Analysis of Autism Spectrum Disorder Based on Facial and Speech Characteristics Using Artificial Intelligence

A. Lakshmi Prasanna , D. Mounika, M. Tejaswi, B. Lakshmi Praveena, B.Tech Student, B.Tech Student, B.Tech Student , B.Tech Student, Assistant Professor VVIT, Nambur,AP, VVIT, Nambur,AP, VVIT, Nambur,AP, VVIT, Nambur,AP

Abstract:

The main objective of this paper is about detecting whether the person is suffering from ASD or not. The scope of paper is to analyze the Autism Spectrum Disorder (ASD) based on facial and speech characteristics using Artificial Intelligence. ASD is a developmental disorder that affects communication and behavior. It can be detected in two ways. First one is taking facial images from the user. We compare the images of a normal person and patient. If both are same he is free from ASD. Second one is speech detection. Several studies have identified vocal differences in children diagnosed with ASD as compared to neuron typical children. For this purpose Artificial Intelligence algorithms are used for better detection accuracy and to get accurate results.

Keywords: Autism Spectrum Disorder, Neural Networks, Artificial Intelligence

I. INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental disorder. In general, neuro developmental disorders symptoms are hyperactivity, deficiency in social communication, deficiency in learning and language. America's children and the environment (ACE) published an article on neuro developmental disorders and also detailed review of ASD and other disorders [1]. ASD can also be caused by genetic, chemicals used in different food items or environmental factors. ASD affected children's ratio is increasing day by day with ratio of 1:68.

ASD can be detected for a person by diagnosis, based on the children and the level of ASD it may require 2 or 3 days. Diagnosis process is manual process conducted by multiple streams of doctors by observing the behaviour of a child. Actually, ASD is detected at the age of 3 years or above 3 years [2] with manual diagnosis. Analysis performed over these accurate results which will be useful to make right decisions in predicting autism spectrum disorder (ASD) at early stages. Thus, early autism intervention using machine learning techniques opens up a new way for autistic individuals to develop the potential to lead a better life by improving their behavioural and emotional skills.

II. AUTISM SPECTRUM DISORDER (ASD)

ASD can be known as psychological and neurological disorder. ASD is caused by unequal development of some regions of brain. Autism spectrums disorders (ASD) are typically are diagnosed by manual process. Even the symptoms dissent for different ASD persons and individuals [3]. The general similarities between ASD individuals are difficulties in social interaction , communication and restricted unimaginative behaviors.

III. ANN (Artificial Neural Networks)

Artificial Neural Network (ANN) is an information processing paradigm that is inspired the brain. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning largely involves adjustments to the synaptic connections that exist between the neurons.

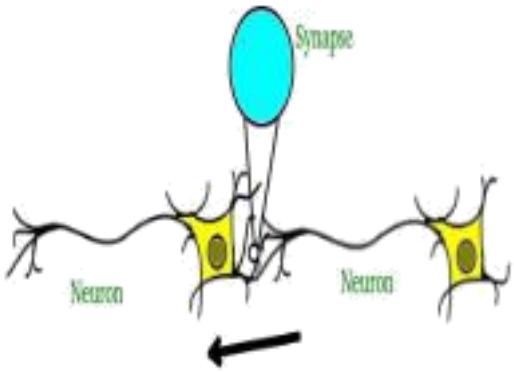

Fig.1. Neuron structure in brain

The brain consists of hundreds of billion of cells called neurons. These neurons are connected together by synapses which are nothing but the connections across which a neuron can send an impulse to another neuron. When a neuron sends an excitatory signal to another neuron, then this signal will be added to all of the other inputs of that neuron. If it exceeds a given threshold then it will cause the target neuron to fire an action signal forward — this is how the thinking process works internally. In Computer Science, we model this process by creating "networks" on a computer using matrices. These networks can be understood as abstraction of neurons without all the biological complexities taken into account. To keep things simple, we will just model a simple NN, with two layers capable of solving linear classification problem.

