Prediction of Autism Spectrum Disorder Using Deep Learning Techniques

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Abstract- *Autism spectrum disorder includes conditions that were previously considered separate autism, Asperger's syndrome, childhood disintegrative disorder and an unspecified form of pervasive developmental disorder. Some people still use the term "Asperger's syndrome," which is generally thought to be at the mild end of autism spectrum disorder. Autism spectrum disorder begins in early childhood and eventually causes problems functioning in society socially, in school and at work, for example. Often children show symptoms of autism within the first year. A small number of children appear to develop normally in the first year, and then go through a period of regression between 18 and 24 months of age when they develop autism symptoms. Some children show signs of autism spectrum disorder in early infancy, such as reduced eye contact, lack of response to their name or indifference to caregivers. Therefore, the proposed system provides an effective solution to predict the presence of autism spectrum disorder in a more efficient way. In this project, we will be using Deep Learning algorithm such as LSTM to determine the presence of disorder at an early stage. The datasets have been collected using Autism Video Dataset for the detection of autism spectrum disorder. The Features will be trained using deep learning algorithm and the model file has been generated. When an input video is given for disease prediction, it can effectivelydetermine the presence of disease. Thus, this project helps in effective diagnosis of the autism spectrum disorder with higher accuracy than the existing models.*

Keywords- Deep Learning, SSBD dataset, classification, prediction, Blazepose, image recognization

I. INTRODUCTION

Autism spectrum disorder is a condition related to brain development that impacts how a person perceives and socializes with others, causing problems in social interaction and communication. The disorder also includes limited and repetitive patterns of behavior. The term "spectrum" in autism spectrum disorder refers to the wide range of symptoms and severity. Autism spectrum disorder includes conditions that were previously considered separate — autism, Asperger's syndrome, childhood disintegrative disorder and an unspecified form of pervasive developmental disorder. Some people still use the term "Asperger's syndrome," which is generally thought to be at the mild end of autism spectrum disorder. Autism spectrum disorder begins in early childhood and eventually causes problems functioning in society socially, in school and at work, for example. Often children show symptoms of autism within the first year. A small number of children appear to develop normally in the first year, and then go through a period of regression between 18 and 24 months of age when they develop autism symptoms. While there is no cure for autism spectrum disorder, intensive, early treatment can make a big difference in the lives of many children. A child or adult with autism spectrum disorder may have problems with social interaction and communication skills, signs: Fails to respond to his or her name or appears not to hear you at times, Resists cuddling and holding, and seems to prefer playing alone, retreating into his or her own world, Has poor eye contact and lacks facial expression, Doesn't speak or has delayed speech, or loses previous ability to say words or sentences, Can't start a conversation or keep one going, or only starts one to make requests or label items, Speaks with an abnormal tone or rhythm and may use a singsong voice or robot-like speech, Repeats words or phrases verbatim, but doesn't understand how to use them, Doesn't appear to understand simple questions or directions, Doesn't express emotions or feelings and appears unaware of others' feelings, Doesn't point at or bring objects to share interest, Inappropriately approaches a social interaction by being passive, aggressive or disruptive, Has difficulty recognizing nonverbal cues, such as interpreting other people's facial expressions, body postures or tone . Some children show signs of autism spectrum disorder in early infancy, such as reduced eye contact, lack of response to their name or indifference to caregivers.

Therefore, the proposed system provides an effective solution to predict the presence of autism spectrum disorder in a more efficient way. There are various Deep learning(DL) approaches used for the prediction of disease. Several machine learning methods, such as support vector machine (SVM), random forest , and k-nearest neighbors have been successfully applied in disease prediction based on clinical data and MRI based prediction. The prediction of Autism Spectrum Disorder (ASD) using deep learning techniques serves several important purposes, contributing to both research and clinical practice. Here are some key purposes.

Deep learning models can analyze diverse data sources to identify potential indicators of ASD at an early age, allowing for timely intervention and support.

Early diagnosis facilitates the prompt initiation of therapeutic interventions, which can significantly improve outcomes for individuals with ASD.

