matrix.

Grey level co-occurrence matrix or gray-level spatial dependence and texture feature are computed for image analysis purpose. GLCM is statistical technique which is used of examining texture that considers the spatial relationship of pixels. It characterize the image texture by removing the lowest pixel and highest pixel in a pixel pair from an image, and then measuring how many pairings of the remaining pixel occur in the same pixels on the image, forming a GLCM, and then calculate statistical measures from image matrix and the feature extraction parameters minimum and maximum value are shown in Table II and the comparison of min and max value is shown in Figure3.

- Image Contrast :- intensity local variation into pixel and its neighboring pixel can be computed as:

  $$contrast = \sum_{i=0,j=0}^{n-1} p_{ij}(i-j)^2 \qquad (1)$$

- Variance is measurement of heterogeneity and computed as

  $$var = \sum_{i=0,j=0}^{n-1}(1-\mu_i)^2 p_{ij} \qquad (2)$$

- Entropy

  Entropy measures the level of visual entropy in an image and rises to its largest value when the intensity of all elements in P matrix is equal. When the image does not have a uniform texture, GLCM elements have large values, implying very high entropy.

  $$E_{ntropy} = \sum_{i,j=0}^{n-1} -(p_{ij})p_{ij} \qquad (3)$$

- Energy is a measurement of global uniformity in image and is calculated as :

  $$E_{ergy} = \sum_{i,j=0}^{n-1}(p_{ij})^2 \qquad (4)$$

- Correlation is the measurement of linear dependency between image grey level and can be found by:

  $$correlation = \sum_{i=0,j=0}^{n-} p_{ij}\frac{(i-\mu)(j-\mu)}{\sigma^2} \qquad (5)$$

Table I : Feature Extraction parameters.

Feature	Feature Value	
	Minimum	**Maximum**
Contrast (C)	0.0016	0.0152

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

variance	217	238
Entropy (E)	0.21	0.25
Energy	22	42
Correlation	0.9878	0.9946

4. Classification

Different approaches for image classification are proposed by users. Most of the classification methods like maximum likelihood, ANN, minimum distance, decision tree, and SVM, are used to make a definitive decision and also required a training sample. Clustering based techniques like k-means and fuzzy clustering also providing good result in classification. The other classification methods that depend on knowledge system are called as knowledge based classification method in which knowledge and rules are generated from experts and by observing data. Now this type of classification is more in use. In our method we used the combination of ANN and SVM. We have taken 235 MRI with clinical dementia rating for our method, so they are trained by neural network. The detail of all is as total= 235; CDR 0=135 (normal), CDR0.5=69 (very mild), CDR 1= 29 (mild) and CDR 2=2 (moderate) .

After the image enhancement and feature extraction, it is presented into large space. To make the analysis process easy they further divided into subspace. The input of ANN is the feature vector and used for classification based on a sub-space. Suppose if we have k no. of sub-spaces then k no. of classification results of sub-space, are as CL_Subspace1, CL_ Subspace 2, CL_ Subspace n. But now the problem is how to combine all results. Mean is one of the simplest to integrate the result of classification and can be computed as:

$$cl = \frac{1}{n}\sum_{i=1}^{n} cl\_suspace_i \quad (6)$$

Or weighted mean value can be computed as:

$$cl = \frac{1}{n}\sum_{i=1}^{n} w_i cl\_suspace_i \quad (7)$$

Where w_i is classification weight and equal to 1.

And after ANN operation we applied support vector machine to integrate the ANN classification result.

5. Result and Discussion

In our work, ML based approach is proposed for AD detection. For experiment the dataset is taken form OASIS Then HC ROIBR is identified and extracted to make the proposed method simple or to avoid unnecessary computation. Then ROIBR features are computed and used in training process. We use the neural network with SVM for classification purpose and the overall

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

accuracy of our proposed method was 85.8 %. .The extracted images are depict in Figure 4-5.

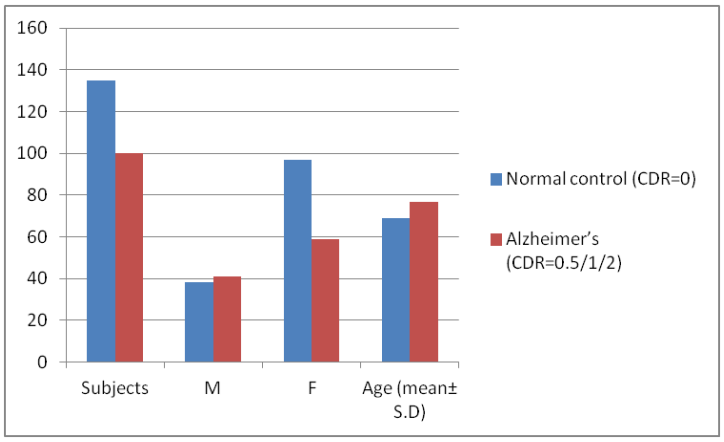


Figure 2. Analysis of Clinical Dementia Rating

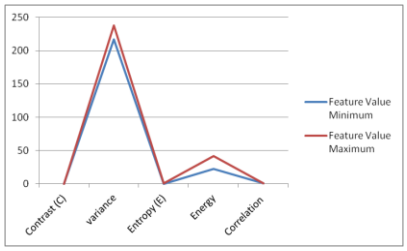
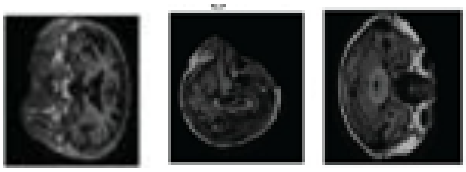
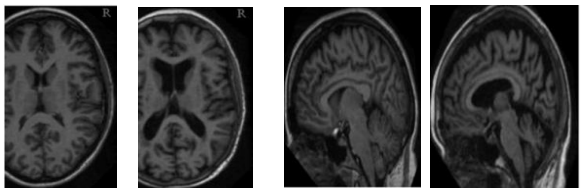


