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ALEX NET BASED DEEP LEARNING MODEL FOR AUTISM DISEASE PREDICTION

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Abstract: Autism Spectrum Disorder (ASD) is a complex neuro developmental condition characterized by challenges in social interaction, communication, and repetitive behaviours. Early detection and intervention are crucial for improving outcomes and quality of life for individuals with ASD. In recent years, deep learning techniques have shown promising results in various medical applications, including disease prediction. Here, we have proposed a deep learning-based approach utilizing Alex Net to focus on feature selection and extraction techniques for the effective detection of ASD using Magnetic Resonance Imaging (MRI)data. At first, the MRI datasets are taken from kaggle.com are preprocessed and segmented. Then, an Alex Net architecture is designed and trained to effectively capture intricate patterns and relationships within the data for accurate prediction of ASD. The proposed deep learning model demonstrates superior performance compared to traditional machine learning methods and baseline models in ASD prediction. Through extensive experimentation and evaluation, the model achieves high accuracy in identifying individuals at risk of ASD. Future research directions may focus on refining the model architecture, incorporating multimodal data sources, and deploying the system in clinical settings to validate its efficacy and real-world utility.

Index Terms - Alex Net, Autism Spectrum Disorder (ASD) , Deep Learning, , Magnetic Resonance Imaging (MRI)

• Introduction

Autism spectrum disorder (ASD) is a neuro developmental disorder that affects individuals across their lifespan. It is characterized by difficulties in social communication, repetitive behaviours, and restricted interests or activities. Although there is no known cure for autism, various treatments and therapies can help individuals with ASD manage their symptoms and improve their quality of life. Deep learning, a subset of machine learning, has emerged as a promising tool for autism prediction due to its ability to analyze large datasets and extract meaningful patterns from diverse sources of information. Deep learning models such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), and their variants have shown significant success in various healthcare applications, including medical image analysis, genomics, and clinical decision support. Feature extraction is a critical step in deep learning-based autism prediction, where the model automatically learns relevant features from the input data. For instance, CNNs can capture spatial patterns in neuroimaging data, while RNNs can model temporal dependencies in sequential behavioural data. Feature selection methods may also be employed to enhance model interpretability and generalization. The performance of deep learning models for autism prediction is evaluated using metrics such as accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC-ROC). Clinical validation studies are essential to assess the model's reliability, clinical utility, and potential impact on early diagnosis and intervention strategies for individuals with ASD. Overall, deep learning holds promise for advancing our understanding of ASD risk factors and improving personalized care for affected individuals.

II. LITERATURE REVIEW

Raj and Masood (2020) investigated the use of machine learning (ML) techniques for autism spectrum disorder (ASD) analysis and detection. Their study employed publicly available datasets on ASD screening for children, adolescents, and adults. They compared six ML algorithms, finding that Convolutional Neural Networks (CNN) achieved the highest accuracy in predicting ASD across all age groups. While these results are promising, the data used wasn't clinical in nature. The study suggests that CNN-based ML models have potential as an assisting tool in ASD screening, but further research with clinical data is necessary.

Omar et al. (2019) explored using machine learning to predict autism spectrum disorder (ASD) in their study "A Machine Learning Approach to Predict Autism Spectrum Disorder." They aimed to develop a model that works across age groups. The researchers tested their approach on two datasets: a self-reported questionnaire (AQ-10) and their own collection of 250 individuals with and without ASD traits. They used a combination of Random Forest algorithms and achieved promising results. Accuracy exceeded 90% with the AQ-10 data, and their own data yielded 88.51% accuracy with good detection rates for both ASD and non-ASD individuals. They even built a mobile app based on their model. However, limitations exist. The researchers' data collection was relatively small, and the AQ-10 questionnaire relies on self-reporting which can be subjective. While the results are encouraging, the model is envisioned as a screening tool, not a replacement for professional diagnosis. Omar et al. (2019) contributes to the research on machine learning for ASD prediction. Their combined Random Forest approach shows promise, but further studies with larger and more diverse datasets are necessary.

Erkan and Thanh (2019) investigated the potential of machine learning (ML) for detecting AS) in children, adolescents, and adults. They explored this by applying three common ML algorithms - Support Vector Machine (SVM), Random Forest (RF), and k-Nearest Neighbors (kNN) - to publicly available datasets for each age group. Their objective was to develop a fast and accessible method to aid early diagnosis.

Encouragingly, the study found that both SVM and RF achieved high accuracy in classifying ASD across all datasets. Notably, the Random Forest method achieved a perfect 100% accuracy for all age groups. However, it's important to consider that the results may be influenced by the specific datasets used. Erkan and Thanh (2019) suggest that machine learning, particularly Random Forests in this case, holds promise as a tool to support early diagnosis of ASD. However, further research is needed to validate these findings with larger and potentially clinical datasets.