The prediction of autism spectrum disorder was carried out on the basis of a traditional machine learning techniques. The techniques were applied on a SSBD dataset balanced by using LSTM algorithm. The technique was applied for the features on the dataset. It can be used in all hospitals at its earlier stage and it can also be used in all laboratories.

Therefore, the proposed system provides an effective solution to predict the presence of autism spectrum disorder in a more efficient way. In this project, we will be using Deep Learning algorithm such as LSTM to determine the presence of disorder at an early stage. The datasets have been collected using Self-Stimulatory Behaviours Dataset (SSBD) and video dataset is used for designing the system.

The datasets will be trained using deep learning algorithm and the model file has been generated. When an input image is given for disease prediction, it can effectively determine the presence of disease. Thus, this project helps in effective diagnosis of the autism spectrum disorder with higher accuracy than the existing models.

In this project we provide an efficient technique to predict the presence of the autism spectrum disorders using advanced deep learning algorithm. In this project, simple pre-processing is used to pre-processing the video datasets.Deep learning has truly come into the mainstream in the past few years. Deep learning uses neural nets with a lot of hidden layers (dozens in today's state of the art) and requires large amounts of training data. These models have been particularly effective in gaining insight and approaching human-level accuracy in perceptual tasks like vision, speech, language processing.

The theory and mathematical foundations were laid several decades ago. Primarily two phenomena have contributed to the rise of machine learning a) Availability of huge data-sets/training examples in multiple domains and b) Advances in raw compute power and the rise of efficient parallel hardware. After trained with LSTM algorithm, the model file has been generated. When an input video is given for disease prediction, it can effectively predict the presence of disease. Thus, this project helps in effective diagnosis of the autism spectrum disorder in a more efficient way.

II. METHODOLOGY

Therefore, the proposed system provides an effective solution to predict the presence of autism spectrum disorder in a more efficient way. In this project, we will be using Deep Learning algorithm such as LSTM to determine the presence of disorder at an early stage. The datasets have been collected using Self-Stimulatory Behaviours Dataset (SSBD) and video dataset is used for designing the system. The datasets will be trained using deep learning algorithm and the model file has been generated. When an input image is given for disease prediction, it can effectively determine the presence of disease. Thus, this project helps in effective diagnosis of the autism spectrum disorder with higher accuracy than the existing models.

A) DATASET COLLECTION

In this project, we are going to collect the dataset and it will be fed for training with the deep learning algorithms. Increasing the amount of dataset increases the accuracy .A data set is a collection of data. Deep Learning has become the go-to method for solving many challenging real-world problems. It's definitely by far the best performing method for computer vision tasks. With enough training, a deep network can segment and identify the "key points" of every person in the video. These deep learning machines that have been working so well need fuel lots of fuel; that fuel is data. The more labelled data available, the better our model performs. The idea of more data leading to better performance has even been explored at a large-scale by Google with a dataset of 300 Million images! When deploying a Deep Learning model in a real-world application, data must be constantly fed to continue improving its performance. And, in the deep learning era, data is very well arguably the most valuable resource.

Figure 1: Dataset Collection

B) DATASET PREPROCESSING

In this project, simple pre-processing is used to pre-processing the video datasets.Deep learning has truly come into the mainstream in the past few years. Deep learning uses neural nets with a lot of hidden layers (dozens in today's state of the art) and requires large amounts of training data. These models have been particularly effective in gaining insight and approaching human-level accuracy in perceptual tasks like vision, speech, language processing. The theory and mathematical foundations were laid several decades ago. Primarily two phenomena have contributed to the rise of machine learning a) Availability of huge data-sets/training examples in multiple domains and b) Advances in raw compute power and the rise of efficient parallel hardware.

Building an effective neural network model requires careful consideration of the network architecture as well as the input data format. The most common image data input parameters are the number of images, image height, image width, number of channels, and the number of levels per pixel. Typically, there are 3 channels of data corresponding to the colours Red, Green, Blue (RGB) Pixel levels are usually [0,255]. Data preprocessing is a process of preparing the raw data and making it suitable for a machine learning model.

