IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

PREDICTION OF AUTISM IN CHILDREN USING MACHINE LEARNING

[1]Thanuja K V, [2]Varsha K S, [3]Shwetha P, [4]Keerthana P T, [5] Prof. (Dr.) Manjunatha R C

[1,2,3,4]Eighth semester, Department of Electronics and Communication Engineering, Global Academy of Technology,
[5]Associate Professor- Department of Electronics and Communication Engineering, Global Academy of Technology, Bangalore, India.

Abstract: Autism Spectrum Disorder is a disability that affects the development of people due to variations caused in the brain. The social interaction of people with ASD is difficult. It also affects how they communicate and behave. The symptoms of the disease usually show up in developmental stages that is within the first two years after birth. It is a neurological disorder and the severity of the disease of each individual is different. In this paper, we have discussed the early prediction of ASD using a Convolutional Neural Network for children. To make it user-friendly we developed a web page where the user can upload an image of the child and check for prediction of disease. Early prediction is beneficial and can help to improve child's health as they get older.

Index Terms **- Autism Spectrum Disorder, Convolutional Neural Network, Early prediction.**

I. INTRODUCTION

A neurological disorder that affects human brain development is Autism spectrum disorder(ASD). Engaging in social interaction, and communication with others is very difficult for the patients. Additionally, they also exhibit common communicative flaws such as delayed speech and language development, a refusal to gesture or react to pointing, and the repetition of phrases, with some of them speaking well and others speaking hardly or not at all. Although there are many different ASD behaviors and differences from child to child, most will exhibit several. A person is affected with autism spectrum disorder for their entire lifetime.

Learning deficits, anxiety, obsession, depression, and many more are the issues faced by patients with autism. Since the condition can't be fully recovered, early detection can mitigate the consequence for a while. Briefly, healthcare experts are still attempting to understand the cause as well. The possibility that both environmental and genetic variables might serve as this disease's underlying causes is intriguing. In children as young as two or three years old, the symptoms of this condition may appear and last a lifetime. ASD is influenced by various risk factors, such as low birth weight, having a sibling with the disorder, and growing older parents, etc. Assuming that human genes are responsible scientists have failed to identify the actual source of ASD. Human genes have an impact on development by altering the surroundings. Up until the age of 18 to 20 months, some ASD children seem to develop normally, but then they either stop gaining new skills or lose the ones they previously had. Some persons with ASD require a lot of assistance in their everyday lives, while others need less. People with the disorder may exhibit unique behaviors as a result of their problems interacting socially and verbally with others. Toddlers commonly display traits including avoiding eye contact, failing to respond to their names by the age of 12, and failing to show interest in others. In this study, the aim is to develop and implement a web page to detect early ASD in children with the help of the CNN algorithm in a small period of time using datasets to get accurate results. Fig.1 shows the learning of an autistic patient.

Fig.1 Image showing an Autistic patient

II. LITERATURE REVIEW

The paper “Diagnosis of Autism Spectrum Disorder Through Eye Movement Tracking Using Deep Learning” by Mumenin et al.[1] suggest an approach for detecting Autism Spectrum Disorder(ASD) using deep learning and eye movement tracking. The study involved collecting eye-tracking data from individuals with and without ASD, then it was used to train a deep-learning model to distinguish between the two groups. The results demonstrated that the suggested strategy was highly accurate in diagnosing ASD. However, there are some potential drawbacks to this study. One is that the sample size of the study may not have been large enough to be representative of the broader population. Additionally, the study did not address the potential biases that may exist in eye-tracking data collection and analysis. Finally, while the proposed method shows promise as a diagnostic tool, it may not be applicable in all cases and should not replace the clinical assessment and diagnosis of ASD by a qualified healthcare professional.