Nogay and Adeli (2020) investigated the use of machine learning (ML) for diagnosing ASD through brain imaging in their study "Machine Learning (ML) for the diagnosis of Autism Spectrum Disorder (ASD) using brain imaging." Their focus was on utilizing brain scans to improve the diagnostic process. The study explored different ML algorithms applied to brain imaging data, potentially offering a more objective method for ASD diagnosis. While the specific algorithms used aren't mentioned in the summary paragraph, it highlights the potential of ML for analyzing brain scans and aiding in ASD detection.

Beary et al. (2020) explored a novel approach to diagnosing ASD in children using facial analysis and deep learning in their paper "Diagnosis of Autism in Children using Facial Analysis and Deep Learning." Their goal was to develop a method for ASD identification based solely on facial images. The researchers employed a deep learning model, specifically Mobile Net with additional layers, to analyze facial features in children's pictures. This model was trained on a dataset of over 3,000 images containing faces of children with and without ASD. The encouraging results showed the model achieved an accuracy of 94.6% in classifying children as potentially autistic or typically developing.

Mohanty, Parida, and Patra (2021) investigated the potential of deep neural networks (DNNs) for identifying ASD in their work "Identification of Autism Spectrum Disorder using Deep Neural Network." Their focus was on exploring DNNs as a tool to aid in ASD diagnosis. The specifics of the DNN architecture and the data used aren't available in a short paragraph review. However, the study highlights the application of deep learning for ASD analysis, potentially offering a more automated approach to the diagnostic process.

III. METHODOLOGY

The proposed system for predicting autism using deep learning can make a significant contribution to early detection, personalized interventions, and improved outcomes for individuals with autism spectrum disorder. The system architecture for the Autism Prediction Using Deep Learning approach is depicted in the figure.1.

In this, the prediction of autism disease is done using the following steps.

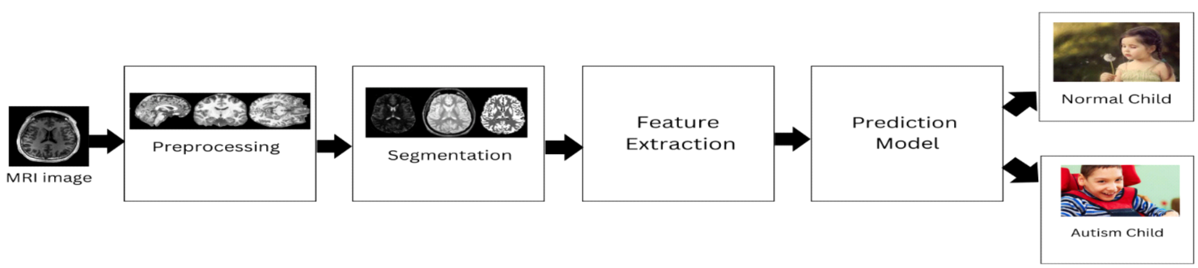


Figure 1 : System Architecture

3.1 DATA COLLECTION AND PREPROCESSING

The MRI dataset utilized for this approach was Collected from Kaggle.com and then the images in the dataset was preprocessed. Pre-processing is the step where the raw data is cleaned, normalized, and transformed into a format suitable for further analysis. In image processing, pre-processing steps may include resizing images to a standard size, converting color spaces, removing noise, and enhancing contrast.The preprocessed image is shownin figure2.

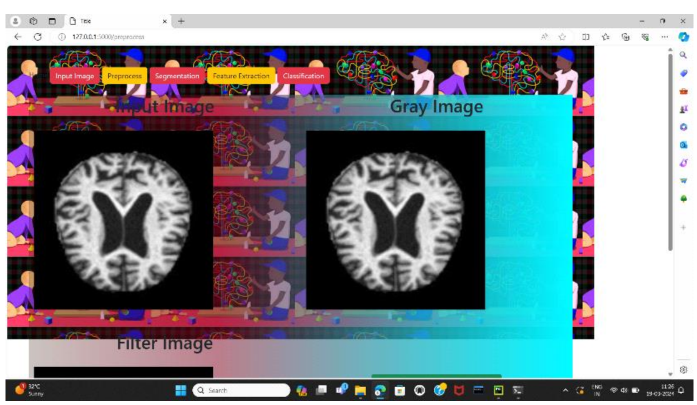


Figure 2:Preprocessing

3.2 DATA SEGMENTATION

After preprocessing, the dataset was splited into training and testing sets. The training set is used to train the model, while the testing set is reserved for evaluating its performance. Segmentation is the process of dividing an image into meaningful regions or segments based on certain criteria, such as color, intensity, texture, or boundaries. This step is crucial for tasks like object detection or image analysis, as it helps isolate the regions of interest from the background or other irrelevant parts of the image.the segmented image is shown in figure3.