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	0	1	2	3	4	5	6	7	8	9	...	57	58	59	60	61	62	63	64	65	label
0	47	36	38	22	37	22	34	22	36	22	...	267.0	163.0	341.0	174.0	279.0	205.0	295.0	240.0	243.0	armflapping
1	47	37	39	21	38	22	36	22	37	22	...	213.0	238.0	276.0	246.0	224.0	262.0	221.0	321.0	156.0	armflapping
2	49	33	41	19	40	19	39	20	38	19	...	215.0	242.0	278.0	251.0	222.0	302.0	234.0	334.0	182.0	armflapping
3	43	29	40	17	40	17	39	18	37	17	...	199.0	250.0	257.0	266.0	207.0	302.0	213.0	332.0	150.0	armflapping
4	49	26	42	13	39	14	39	15	37	14	...	204.0	245.0	334.0	249.0	221.0	263.0	307.0	313.0	159.0	armflapping

5 rows × 67 columns

Figure 2: Data Preprocessing

C) FEATURE EXTRACTION USING BLAZEPOSE

In this project, BlazePose algorithm is used for feature extraction. BlazePose (Full Body) is a pose detection model developed by Google that can compute (x,y,z) coordinates of 33 skeleton keypoints. It can be used for example in fitness applications. BlazePose consists of two machine learning models: a Detector and an Estimator. The Detector cuts out the human region from the input image, while the Estimator takes a 256x256 resolution image of the detected person as input and outputs the keypoints. BlazePose outputs the 33 keypoints according the following ordering convention. This is more points than the commonly used 17 keypoints of the COCO dataset. The Detector is an Single-Shot Detector (SSD) based architecture. Given an input image (1,224,224,3), it outputs a bounding box (1,2254,12) and a confidence score (1,2254,1).

The 12 elements of the bounding box are of the for(x,y,w,h,kp1x,kp1y,…,kp4x,kp4y), where kp1x to kp4y are additional keypoints. Each one of the 2254 elements has its own anchor, anchor scale and offset need to be applied.

There are two ways to use the Detector. In box mode, the bounding box is determined from its position (x,y) and size (w,h). In alignment mode, the scale and angle are determined from (kp1x,kp1y) and (kp2x,kp2y), and bounding box including rotation can be predicted. The Estimator uses heatmap for training, but computes keypoints directly without using heatmap for faster inference.The first output of the Estimator is (1,195) landmarks , the second output is (1,1) flags. The landmarks are made of 165 elements for the (x,y,z,visibility,presence) for every 33 keypoints .The z-values are based on the person's hips, with keypoints being between the hips and the camera when the value is negative, and behind the hips when the value is positive. The visibility and presence are stored in the range of (min_float,max_float) and are converted to probability by applying a sigmoid function. The visibility returns the probablity of keypoints that exist in the frame and are not occluded by other objects. presence returns the probablity of keypoints that exist in the frame.

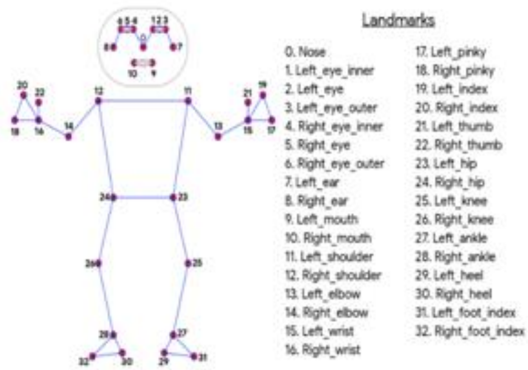

Figure 3: Feature Extraction

D) TRAINING WITH ALGORITHM

After the feature extraction process, these features are given to deep learning algorithm which will undergo training of the features and output accuracy. In this project, LSTM is used to train the datasets.Long short-term memory (LSTM) is an artificial Recurrent Neural Network (RNN) architecture used in the field of deep learning. Unlike standard feedforward neural networks, LSTM has feedback connections. It can process not only single data points (such as images), but also entire sequences of data (such as speech or video). For example, LSTM is applicable to tasks such as unsegmented, connected handwriting recognition, speech recognition and anomaly detection in network traffic or IDSs (intrusion detection systems). A common LSTM unit is composed of a cell, an input gate, an output gate and a forget gate. The cell remembers values over arbitrary time intervals and the three gates regulate the flow of information into and out of the cell.