Hrishikesh [2]Narayanankutty et al. paper, "Prediction of Autism Spectrum Disorder using Deep Learning on Facial Images”, proposes using deep learning algorithms and facial images to diagnose ASD. The literature review provides an overview of existing studies related to ASD diagnosis using facial features and machine learning techniques. The authors highlight the potential of deep learning algorithms to improve ASD diagnosis, as facial images can provide valuable information. However, the authors note the challenges that remain, such as limited sample sizes and lack of diversity, which affect the accuracy and applicability of the models. They acknowledge that their study also faces these limitations.

The paper "Predicting Autism Spectrum Disorder from Facial Images using Convolutional Neural Networks" by [3]Wajiha Shireen et al. presents a technique for identifying individuals with autism spectrum disorder (ASD) based on their facial images. To accomplish this, the researchers collected a dataset of facial images from both ASD and non-ASD children and employed convolutional neural networks (CNNs) to extract facial features and classify them into either the ASD or non-ASD group. The proposed method achieved an accuracy rate of 84.62%. According to the paper, CNN-based approaches hold promise as an effective means of diagnosing ASD, and the presented method could potentially serve as a screening tool for the disorder in children. However, the study's authors acknowledge that their research has some limitations, including the small sample size and the need for additional validation using bigger and more varied datasets.

[4]Arghadeep Sarkar et al. paper presents a novel method for diagnosing ASD using machine learning algorithms and facial images. The study aims to address some of the challenges associated with traditional diagnostic methods, such as the lack of trained professionals and long wait times for diagnosis. The authors train their machine learning model on a dataset of facial images from individuals diagnosed with ASD and typically Developing individuals. However, the dataset sample size is relatively small, which might limit the generalizability of the findings. Moreover, the study does not account for demographic factors such as age, gender, and ethnicity, which may impact the accuracy of the model. Additionally, the study only uses facial images as the input modality, which may introduce potential biases and limitations in detecting ASD accurately. Nonetheless, the paper presents a promising approach for future research into automated ASD diagnosis, which could potentially lead to earlier diagnosis and improved outcomes for individuals with ASD.

III. METHODOLOGY

The dataset was divided into train, test, and validation set. The train set consists of 1,882 images (941 Autistic and 941 Non Autistic). The test data consists of 588 images (294 Autistic and 294 Non Autistic). The valid set consists of 235 Autistic and 229 Non Autistic.

The dataset which later undergoes training is prepared by normalizing the pixel values and resizing the photos to a uniform size of 224x224 pixels.80% of the data was in the training set and 20% in the validation set. To classify the images and predict the disease, for feature extraction and classification, we used the VGG19 model which is a convolutional neural network that is 19 layers deep. The last layer of the VGG19 pre-trained model is replaced with a new fully connected layer.

CNN algorithm is a popular algorithm for the classification of images used in various fields, especially in medical diagnosis.3 completely linked layers come after 16 convolutional layers in the VGG19 model architecture. The convolutional layer size is set to a 3x3 filter. Each convolutional layer is followed by a max pooling layer with a stride of 2 pixels and a 2x2 filter size. Each of the completely connected layers has 4096 neurons, and the classification of softmax layer comes after that. We have fine-tuned the model, modified the last layer, and added fully connected layers. The VGG19 pre-trained model is used as the base model, then the final layer is passed into an additional GlobalMaxPooling2D layer. The output of the GlobalMaxPooling2D layer is then passed to a fully linked dense layer with 512 hidden units and ReLU activation. To avoid overfitting, a dropout layer is inserted at a rate of 0.5. Afterward, it’s done by the classification layer with a final sigmoid layer. A dense layer with a softmax activation is added for the classification output, then the model is trained on the training set. We incorporated early stopping to prevent overfitting and saved the best model in h5 format. This model is used to predict disease using a web page designed using Spyder IDE.

IV. IMPLEMENTATION

The dataset has been taken from Kaggle which is publicly accessible and we also customized the dataset by adding several images of toddlers. The necessary libraries are included such as Tensor Flow, Keras, NumPy, Pandas, matplotlib, and sklearn. Google Drive is mounted to access the dataset. Then, prepare the data by normalizing the pixel values and resizing the photos to a uniform size of 224x224 pixels. Image labeling is done as 'Autistic' and 'Non Autistic' by assigning 1 and 0 respectively. The ratio of the training set to the validation set is 80:20.