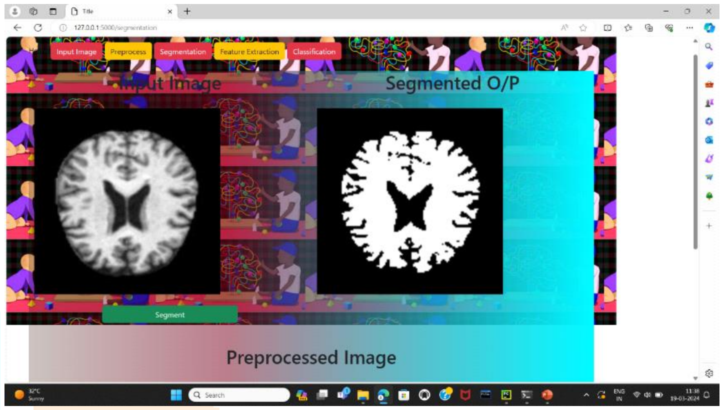


Figure 3:Data Segmentation

3.3 DATA SPLITTNG

Split the dataset into training, validation, and testing sets for model development and evaluation

- **MODEL CONSTRUCTION**

i)Initialize Alex Net model.

Alex Net is a deep learning architecture commonly used for image classification tasks.. It consists of convolutions, max pooling and dense layers as the basic building blocks. Grouped convolutions are used in order to fit the model across two GPUs.

- Moderate-Demented image total:64.
- Non-Demented image total:3200.

The AlexNet contains 8 layers with weights: 5 convolutional layers, 3 fully connected layers. It is depicted in figure

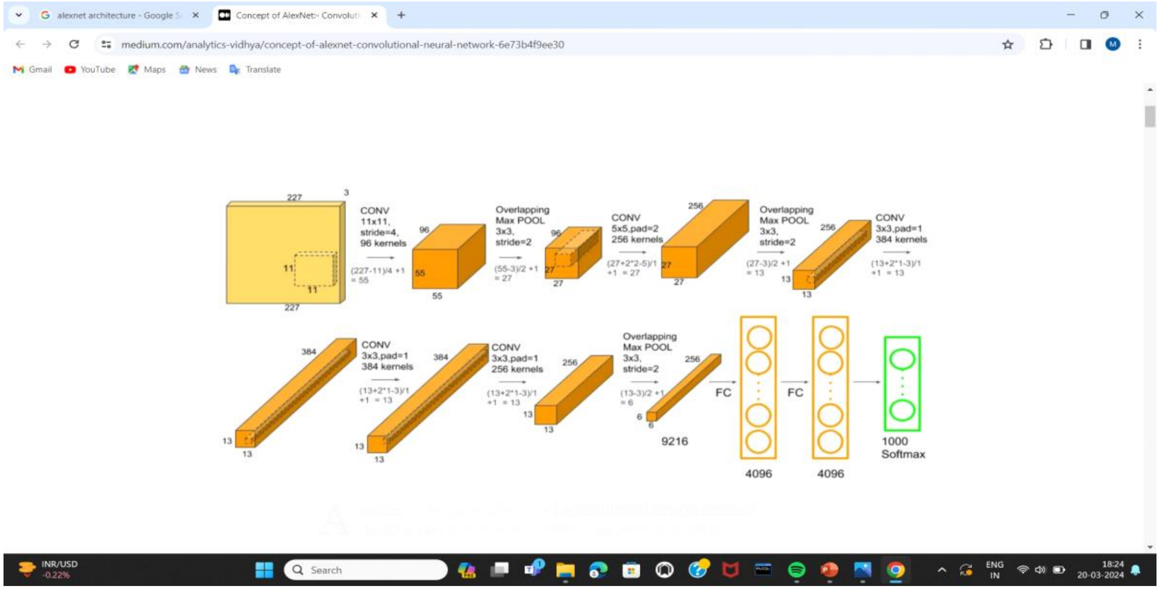


Figure 4: AlexNet Architecture

- **CONVOLUTIONAL LAYER:**

A convolutional layer is the main building block of a CNN. It contains a set of filters (or kernels), parameters of which are to be learned throughout the training. The size of the filters is usually smaller than the actual image.

- **RELU LAYER:**

It is applied to the output of a neuron to introduce non-linearity and enable the network to learn complex patterns and relationships in the data. ReLU function outputs the input value if it is positive, and if the input value is negative, it outputs zero.

- **POOLING LAYER:**

The Max pooling layer helps to reduce the spatial dimensions of the data while retaining important features. There are three max-pooling layers in the AlexNet, which have a filter of size 3×3 with a stride of 2.