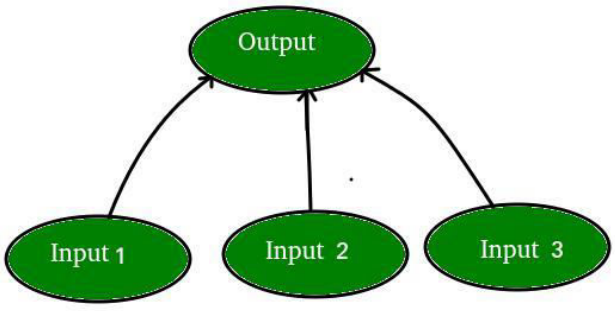

Fig 2 Simple structure of Neural networks

IV. CNN (Convolutional Neuron Networks)

A convolutional neuronal network (with the acronyms CNNs or ConvNets) is a concrete case of Deep Learning neural networks, which were already used at the end of the 90s but which in recent years have become enormously popular when achieving very impressive results in the recognition of image, deeply impacting the area of computer vision. The convolutional neural networks are very similar to the neural networks of the previous posts in the series: they are formed by neurons that have parameters in the form of weights and biases that can be learned. But a differential feature of the CNN is that they make the explicit assumption that the entries are images, which allows us to encode certain properties in the architecture to recognize specific elements in the images. To get an intuitive idea of how these neural networks work, let's think about how we recognize things. For example, if we see a face, we recognize it because it has ears, eyes, a nose, hair, etc. Then, to decide if something is a face, we do it as if we had some mental boxes of verification of the characteristics that we are marking. Sometimes a face may not have an ear because it is covered by hair, but we also classify it with a certain probability as face because we see the eyes, nose and mouth. Actually, we can see it as a classifier equivalent to the one presented in the post "Basics concepts of neural networks". which predicts a probability that the input image is a face or no face. But in reality, we must first know what an ear or a nose is like to know if they are in an image; that is, we must previously identify lines, edges, textures or shapes that are similar to those containing the ears or noses we have seen before. And this is what the layers of a convolutional neuronal network are entrusted to do. But identifying these elements is not enough to be able to say that something is a face. We also must be able to identify how the parts of a face meet each other, relative sizes, etc.; otherwise, the face would not resemble what we are used to. Visually, an intuitive idea of what layers learn is often presented with this example from an article by Andrew Ng's group.

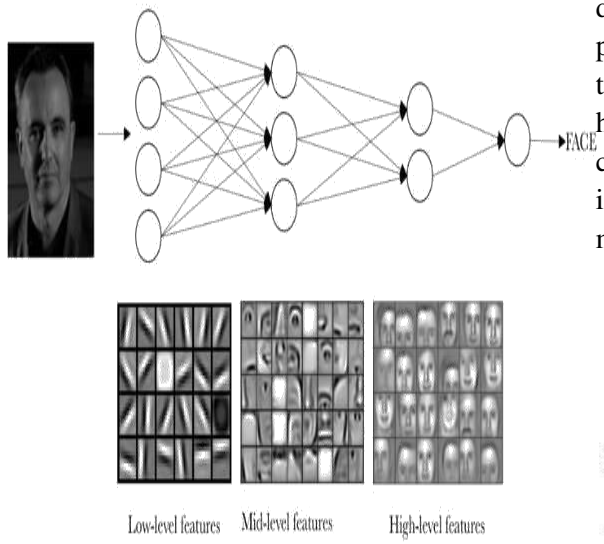

Fig. 3. Facial characteristics Detection Process

The idea that we want to give with this visual example is that, in reality, in a convolutional neural network each layer is learning different levels of abstraction. The reader can imagine that, with networks with many layers, it is possible to identify more complex structures in the input data.

V. Speech Characteristics Analysis

This study aimed to analyze prosodic elements of speech segments of students with Autism Spectrum Disorders (ASD) and compare with the control group, using an acoustic analysis. Speech recordings were performed with a sample of individuals with ASD (n = 19) and with typical development (n = 19) of the male gender, age range: 8-33 years. The prosody questionnaire ALIB (Brazilian Linguistic Atlas) was used as script, which contains interrogative, affirmative and imperative sentences. Data were analyzed using the PRAAT software and forwarded to statistical analysis in order to verify possible significant differences between the two groups studied in each prosodic parameter evaluated (fundamental frequency, intensity and duration) and its respective variables. There were significant differences for the variables tessitura, melodic amplitude of tonic vowel, melodic amplitude of pretonic vowel, maximum intensity, minimum intensity, tonic vowel duration, pretonic vowel duration and phrase duration. Individuals with ASD present significant differences in prosody compared to those with typical development. It is noteworthy, however, the necessity of additional studies on the characterization of prosodic aspects of speech of individuals with ASD with a larger sample and a more restricted age group.