Hyperparameters 'epoch' and 'batch size' is set to 23 and 64 respectively. The VGG19 pre-trained model is loaded with an input image and the top layer is set to 'False' means the last layer of fully connected to the original model is not included. The output layer is flattened to 1 dimension via GlobalMaxPooling and the output of the last layer of the pre-trained model is retrieved. Classification is achieved through 2 output unit softmax layers.
To build the model we used the stochastic gradient descent (SGD) optimizer with a learning rate of 0.001, and accuracy and loss are used as the assessment metrics. The summary of the model is printed to show the layers and parameters of the model.

The training dataset is augmented with random rotations, rescaling, shearing, zooming, and switching to increase the resilience of the model. Once the data augmentation is complete, the pandas data frame is created for training and validation sets. A total of 1523 images belonging to 2 classes were validated while preparing the training generator and 170 images belonging to 2 classes were validated while preparing the validation generator. The model is trained using the "fit" method and the "evaluate" method is used to evaluate the model. The trained model evaluates the test dataset to calculate the accuracy and loss. plt.plot() method is used to plot accuracy and loss graphs.

The trained model is saved in h5 file format using the "save" method of Keras. The h5 file is saved and then used in Spyder IDE for designing a web page. Spyder is an integrated development environment (IDE) for data analysis, scientific computing, and machine learning in Python.

Flask web application is used that allows users to upload an image file and make predictions using the developed VGG19 model for autism classification. The script uses the Flask web framework to create routes for the web application and also uses the Keras library to load the developed trained model for autism classification.

The script uses the model_predict() method and stores the image to a specified directory when a user uploads an image file using the web page. This allows the developed model to be used to make predictions. The model_predict() function scales the uploaded picture file to the model's input size (224x224) as a preprocessing step before running it through the trained model to provide predictions. The function returns the anticipated class label ('AUTISTIC' or 'NON AUTISTIC'), which is then shown on the web page.

V. RESULTS AND DISCUSSION

The accuracy of the model is 88.28%. The VGG19 model performance for the training and validation data for ASD prediction is shown in Fig.2, with the y-axis indicating the score percentage and the x-axis representing the number of epochs. Fig.2(a) shows a model accuracy plot where the validation accuracy exceeds the training accuracy. But after 20 epochs both the accuracy plot starts converging.

In the training process, the accuracy possible from 21 epochs is 77%. We have run 21 epochs and got this result[20]. In the training process, the accuracy of the VGG19 model rose from 56% to 85% after 25 epochs, and in the validation process, its accuracy was 82%[21]. Our model achieved better test accuracy of 88.28% and valid accuracy of 85.16% for 23 epochs. Fig.2(b) shows a Model loss plot where the training loss is more than the validation loss initially but reduces gradually.

