Available online @ https://jjem.jnnce.ac.in
https: www.doi.org/10.37314/JJEM.SP0202
Indexed in International Scientific Indiexing (ISI)
Impact factor: 1.395 for 2021-22
Published on: 08 December 2024

Autism Spectrum Disorder Detection Using Facial Recognition With Machine Learning

Bhumika U P[1*], Dr Raghavendra S P[2]

Student[1], Assistant Professor[2], Department of Master of Computer

ApplicationsJNN College of Engineering, Shivamogga

upbhumika@gmail.com , raghusp@jnnce.ac.in

Abstract

A neurodevelopmental disorder that is as crucial as behavioral, social, and communication anxiety is autism spectrum disorder or ASD. This is especially true in the case of people with autism since getting a diagnosis early is vital in enhancing outcomes for the individual. This paper discusses a new machine and deep learning technique with facial image recognition for screening ASD in children. The process will include evaluation of the facial features and training a classifier to estimate the chances of ASD using ResNet50 of CNN models. It was noted that positive results can be achieved once the proposed approach had been applied and tested on the datasets that are accessible to the public. This unpretentious and relatively cheap approach may serve as an avenue for an early stage of ASD prediction, and conversely, improve first level preventions significantly.

Keyword: *Autism Spectrum Disorder (ASD), Machine learning, ResNet50, Convolutional Neural Networks(CNN).*

1. Introduction

Autism spectrum disorder is a neurological condition that pertains to issues regarding behavior, interaction, and communication. Some of the diagnostic aspects include repetitive movements or a stereotyped approach to activities, preoccupations with matters that are narrow and specific, and social difficulties. Indeed, the treatment for the ASD impacts very much on the life span of the afflicted individuals, and is effective if diagnosed at an early age. The human brain is one of the most complicated and mostly directed organs caused by a tremendous amount of connections and genetic variations; therefore, it provides alternative challenges and opportunities in identifying and diagnosing ASD. Synapse connections, which do not provide the network scale, enhance the brain's performance. Therefore, it will promote early treatment and appropriate interventions to enhance the quality of life of the patients suffering from the disorder as well as their families. Thus, when it comes to personal and interpersonal interaction, facial structure and movements prove to be relatively crucial characteristics. From facial photos, recent studies show that the disorder could be identified by employing machine learning methodologies as ASD. The applied deep learning models proved to be successful in identifying autistic features from facial photographs, this includes particularly Convolutional Neural Networks. This proposed method identifies large scale and diverse facial image databases, as well as high computation capabilities to work on them as available for successful development and training of these models. The present paper enshrines a study undertaken with a purpose of designing a machine learning system for screening of ASD employing facial images. They can hence evaluate the effectiveness of varied deep learning models and machine learning algorithms in the prognosis of ASD enabling it to look at the facial photos of individuals with ASD as well as those who do not have ASD. A technique that has been proposed is the prediction of ASD relying on face images and the analysis using ResNet50 deep learning approach. Experimentations have made ResNet50 efficient in different diverse tasks on image classification and the training of deeper neural networks than the methods developed prior to it. This model will then get high accuracy scores when evaluated on a number of public datasets of face photos belonging to ASD and non-ASD individuals for ASD prediction. The study enriches the rapidly developing pool of the approach for predicting ASD based on machine learning and offers an effective and realistic method to diagnose the illness as soon as it starts. More importantly doing so will improve the treatment of the patients, if an early diagnosis means that some actions can be taken.

