International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

IJIEMR Transactions, online available on 05th Apr 2023. Link :http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=Issue 04

10.48047/IJIEMR/V12/ISSUE 04/15

Title AUTISM SPECTRUM DISORDER DETECTION

Volume 12, ISSUE 04, Pages: 105-112

Paper Authors

S. Narendra, Karasani Pavani, Kannamangalam Durga Devi, Malineni Ritika, Jaladi Mohan Sri Sai

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

AUTISM SPECTRUM DISORDER DETECTION

S. Narendra[1], M. Tech, Assistant Professor, Department of CSE,
Vasireddy Venkatadri Institute of Technology, Nambur, Guntur Dt., Andhra Pradesh.
Karasani Pavani[2], **Kannamangalam Durga Devi**[3], **Malineni Ritika**[4], **Jaladi Mohan Sri Sai**[5]
[2,3,4,5] UG Students, Department of CSE,
Vasireddy Venkatadri Institute of Technology, Nambur, Guntur Dt., Andhra Pradesh.
[1]narendracse@vvit.net , [2]karasanipavani@gmail.com , [3]durga20010615@gmail.com
[4]malineniritika5@gmail.com , [5]jaladimohansai@gmail.com

Abstract:

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social communication and interaction, and repetitive behaviours and interests [5]. Early diagnosis and intervention can significantly improve outcomes for individuals with ASD. A public dataset termed the Autism Brain Imaging Data Exchange (ABIDE) contains neuroimaging and clinical information on people who have or have not ASD. In this study, using the ABIDE-1 dataset, we suggest a Convolutional Neural Network (CNN) model with MobileNet architecture for the detection of ASD. Previous research on the detection of ASD using neuroimaging data has used various machine learning algorithms. However, these algorithms have limitations in terms of scalability and performance. CNNs have been shown to outperform other machine learning algorithms in several image classification tasks, and have recently been applied to neuroimaging data for the detection of ASD. The proposed CNN model with MobileNet architecture was trained and tested on the ABIDE-1 dataset, which contains resting-state functional magnetic resonance imaging (rs-fMRI) data from 400 individuals with ASD and 405 typically developing (TD) controls taken from 20 different sites. The dataset was preprocessed to remove noise and artifacts, and the rs-fMRI data were transformed into a connectivity matrix using the Power atlas. The proposed model was trained on 90% of the data and tested on the remaining 10%.

Keywords: CNN, ABIDE-1, Adam, ASD.

Introduction:

Autism Spectrum Disorder (ASD) is a complex and diverse condition that affects a person's social communication and behaviour. ASD affects one out of every 54 children in the United States, making it one of the most common neuro developmental disorders, according to the Centers for Disease Control and Prevention (CDC). Early detection and intervention for ASD have been shown to improve outcomes for those who have the disorder. Current diagnostic tools, on the other hand, rely on behavioural assessments, which can be subjective and time-consuming, causing delays in diagnosis and treatment. Convolutional Neural Networks (CNNs), for example, have shown great promise in detecting and classifying complex patterns in large datasets. CNNs have been extensively utilized in computer vision tasks like image recognition, object detection, and segmentation, and they have shown promising results when evaluating medical imaging data like brain scans. In this project using CNN model used to identify whether the person having ASD or not using the well-trained and tested dataset called ABIDE-1 which typically having the brain images of persons with and without ASD. Convolutional Neural Networks (CNN) are deep neural networks that are commonly used for image recognition and classification. CNNs use convolutional, pooling, and fully connected layers to learn complex patterns and features from images.