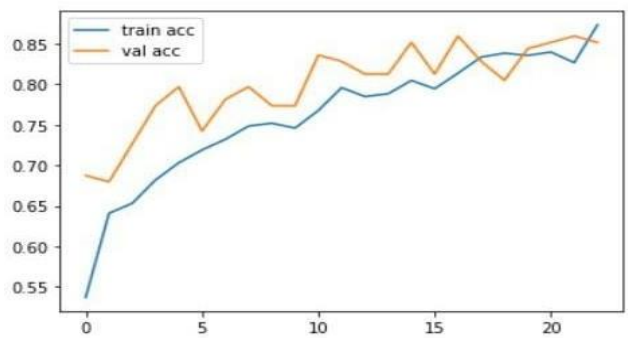

Fig.2(a) Model Accuracy Plot

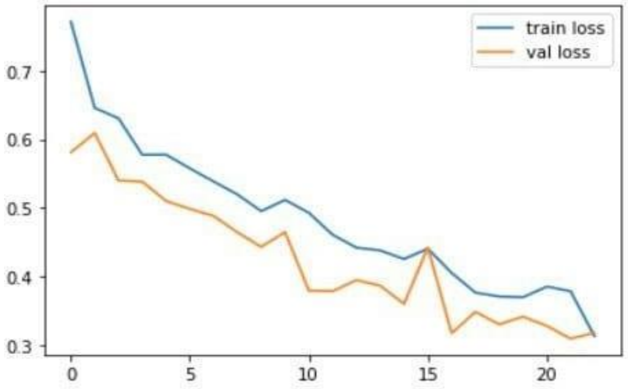

Fig.2(b) Model Loss Plot

Fig.2 Overall performance plot for the VGG19 model

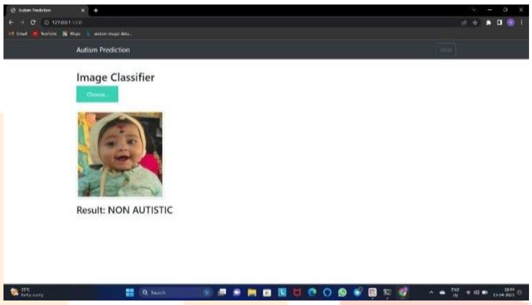

Fig.3 Web page predicting NON AUTISTIC child

Flask application is used for designing a web page. The user uploads an image, and after resizing, the model predicts the disease and displays the message on a web page. Fig.3 and Fig.4 shows the webpage showing 'NON AUTISTIC' and 'AUTISTIC' results. A web page makes it easy for anyone to use it at ease.

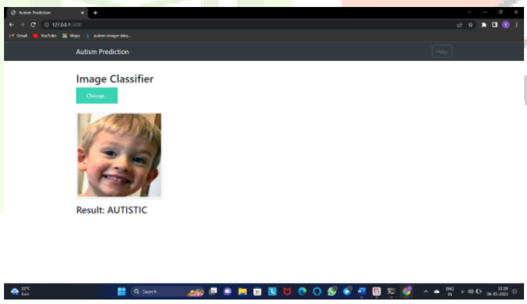

Fig.4 Web Page predicting AUTISTIC child

VI. CONCLUSION

This study develops a model that can identify and assess behaviors associated with Autism Spectrum Disorders in toddlers. Early detection of ASD can alleviate many difficulties faced by children such as communication, social skills, and learning disabilities. The study used CNN and performance evaluation metrics to analyze non-clinical datasets of children. In addition to improving the accuracy of autism screening, this framework will also accelerate the formal diagnosis process. Inexperienced clinicians may lack confidence in diagnosing autism cases, making computer assistance necessary for accurate results. We recommend further study on large varied datasets and improve the accuracy of the model.

ACKNOWLEDGEMENT

We would want to offer our heartfelt thanks to our college- Global Academy of Technology, Bangalore for allowing us to conduct this project, as well as our guide, Dr. Manjunatha RC.

REFERENCES

[1] Mumenin, Nasirul & Islam, Md & Chowdhury, Md. Reasad & Yousuf, Mohammad. (2023). "Diagnosis of Autism Spectrum Disorder Through Eye Movement Tracking Using Deep Learning". 10.1007/978-981-19-7528-8_20

[2] Narayanankutty H, Vijayalakshmi R, & Ranjith R. "Prediction of Autism Spectrum Disorder using Deep Learning on Facial Images". In Proceedings of the 2020 12th International Conference on Computer and Automation Engineering (ICCAE 2020) (pp. 170-174). IEEE. https://doi.org/10.1109/ICCAE48529.2020.9078626.