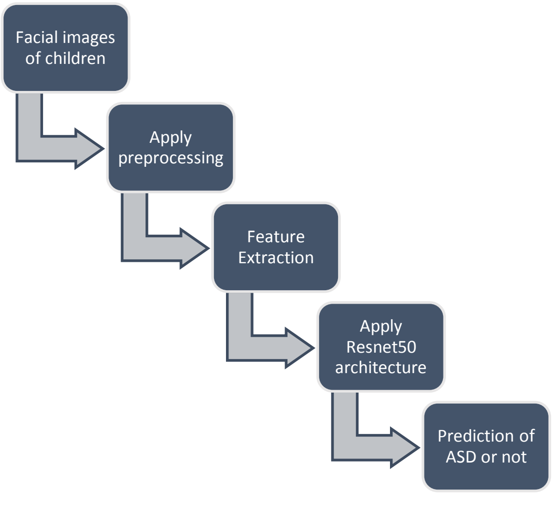

Fig. 1 Methodology Framework

2. Literature Survey

In related work, a review of multiple methods and processes has been conducted. Grossard et al (2018) [1] presented JEMImE is a multimodal emotional imitation game propose in order to help struggling children from ASD in recognizing emotions such as sadness, anger and happiness through a 3D virtual environment. Among the various visual and motivational elements of the game, it promoted kids to read facial expressions and emotions from people. Guha et al (2015) [2] applied some machine learning classifiers to form detector in an investigation of adult autistics of aping a sort. The aim is to investigate the cause of this problem and the different kinematic characteristics under the similar test conditions. The sample consists of 16 individuals who attend an ASC with a full repertoire of hand movements. Ibala et al (2000) [3] applied group approaches and transfer learning on divided facial photos of people which shows presence or absence of ASD, falling into seven main emotional categories: sadness, anger, neutrality, fear, surprise, disgust, and happiness. While using ensemble approaches, the best accuracy attained was 67.2%, with transfer learning attaining 78.3%. Li.et.al (2017) [7] implemented ensemble techniques and transfer learning to classify face photographs of people with or without ASD based on seven basic human emotions: sadness, anger, neutrality, fear, surprise, disgust, and happiness. With transfer learning, the maximum accuracy reached 78.3%, while with ensemble techniques it was 67.2% at the result. Mythili et.al (2014)[8] have used grouping of ASD with an objective of identifying and quantifying symptoms of autism. They have made use of fuzzy logic and support vector machines for the checking and tracking children regarding their social behavior and interactions, along with WEKA a data mining tool. Niu et al (2020)

[9] Developed and tested a prototype deep learning framework for ASD classification with the lowest error rate of 73. 2% from an algorithm. This system enables for the recognition of ASD without requiring a health care provider's input. The only way to improve a prototype that was

analogue to the straightforward algorithm, used in machine learning, was to link functional outcomes throughout each layer of the brain with a unique character of a people. These results suggest that effective creation of deep learning models has potential. Thus, the objective of this work can be stated as follows, in the future, it will be possible to create an automated clinical test for ASD using techniques of deep learning. Pramerdorfer et al (2016) [10] evaluated the performance of various CNN models in the detection task. These fundamental architectures of the CNNs greatly enhanced the detection performance of the software for the detection task, in comparison to their rival models. However, recently, a deep CNN ensemble developed attained an accuracy of 75.2%, way higher compared with previously developed models. Moreover, this model saves a time since additional data for face registration and training are not required. Srivastaw et al (202)proposed literature adopted the data-centric approach for ASD diagnosis using facial features, recent research reported an increment of 3% in prediction accuracy using augmented eye- tracking data. Hence, the team wish to create this dataset via pre-processing and augmentation so that this will enable an independent test of the likelihood of improvement in performance matrices. They organized that artificial enhanced image based on X-ray increased the correctness of COVID-19 pneumonia by 3. 2%. Thabtah et al(2017)[12] included algorithms for machine learning within the ASD screening model as proposed by the authors of this work in which they identified several benefits and risks related to various ways to classifying the ASD. The givenDSM-IV handbook was used instead of the DSM-5 text, discussing the errors related to the testing procedure for the detection of autism spectrum disorders. Yolcu et al (2019)[15] identified facial characteristics that were strongly connected with ASD. In identifying the right facial expressions, they used another model of CNN which had the highest rate of prediction at 94.44%. In order to further development, the study team improved the model to teach it to identify face characteristics in children with neurological disorder lips, eyes, eyebrow. It gave differential diagnosis a more approachable standing by an inclusion of the models during the creation of the iconized images.

3. Proposed System

The collected dataset can either be applied for consolidation form or in training, validation, and testing forms. In consolidation form, there exists a random split from the data loader thatshould be done before feeding into the CNN. However, the consolidation form comprises two subdirectories of autistic and non-autistic. The other form also has the same case which comprised of two subdirectories for testing, validation, and training one for autistic people and the other one for non-autistic people. Image analysis could be applied to classify individuals on the autistic spectrum through setting up unique visual features. Thus, since facial expressions convey emotions and social interactions, they are important in this context. Because persons with autism demonstrate a typical eye contact, eye-gaze patterns are suitable in which the person body language helps explain strange behaviors that sometimes

characterize individuals with autism through gestures andpostural cues. This means being contextually aware of the individual interacting with a view to social and environmental settings.