LSTM networks are well-suited to classifying, processing and making predictions based on time series data, since there can be lags of unknown duration between important events in a time series. LSTMs were developed to deal with the vanishing gradient problem that can be encountered when training traditional RNNs. Relative insensitivity to gap length is an advantage of LSTM over RNNs, hidden Markov models and other sequence learning methods in numerous applications.

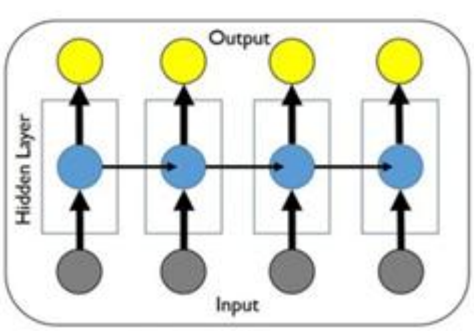

FIGURE 4:LSTM ALGORITHM

E) PROBABILITY CALCULATION

Probability = (obtained value)/(threshold value)

Probability of the disease is calculated by dividing the obtained value to the threshold value. The threshold value is the maximum distance of any particular action done by the patient; this value is obtained from the dataset. The obtained value is the maximum distance of any particular action done by the patient, in that particular input videos.

F) PREDICTION OF DISEASE

After trained with LSTM algorithm, the model file has been generated. When an input video is given for disease prediction, it can effectively predict the presence of disease. Thus, this project helps in effective diagnosis of the autism spectrum disorder in a more efficient way.

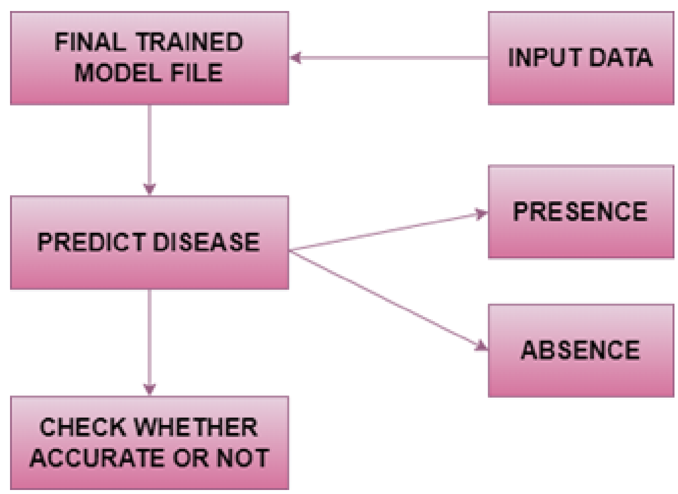

FIGURE 5: PREDICTION OF DISEASE

III. EXPERIMENTAL RESULT

We have used videos from the SSBD dataset to calculate the performance of our projected technique for the prediction of autism disorder. Performance is measured in terms of ACC (accuracy), ROC, AUC, Recall, PRE (precision), and F1-score

The following formulas are used to calculate these performance metrics: _.
Notations: PREC = precision, ACC = accuracy,
TP stands for true positive, TN for true negative, FP for false positive, and FN for false negative.

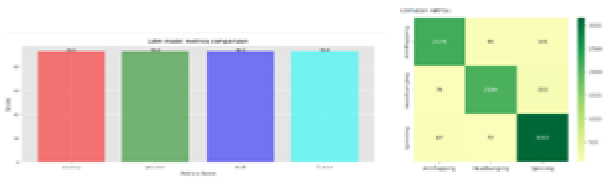

Figure 6: Experimental Result

IV. RESULT

We have used videos that had been cropped to x480 and X360 sizes in order to compare and classify the symptoms. This classifier has been trained to diagnose autism and provide results.

Figure 7: Accuracy Of The Models

As a result, the graph figure 7 illustrates the accuracy attained by these models.

Table 1: Result table showing achieved values of all the performance metrics.