Literature survey:

1) In order to predict ASD/NoASD and facial emotion in ASD and NoASD children, a Deep Neural Network model with multi-label classification is proposed in this paper. The suggested model is more reliable and efficient. In addition, the model can be used to extract action units, arousal, and valence from facial images of autistic children. Understanding children's behavior and predicting ASD depend heavily on facial characteristics.
2) A 3D-Res2Net-based diagnostic model for ASD is proposed in this paper, combining the multi-scale mechanism and attention mechanism. By hiding redundant areas in the original feature map, the residual attention module directs the network's attention to crucial components. The use of low-level semantic information was improved by the introduction of a multi-scale mechanism. The two taken together allow the network to more accurately identify hidden lesions in the fMRI of ASD patients. The experiments on the ABIDE dataset demonstrated the superiority of the proposed model over the SVM-based model, DTL-NN, and Brain Net CNN.
3) We present a thorough analysis of applying three appropriate CNN models for three different atlases to rs-fMRI data from the ABIDE I dataset in order to diagnose ASD. On the basis of three different brain atlases, we first computed three functional connectivity matrices. We used ensemble learning to determine the final prediction, which was then compared to the ground truth to determine the effectiveness of our method. Given the full-scale ABIDE dataset, we outperformed current ASD prediction results with an accuracy of 74.53%.
4) In this paper, we train and validate a number of models for early autism detection. We study the psychological factors related to ASD in both toddlers and adults after conducting a thorough literature review of the state-of-

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

the-art and related studies. The proposed methodology's implementation is what follows. Data was prepared for training 4 ML models and 1 DL architecture by cleaning, processing, and one hot encoding (GRU). [17] In both categories, perfect accuracy (100%) was achieved (through the Random Forest classifier and GRUs). To thoroughly assess the effectiveness of each model, various other metrics have been compared. More data can be gathered to enable the training of more sophisticated and effective deep learning architectures with minimal parameters.

Problem Identification:

Due to the variety of symptoms and lack of objective biomarkers, diagnosing autism spectrum disorder (ASD) can be difficult for medical professionals. The use of behavioral assessments in traditional diagnostic techniques can be arbitrary and time-consuming. Furthermore, early diagnosis of ASD is essential for effective intervention and treatment, However, many children do not learn they have a condition until much later in life, which causes interventions to be put off and worse outcomes. Convolutional neural networks (CNNs), is of DL model, have demonstrated promise in detection of ASD from neuroimaging data. Although this limits the generalizability of the findings, earlier research has mainly concentrated on small datasets or datasets from a single site. Therefore, the development of a CNN model for ASD detection using a large, multi-site dataset like the Autism Brain Imaging Data Exchange (ABIDE) dataset is key problem addressed in this research paper. The proposed CNN model seeks to improve the accuracy of ASD detection and give medical professionals a more efficient and fair and unbiased diagnostic tool.

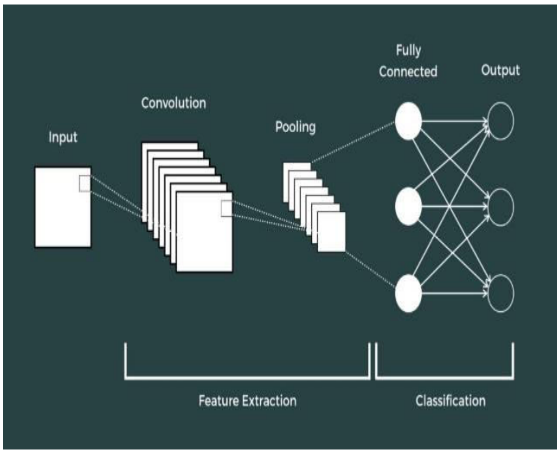

Fig.1. CNN Architecture

Methodology:

In this paper, the proposed methodology for detecting the autism, the FMRI images are given as input to a CNN model of Mobile Net architecture which classifies into 2 classes of autism and control.