[3] Shireen W, Khan M, & Islam R. "Early diagnosis of autism spectrum disorder using facial features and machine learning techniques", Biomedical Signal Processing and Control(2021), 68,102656. https://doi.org/10.1016/j.bspc.2020.102656

[4] Arghadeep Sarkar, Akash Gupta, and Sanjoy Kumar Saha. "Automated Diagnosis of Autism Spectrum Disorder using Machine Learning and Facial Image". Journal of Medical Systems(2022), 46(1), 6.

[5] Anagnostopoulos C, Giannouzakos S, Spiliopoulos V,& Nikolopoulos. "Early diagnosis of autism spectrum disorder using deep learning and facial expression recognition technologies". Journal of Medical Systems(2020), 44(6), 107.

[6] Das R, Ghosh S, & Chatterjee A. "Early Diagnosis of Autism Spectrum Disorder using Facial Images and Deep Learning". Journal of Ambient Intelligence and Humanized Computing(2021), 12(10), 10209-10221.

[7] Li Y, Li Z, Li B, Wang Y, Li J, Li M, & Zhang B. "Prediction of autism spectrum disorder based on facial features using deep learning",Journal of Biomedical Informatics(2022), 124, 103868.

[8] Liu Y, Yang J, Zhang S, & Wang L. "Prediction of Autism Spectrum Disorder Using Facial Features"(2022): A Meta-Analysis. Frontiers in Psychiatry, 13, 815651.

[9] Khosla A, Tran T, & Wen J. "Autism Spectrum Disorder Detection through Facial Key Point Analysis". Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops(2019), 23-32.

[10] Khorrami S, Farsiu S, Jafari-Khouzani K, & Elmore L. "Autism spectrum disorder diagnosis using facial keypoint detection and deep neural networks". Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops(2019).

[11] Tan C, Sun F, Kong T, Zhang W, Yang C, & Liu C. Deep learning for automatic detection of autism spectrum disorder using facial expression and head movement. Scientific reports(2018), 8(1), 1-14.

[12] P Murugappan, R K Rajesh, and S Yaacob, "Automatic detection of autism using facial cues," International Conference on Computer Applications and Industrial Electronics (ICCAIE), 2011, pp. 432-435.

[13] N A Maleki, H A Moghaddam, and A R Ahmadi, "Autism detection using facial features," in IEEE International Conference on Computer and Information Technology (CIT), 2013, pp. 100-105.

[14] S Zhang, Y Lian, and X Zhang, "Facial feature extraction and selection for autism classification," in IEEE International Conference on Systems, Man, and Cybernetics (SMC), 2014, pp. 446-451.

[15] M Jaiswal, A Valstar, and I Mehta, "Facial feature analysis for autism spectrum disorder diagnosis," in IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2015, pp. 2741- 2745.

[16] M Jaiswal, A Valstar, and I Mehta, "Prediction of Autism Spectrum Disorder severity using facial features," in IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2016, pp. 2315-2319.

[17] R Kalra, S K Jindal, and S K Sood, "Autism diagnosis based on facial features using SVM classifier," in IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), 2017, pp. 1-6.

[18] T A Salam, A Ahmad, and M A Khan, "Autism spectrum disorder detection using facial attributes and deep learning," in International Conference on Computing, Mathematics and Engineering Technologies (iCoMET), 2018, pp. 1-5

[19] B M Al-akrash, R N Almutairi, and M M Almutairi, "Autism diagnosis using deep learning algorithms and facial emotion recognition," in IEEE4th Middle East Conference on Biomedical Engineering (MECBME), 2018, pp. 15-18.

[20] Md Tahmid Zoayed , Sayma Haque Arshe and Plabon Banik, " Autism Detecting Model using Image", 2022.

[21] Fawaz Waselallah Alsaade and Mohammed Saeed Alzahrani, "Classification and Detection of Autism Spectrum Disorder Based on Deep Learning Algorithm," Hindawi Computational Intelligence and Neuroscience Volume 2022, Article ID 8709145, 10 pages https://doi.org/10.1155/2022/8709145

[22] Dataset- https://www.kaggle.com/datasets/cihan063/autism-image-data