VI. RESULTS

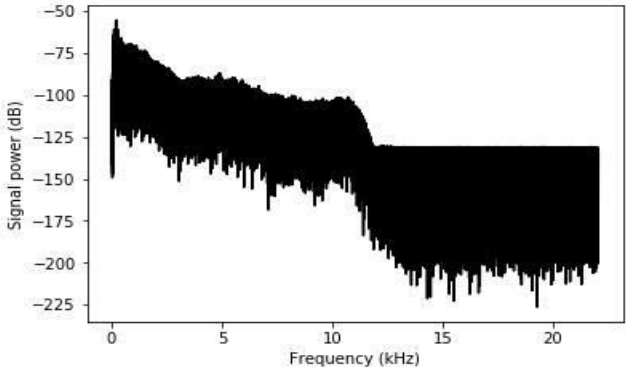

Fig. 4. ASD Speech analysis

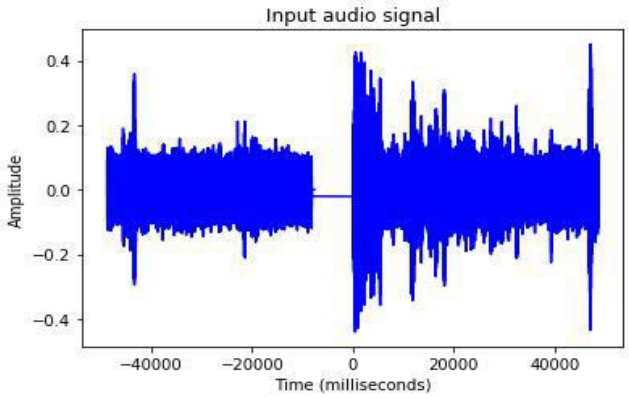

Fig . 5. Non ASD Speech Analysis

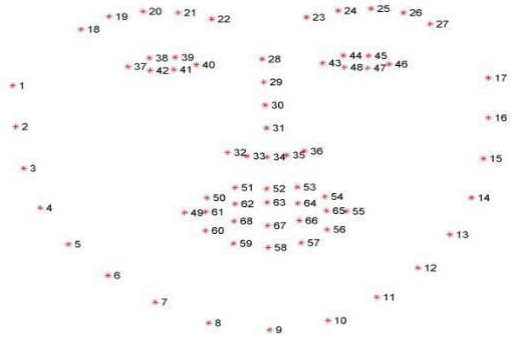

Fig .6. Facial Analysis – Face Land Marks

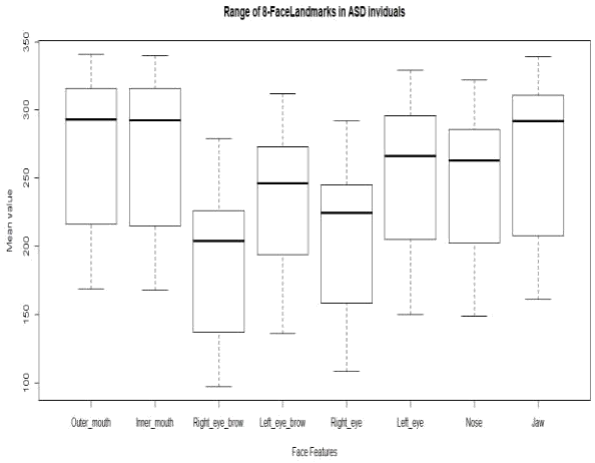

Fig. 7. Facial Feature Analysis in ASD

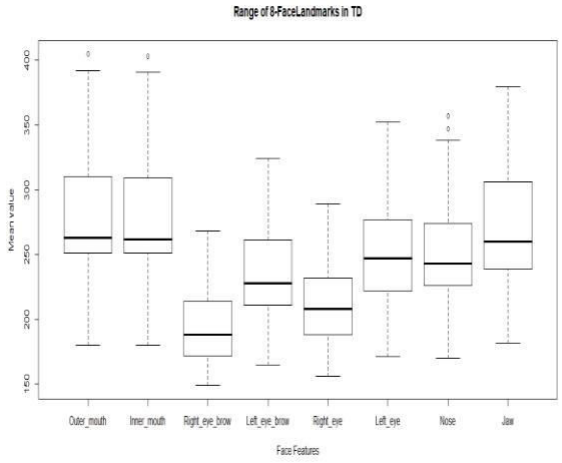

Fig. 8. Facial Feature Analysis in Non ASD

Figure 7 and 8 shows the range of values of 8 features landmarks calculated values for ASD and TD. The median value is high in ASD than in TD for 8 features.

VII. CONCLUSION AND FUTURE WORK

ASD is a neurodevelopmental disorder and is a lifelong disorder. The prediction process of ASD is a long process. For better treatment and improvement in behaviour, detection process must be fast, efficient and accurate. Machine learning is one of the emerging methodology which takes less time to predict new results. This paper presents comparative analysis of supervised learning algorithms which helps in predicting ASD and selection of supervised learning algorithm. This work can extended to work with different types of ASD data like MRI scan data, EEG data and gene sequences data.

References

[1] A. M. Daniels, R. E. Rosenberg, J. K. Law, C. Lord, W. E. Kaufmann,and P. A. Law, "Stability of initial autism spectrum disorder diagnoses in community settings," *Journal of Autism and Developmental Disorders*, vol. 41, no. 1, pp. 110–121, 2011.

[2] Tracy A Becerra, PhD, OTR/L, Maria L Massillon, PhD; Vincent M You, PhD, Ashley A Owen-Smith, PhD, Frances L Lynch, PhD, Phillip M Crawford, MS, Kathryn A Pearson; Magdalena E Pomichowski, MPH; Virginia P Quinn, PhD; Cathleen K Yoshida, MA, Lisa A Crone, PhD, *A Survey of Parents with Children on the Autism Spectrum: Experience with Services and Treatments*, https://doi.org/10.7812/TPP/16-009

[3] Caroline P. Whyatt† and Elizabeth B. Torres*, *Autism Research: An Objective Quantitative Review of Progress and Focus Between 1994 and 2015* , doi: 10.3389/fpsyg.2018.01526.