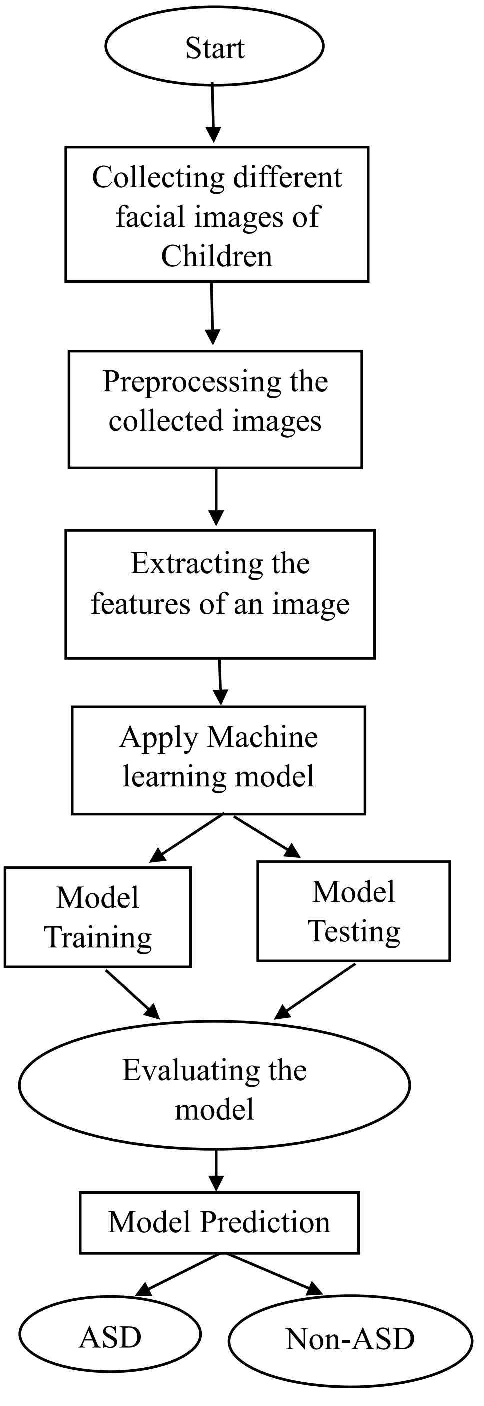

Fig. 2 The Proposed Methodology

Features therefore would consist of repeated behaviors, which are universally characteristics of autism, and dynamics in social interaction. These features are extractable and assessable from pictures which they are used by the learning methods like, machine learning and deep learning for opening a complex spectrumof autism.

ResNet means Residual Network in which state-of-the-art CNN that reduces the difficulty of vanishing gradients in training of extraordinarily deep networks, using residual blocks. Rather than making layers learn the fundamental mapping, the basic idea of ResNet50 is to adjust the network to that of the residual mapping. It lets the network to that of the residual mapping. It lets the network attempt to match residual models based on the input data instead of the original input data itself which is even more interesting is that at each multilayer residual block of Resnet, the output is fed together with the input before it is given.

$$X_{out} = F_{(Xin)} + X_{in} \text{ ....(1)}$$

In terms of a residual block, this would mean that X_{in} is the input $_{(Xin)}$ is the transformation layers inside a residual block apply on the input, and X_{out} denotes an output, where it gives the total of an original input and a transformed input.

This method utilizes precision, recall, accuracy, and error rate as the measures that should be optimized. The following method's evaluation metrics are the classifier accuracy which is described as the ratio of the count of positive samples to the total count of samples that are positive.

$$Accuracy = \frac{TP+TN}{TP+FP+TN+FN} \text{.........(2)}$$

Where, the images have been identified as Truly positive images (TP) are those that have successfully identified as has been regulated with fake negative images (FN) are the ones in which they incorrectly identified as such images that were mistakenly labeled as false positives (FP) but correctly identified as true negatives (TN). When an altered image or a real image is mistakenly identified as authentic, it's called misclassification. This model achieves a testing accuracy of 0.975

and a training accuracy of 0.998 using flip, noise, and all.

The incorrect predictions with respect to the suggested method are the error, where it is used to know about the wrong predictions as a result.

$$Error = \frac{TP+FN}{TP+FP+TN+FN} \text{...........}(3)$$

The proportion of relevant cases amongst the retrieved instances is known as precision or positive predictive value. It assesses the model's efficiency with regards to the effectiveness on all the classes that are involved. It is useful if each class should possess the similar weight with an effect size 0. 987. The percentage composed of the exact outcomes from the entire total estimates has been computed.

$$Precision = \frac{TP}{TP+FP} * 100 \text{............}(4)$$

Recall or sensitivity represents the proportion of relevant events which can be identified. Looking at the performance measurement of a model, among the critical features where the amount of class input samples recommended by the model, which offers 0.975 during the testingand training phase.

$$Recall = \frac{TP}{TP+FN} * 100 \text{...........}(5)$$

While testing the model, the F1 score combinesboth recall and precision variables. It ranges between 1, the highest value, and 0, the lowest. If it is maximum, it will then be an ideal model. In this it gives about 0.998 value.

$$F1 = 2 * \frac{Precision*Recall}{Precision+Recall} * 100 \text{......}(6)$$

4. Results And Discussion

Several tests were then held on the proposed model with regard to autism spectrum disorder diagnosis. For this, the dataset had a testing share of 10%, while training and validation shared the remaining 90%. Each model was trained and then evaluated to measure its execution in detecting ASD. To extract the data from the facial images, a pre-trained convolutional neural network known as ResNet50 was used. These features were shifted into the next layer of their built neural network to sort the images into two categories as either ASD or non-ASD. The performance metrics that turned up highly in the detailed findings from the ResNet50 model proved its efficacy in finding important parts for this particular application. The model was constructed and evaluated from the support of an openly available data set, after which it obtained a rating of 97 % accuracy.Accordingly, the proposed approach can provide a discrete, inexpensive way to detect ASD in its early years.