Figure 3. Comparison of min and max value



(a) (b) (c)

Figure 4 (a) Sagittal (b) Coronal (c) Axial view of input images



(a) (b) (c) (d)

Figure 5 (a-b) Normal brain and (c-d) abnormal brain

6. Conclusion and Future work

In this work, an AI based methodology for discovery of Alzheimer's illness is proposed.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

The OASIS dataset was utilized for tests. The surface, region and shape highlights from hippocampus area of MRI examine are removed. The printed highlights from OASIS were additionally removed. These highlights were utilized to prepare the neural organization with error back engendering for grouping. The proposed framework has a normal precision of 87.83%.In future planning to extract three dimensional images volumetric analysis.

7. References

1. C. S. Lee, G. N. Paul, J. W. Sallie, E. N. David, "Cognitive and system factors contributing to diagnostic errors in radiology," American Journal of Roentgenology, vol. 201(3), pp. 611-617, 2013.
2. Alzheimer's Association, "2016 Alzheimer's disease facts and figures," Alzheimer's & Dementia, vol. 12(4), pp. 459-509, 2016.
3. http://https//www.who.int/news-room/fact%20sheets/detail/dementia#:~:text=Worldwide%2C%20around%2050%20million%20people,dependency%20among%20older%20people%20worldwide.
4. Yang Han, Xing-Ming Zhao "A hybrid sequential feature selection approach for the diagnosis of Alzheimer's Disease", 2016 International Joint Conference on Neural Networks (IJCNN).
5. Shichao Zhang, Senior Member, IEEE, XuelongLi, Fellow, IEEE, Ming Zong, Xiaofeng Zhu, and RuiliWang. ―The paperEfficient kNN Classification With Different Numbers of Nearest Neighbors‖. (Shichao Zhang, 2017)
6. Emina Alickovic , and Abdulhamit Subasi. ―Automatic Detection of Alzheimer Disease Based on Histogram and Random Forest ‖ (Subasi, 2011)
7. K.R Kruthika , Rajeswari, H. D Mahesh Appa. ―Multistage Classifier based approach for AD prediction & retrieval‖ (Scholar)∗, 2018)
8. Lauge Sørensen et.al "Early detection of Alzheimer's disease using MRI hippocampal texture", US National Library of Medicine National Institute of Health, DOI:10.1002/hbm.23091,Epub 2015 Dec 21.
9. M.Evanchalin,Sweety,G.Wiselin Jiji "Detection of Alzheimer Disease in Brain Images Using PSO and Decision Tree Approach", 2014 IEEE International Conference on Advanced Communication Control and Computing Technologies (ICACCCT).
10. Marcus, DS, Wang, TH, Parker, J, Csernansky, JG, Morris, JC, Buckner, RL. "Open Access Series of Imaging Studies (OASIS): Cross-Sectional MRI Data in Young, Middle Aged, Nondemented, and Demented Older Adults." Journal of Cognitive Neuroscience. 19:1498-1507.
11. Open Access Series of Imaging Studies (OASIS), online: http://www.oasis- brains.org
12. K.Venkatachalam, A.Devipriya, J.Maniraj, M.Sivaram, A.Ambikapathy, Iraj S Amiri, "A Novel Method of motor imagery classification using eeg signal", Journal Artificial Intelligence in Medicine Elsevier, Volume 103, March 2020, 101787

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 2782 - 2792
Received 16 February 2021; Accepted 08 March 2021.

13. Yasoda, K., Ponmagal, R.S., Bhuvaneshwari, K.S. K Venkatachalam, " Automatic detection and classification of EEG artifacts using fuzzy kernel SVM and wavelet ICA (WICA)" Soft Computing Journal (2020).
14. P. Prabu, Ahmed Najat Ahmed, K. Venkatachalam, S. Nalini, R. Manikandan,Energy efficient data collection in sparse sensor networks using multiple Mobile Data Patrons, Computers & Electrical Engineering,Volume 87,2020.
15. V.R. Balaji, Maheswaran S, M. Rajesh Babu, M. Kowsigan, Prabhu E., Venkatachalam K,Combining statistical models using modified spectral subtraction method for embedded system,Microprocessors and Microsystems, Volume 73,2020.
16. Malar, A.C.J., Kowsigan, M., Krishnamoorthy, N. S. Karthick, E. Prabhu & K. Venkatachalam (2020). Multi constraints applied energy efficient routing technique based on ant colony optimization used for disaster resilient location detection in mobile ad-hoc network. Journal of Ambient Intelligence and Humanized Computing, 01767-9. IF 4.5