Performance parameters	Results
Accuracy	0.91%
Precision	91.25%
Recall	91.56%
F1-score	91.18%
ROC Curve	0.98.6%

In the process of training the model, the sample dataset was further split into four internal subgroups of samples. Each epoch is split into two parts: one for testing and one for the training routine. Both "acc" and "loss" denote positive values, with "acc" standing for positive values and "loss" for negative values. The models' accuracy and loss are shown in the graphs below.

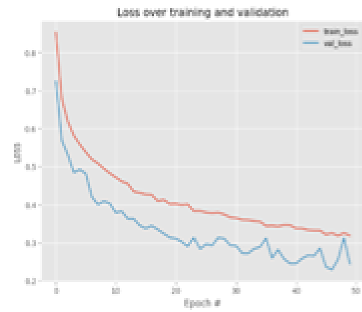

Figure 8: Loss For The Models

The misclassification that occurs during implementation is analysed using the Confusion matrix displayed in Figure 8. Each row displays an event from the prediction class, and each column displays an event from the real class.

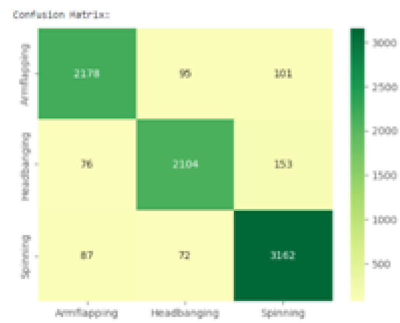

Figure 9: Confusion Matrix

Classes that have been correctly classified are shown on diagonals. Both the misclassified classes and the misclassified objects are displayed in this matrix. Higher AUC shows which model is more reliable. 1 is the highest point that one can have as it is the best result because at that point right angle triangle will be formed. For debugging the model ROC curve is very helpful. The FIGURES 10 represents the ROC Curve for these models. From the ROC Curve we where able to understand that Model is more reliable than the other models.

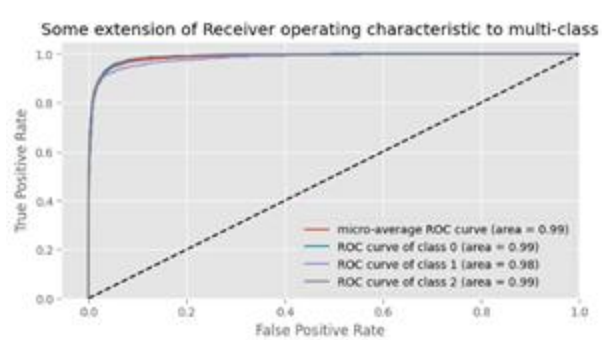

Figure 10: Roc Curve

V. CONCULSION

In conclusion, the prediction of Autism Spectrum Disorder (ASD) using Deep Learning (DL) techniques holds significant promise and brings several important advantages to the field of healthcare. The integration of DL into ASD prediction offers a range of benefits, including early detection, objective assessments, scalability, and the potential for individualized treatment plans. These advancements contribute to more efficient resource utilization, reduced diagnostic delays, and increased accessibility to diagnostic tools.

DL models, with their ability to analyze complex datasets, provide valuable insights into the patterns and features associated with ASD. This not only aids in early identification but also enhances our understanding of the heterogeneous nature of the disorder. The personalized approach facilitated by DL supports the design of tailored intervention strategies, ultimately improving outcomes for individuals with ASD.

However, it's crucial to approach the application of DL techniques in ASD prediction with ethical considerations in mind. Ensuring transparency, interpretability, and ongoing validation of models is essential to build trust among healthcare professionals, patients, and the broader community. Additionally, collaboration between multidisciplinary teams, including clinicians, researchers, and machine learning experts, is vital for the responsible development and deployment of predictive models.

As the field continues to evolve, the integration of DL into ASD prediction has the potential to not only enhance diagnostic processes but also contribute to a deeper understanding of the underlying mechanisms of ASD. This, in turn, can pave the way for more targeted interventions and therapies, further improving the quality of life for individuals on the autism spectrum disorder prediction.

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