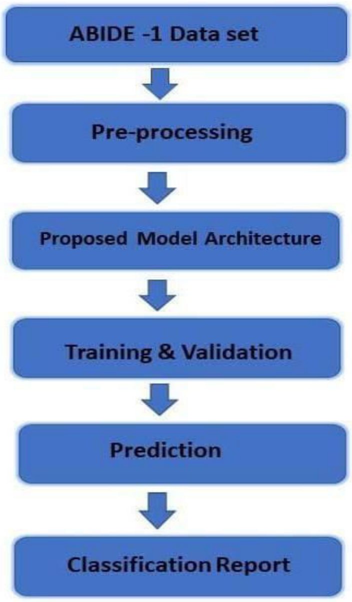

Fig.2. Proposed Methodology

System Implementation:

CNN (Convolutional Neural Network) a well-liked deep learning technique for image classification and recognition tasks is the convolutional neural network (ConvNet/CNN). By giving different objects and elements in the image learnable weights and biases, it is able to recognise key details and patterns in images.Convolutional, pooling, and fully connected (FC) layers make up the three main types of layers in CNN architecture. By using a convolution operation, convolutional layers are in charge of extracting features from the input images. Pooling layers Using the maximum or average value within a particular area, the feature map's spatial size can be reduced. The final classification determination is made by fully connected layers using the features that have been learned from previous layers.In addition to these layers, CNNs also have a dropout layer that randomly removes some neurons during training to prevent the model from becoming overfit. The activation function, such as Sigmoid, adds nonlinearity to the model and enables it to learn complex features.

A) Dataset & Preprocessing:

The Autism Brain Imaging Data Exchange (ABIDE-1) dataset is a publicly available neuroimaging dataset that includes structural magnetic resonance imaging (sMRI) and functional MRI (fMRI) [5] data from individuals with Autism Spectrum Disorder (ASD) and typically developing (TD) individuals. The dataset consists of 871 subjects from 20 different sites, with 400 subjects diagnosed with ASD and 405 TD subjects. The sMRI data includes T1-weighted images with 1 mm isotropic resolution, while the fMRI data includes resting-state fMRI with a voxel size of 3 mm isotropic resolution. The neuroimaging data is preprocessed using standardized procedures to ensure consistency across different sites. The preprocessing steps include motion correction, skull stripping, spatial normalization, and smoothing of the neuroimaging data.

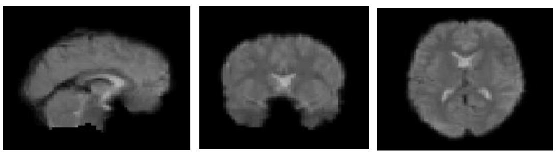

Fig.3. Each ABIDE ASD Sample Data includes three planes:

(i) Axial

(ii)Sagital

(iii) Coronal

B) Proposed Model Architecture:

The proposed architecture for the ASD detection CNN model is MobileNet, which is a deep convolutional neural network architecture pre-trained on the ImageNet dataset path is given as input to ImageDataGenerator which reads the images and provides output in an array form.The validation_split is .10 i.e 10% test data and 90% train data. The trained data is of categorical class mode having target size (128,128) of batch_size (18).The sequential model using the MobileNet architecture consists of residual blocks with multiple layers, which allow in order to effectively train deep neural networks. The MobileNet architecture consists of depthwise separable convolution layers, which reduce the number of parameters and computations required to train the network.

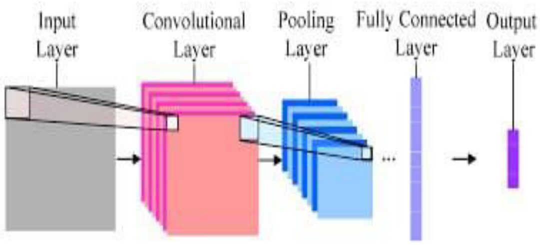

Fig.4. Mobile Net Architecture

Instead of a standard convolution operation that applies the same filter to each input channel, depthwise separable convolutions apply a separate filter to each input channel, followed by a pointwise convolution that applies a 1x1 filter to combine the results from all channels. This significantly reduces the number of parameters in the model and makes it more computationally efficient. A fully connected Dense layer with a Sigmoid activation function is used for the classification of ASD and TD individuals. The Adam optimizer to updates the network's weights and biases during the training process. Adam optimizer works by maintaining a rate of learning for each weight parameter, adapting the learning rate based on the past gradient descent and past squared gradients.The performance of the model is evaluated using various metrics, including Accuracy, AUC, Precision, Recall, and SpecificityAtSensitivity.It is important to note that the proposed architecture may vary depending on the specific implementation and modifications made to the pre-trained MobileNet architecture.