- **FLATTERING LAYER:**

Flattening is used to convert all the resultant 2-Dimensional arrays from pooled feature maps into a single long continuous linear vector. The flattened matrix is fed as input to the fully connected layer to classify the image.

This involves specifying parameters such as the learning rate, maximum depth of trees, number of trees (boosting rounds), and other hyper parameters.Train the deep learning model using the training data, optimizing hyper parameters, and monitoring performance on the validation set to prevent overfitting

3.5 FEATURE EXTRACTION

GLCM (Gray-Level Co-occurrence Matrix) feature extraction is a technique used to extract texture information from images. It involves analyzing the spatial relationships between pixel intensities in an image to derive texture features such as contrast, homogeneity, energy, and correlation. These features can be valuable for tasks like texture classification or analysis.

3.6 PREDICTION

The trained model is then used to make predictions on new, unseen data. The success of the model depends on factors such as the quality of the data, appropriate hyper parameter tuning, and the relevance of features to the target variable.In this phase, the pre-processed and segmented images, along with their extracted features (such as GLCM features), are fed into the AlexNet model for classification. The model learns to classify the images into predefined categories or classes based on the features it has been trained on.

3.7 DEPLOYMENT AND USER INTERFACE:

A user-friendly interface was developed for the autism prediction system, allowing users to input relevant data for prediction. It ensures the system's scalability, security, and compliance with data privacy regulations (e.g., GDPR, HIPAA) when handling sensitive information.

IV.RESULTS AND DISSCUSSION

Studies exploring Convolutional Neural Networks (CNNs), a type of which AlexNet is, have shown promise in Autism Spectrum Disorder (ASD) prediction as mentioned in figure These studies report high accuracy, exceeding 95% for adults and 98% for children. This suggests CNNs could potentially offer faster, more objective screening for ASD.

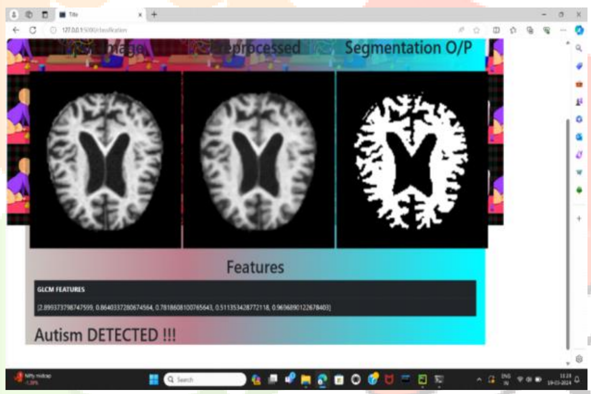
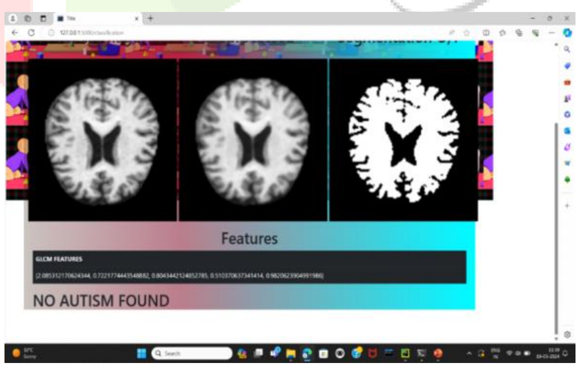


Figure 5: (a) Autism Detected Result



(b) No autism found result

However, there are limitations. The accuracy of CNNs can be heavily influenced by the training data, and they might not perform well on unseen data. Additionally, their inner workings are often opaque, making it difficult to understand how they arrive at predictions. Furthermore, ethical considerations regarding AI-based diagnosis and potential biases in the data need to be addressed before widespread clinical use.

Future research directions include using larger and more diverse datasets, particularly clinical data, to improve generalizability. Developing interpretable CNN models to understand their decision-making processes would also be valuable. Ultimately, the goal would be to integrate CNN models into existing diagnostic workflows to support, not replace, professional evaluation.

V.CONCLUSION

While the use of convolutional neural networks, similar to AlexNet, shows promise for early autism spectrum disorder (ASD) detection, further research is needed to solidify its role in clinical settings. These models demonstrate potential for improved screening accuracy by extracting features from datasets. However, challenges exist, such as model generalizability and the lack of interpretability in their decision-making processes. Future research with larger and more diverse datasets, especially clinical data, is essential. Additionally, efforts to make these models more interpretable and fostering collaboration with healthcare professionals are crucial for real-world application. This line of research has the potential to become a valuable tool for improving early detection, enabling personalized interventions, and ultimately, enhancing the quality of life for individuals with ASD.

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