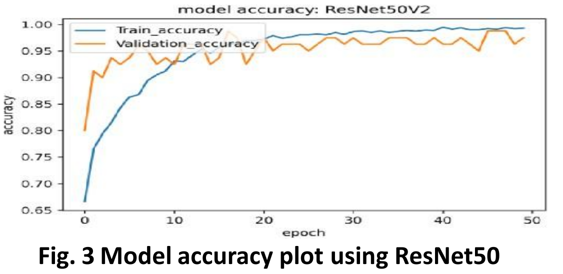

Fig. 3 Model accuracy plot using ResNet50

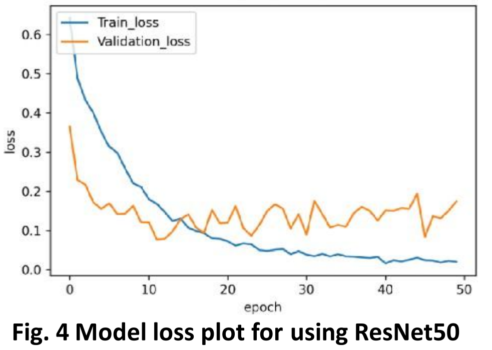

Fig. 4 Model loss plot for using ResNet50

5. Conclusion

ASD is a neurodevelopmental disorder affecting social, communicative, and behavioralexpertise. Early diagnosis can very significantly improve prognosis and development in a kid where, the algorithms like deep learning are recently being used for the detection of face picture data where the goal is to identify ASD.With a 97% accuracy rate, Residual Network 50, or ResNet50, is a part of the deep learning method where it is widely used to image analysis applications. This described system is an autism detection system developed with facial image processing and ResNet 50. By using several methods of deep learning for evaluating the model's performance based on application and adding further data to develop the model's accuracy, the suggested approach can be improved further. More relevant data, such as speech or audio analysis, can also be included to enhance the model and its ASD prediction capability. In a proposed autism prediction using a ResNet50- based approach can quickly diagnose ASD and hence facilitate early intervention with therapy to improve the value of life of the child.

References

1. Grossard et.al. International Conference on Automatic Face & Gesture Recognition. IEEE,Piscataway, NJ (2018).

2. Guha.et.al. International Conference on Acoustics, Speech and Signal Processing (ICASSP), IEEE, Piscataway, NJ (2015).

3. Ibala.et.al. Encephalopathy after pertussis immunization. Arch, Pediatr (2000).

4. J. A. Kosmicki et.al., Searching for a minimal set of behaviors for autism detection through feature selection-based machine learning. Transational Psychiatry(2015).

5. Karunakaran P et.al., Early prediction of autism spectrum disorder by computational approaches to fMRI analysis with early learning technique. Journal of Artificial Intelligence (2020).

6. Ke Fengkai et .al., Exploring the structural and strategic bases of autism spectrum disorders with deep learning. IEEE Access(2020).

7. Li.et.al. Applying machine learning to identify autistic adults using imitation: an exploratory study. PLoS One, (2017).

8. Mythili.et.al. A study on Autism spectrum disorders using classification techniques. International Journal of Soft Computing and Engineering (IJSCE) (2014).

9. Niu.et.al. Multichannel deep attention neural networks for the classification of autism spectrum disorder using neuroimaging and personal characteristic data complexity, (2020).

10. Pramerdorfer.et.al. Facial expression recognition using convolutional neural networks, state of the art. (2016).

11. Srivatsav.et.al. classification for pneumonia detection using transfer learning with gan based synthetic image augmentation in11th International Conference on Cloud Computing, Data Science & Engineering (Confluence), Noida, India (2021).

12. Thabtah.et.al. Autism spectrum disorder screening: machine learning adaptation and DSM-5 fulfillment in 1st International Conference on Medical and Health Informatics,New York (2017).

13. Tyagi et.al. Machine Learning Techniques to Predict Autism Spectrum Disorder. IEE Pune(2018).

14. Vaishali R. et.al., A machine learning based approach to classify Autism with optimum behavior sets. International Journal ofEngineering & Technology (2018).

15. Yolcu.et.al. Facial expression recognition for monitoring neurological disorders based on convolutional neural network. Multimedia Tools Application(2019).