For binary classification tasks, deep learning models frequently employ the loss function binary cross-entropy (BCE). It calculates the discrepancy between actual binary labels and predicted probabilities.

The BCE is given by the formula:

$L(y, \hat{y}) = -[y \log(\hat{y}) + (1-y) \log(1-\hat{y})]$

The predicted probability of the positive class is, and y is the true binary label (0 or 1). (between 0 and 1).

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 mobilenet_1.00_224 (Functio  (None, 1024)             3228864
 nal)

 dropout (Dropout)           (None, 1024)              0

 flatten (Flatten)           (None, 1024)              0

 dense (Dense)               (None, 2)                 2050

=================================================================
Total params: 3,230,914
Trainable params: 2,127,874
Non-trainable params: 1,103,040
```

Fig.5. Summary of the model.

Results:

The results obtained in the detection of Autism Spectrum Disorder (ASD) using the ABIDE-1 dataset are promising. With an accuracy of 87%, the optimization algorithm Adam demonstrates a strong ability to correctly identify individuals with ASD based on neuroimaging data. The model is trained for 30 epochs.

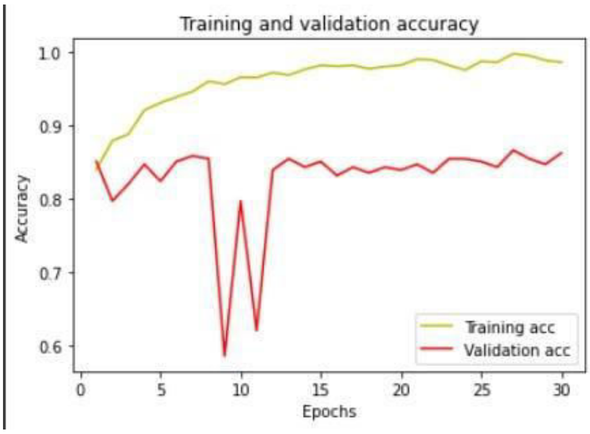

Fig.6. Training and validation Accuracy of Mobile Net Architecture of ABIDE dataset.

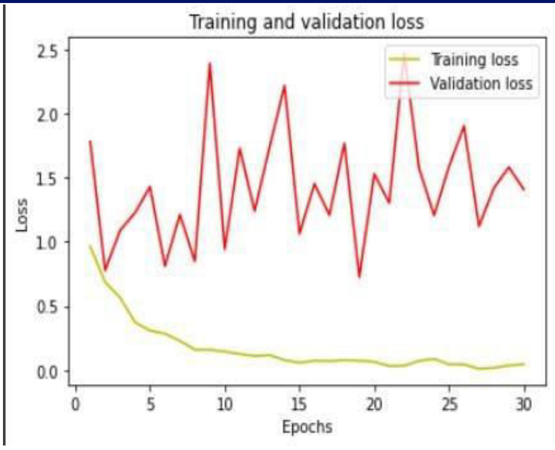

Fig.7. Training and validation Loss of MoblieNet architecture on ABIDE dataset.

Classification Report:

The MobileNet model is trained on the ABIDE dataset and performance of the Model is visualized.

The model performed with accuracy 87%. And the classification report contains the precision, recall, f1-score and support, along with the confusion matrix are generated and visualized as below.

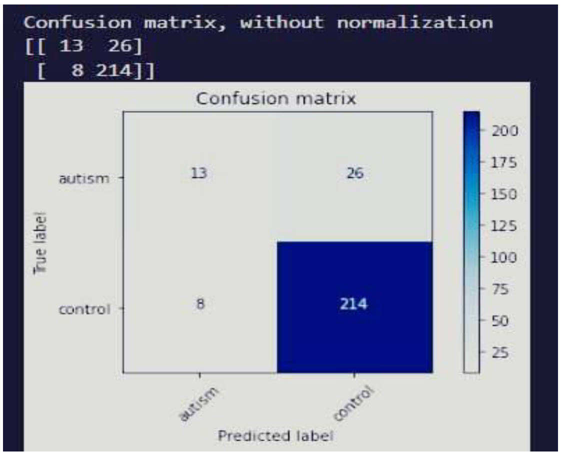

Fig.8. Confusion matrix on Unmasked-images dataset.

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

	precision	recall	f1-score	support
autism	0.62	0.33	0.43	39
control	0.89	0.96	0.93	222
accuracy			0.87	261
macro avg	0.76	0.65	0.68	261
weighted avg	0.85	0.87	0.85	261

Fig.9. Classification Report

Conclusion:

In this paper, the results produced by the proposed methodology are better when compared to the results produced by other methodologies. The classification using the MobileNet Architecture model on the Abide dataset is performed well on the train dataset and produced 87% accuracy, with a loss value of 1.40.

Limitations and Future Scope:

It is a light weight model. For the future work the proposed model uses mobile net which uses less number of parameters when compared with other models. The proposed model achieved an accuracy of 87%. With the parameter tuning accuracy can be improved further.

Reference:

[1] T. L. Praveena and N. V. M. Lakshmi, "Multi Label Classification for Emotion Analysis of Autism Spectrum Disorder Children using Deep Neural Networks," 2021 Third International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2021, pp. 1018-1022, doi: 10.1109/ICIRCA51532.2021.9545073.

[2] H. Zhang and Z. Wang, "Multi-scale Convolutional Network for fMRI-Based Diagnosis of Autism Spectrum Disorder," 2022 7th International Conference on Signal and Image Processing (ICSIP), Suzhou, China, 2022, pp. 804-808, doi: 10.1109/ICSIP55141.2022.9887213.

[3] J. Deng, M. Rakibul Hasan, M. Mahmud, M. Mahbub Hasan, K. Asif Ahmed and M. Zakir Hossain, "Diagnosing Autism Spectrum Disorder Using Ensemble 3D-CNN: A Preliminary Study," 2022 IEEE International Conference on Image Processing (ICIP), Bordeaux, France, 2022, pp. 3480-3484, doi: 10.1109/ICIP46576.2022.9897628.

[4] S. Lodha, N. Lodha, H. Malani, P. Devashetti and A. Rajguru, "Early diagnosis of Autism using Machine Learning techniques and Gated Recurrent Units," 2022 8th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2022, pp. 1152-1158, doi: 10.1109/ICACCS54159.2022.9785287

[5] Ousley, O., Cermak, T. Autism Spectrum Disorder: Defining

Dimensions and Subgroups. Curr Dev Disord Rep **1**, 20–28 (2014). https://doi.org/10.1007/s40474-013-0003-1

[6] Sri Hari Nallamala, et.al, "Breast Cancer Detection using Machine Learning Way", International Journal of Recent Technology and Engineering (IJRTE), ISSN: 2277-3878, Volume-8, Issue-2S3, Page No: 1402 – 1405, July 2019.

[7] Sri Hari Nallamala, et.al, "Qualitative Metrics on Breast Cancer Diagnosis with Neuro Fuzzy Inference Systems", International Journal of Advanced Trends in Computer Science and Engineering, (IJATCSE), ISSN (ONLINE): 2278 – 3091, Vol. 8 No. 2, Page No: 259 – 264, March / April 2019.