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Augmented Behavior Analysis for Childrenwith Developmental Disabilities: Building Towards Precision Treatment

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Abstract: Children with autism have a developmental problem that gets worse with time. Children with autism have difficulty communicating and interacting with others, and they also exhibit restricted behavior. If their illness is recognized early on and they receive comprehensive care andtherapy, children with autism can enjoy happy, full lives. In wealthy countries, it might be difficult to diagnose autistic children until it is too late. Since there are no specific medical tests for autism, a qualifiedmedical professional must make the diagnosis. Given that youngsters need to be closely monitored, medical experts require plenty of time toidentify it. In this study, useless to most people images of children wereutilized to identify those with autism using artificial intelligence technologies. For the diagnosis of, we have utilized five different algorithms to analyze the prevalence of autism spectrum disorder (ASD) in children: Multilayer Perceptron (MLP), Random Forest (RF), Gradient Boosting Machine (GBM), AdaBoost (AB), and Convolutional Neural Network (CNN). When comparing different algorithms' categorization outcomes, we found that CNN outperformed other traditional Machine Learning (ML) techniques with an accuracy of 92.31%, outperforming all other algorithms. Hence, we suggested a CNN-based prediction model to detect ASD, particularly in youngsters.

Keywords: Convolutional Neural Network (CNN), autism spectrum disorder and Machine Learning

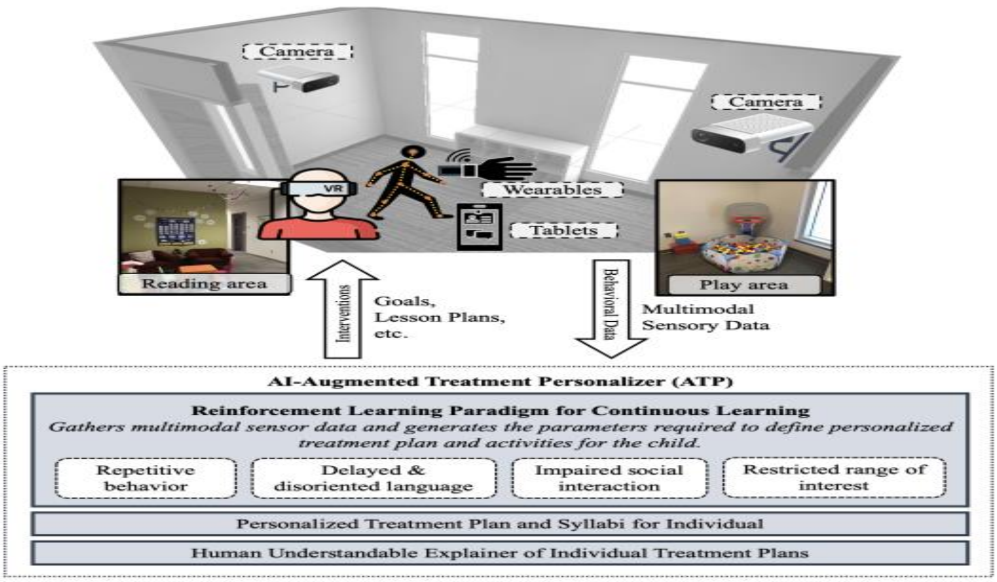

Fig 1 The platforms for applied behavior analytics with AI augmentation's systems architecture are shown. Invasive and non- invasive sensors gather multimodal sensory data, which is then processed by AI algorithms to enhance the treatment and learning paradigms used by behavior analyzers. Experts can access and safely save all data in the cloud. The reinforcement paradigm is configured differently for each person.

I. INTRODUCTION

The neurological disease known as autism inhibits children from interacting socially. Children that suffer from this condition usuallyhave difficulty understanding, remembering details, interacting withothers, and communicating [1][2]. Childhood is when autism first manifests itself, and it lasts until adolescence and adulthood. Out ofevery 54 children, 1 has difficulties connected to autism [3]. More than four times as many boys as likely as girls to be diagnosed with autism, despite the fact that people of all racial and cultural backgrounds are regularly impacted by it.

Children are often only diagnosed around the age of four [4], despite the fact that they can routinely be diagnosed as early as two years old. The sooner they aredetected, the quicker it may be stopped. Therefore, by giving autisticchildren the right care and instruction, it may be able to enhance their behavior and communication skills [5][6]. Today, to determine if achild has autism or not, doctors or specialists consider the child's behavior and developmental stage. This technique is time consuming and requires experts who have received extensive training It might be difficult for doctors or other medical professionals to diagnose children with autism just by watching their behavioral activities over a set amount of time.

Once more, there is a significant scarcity of medical professionals with the necessary training in many rural and undeveloped areas, and many people cannot afford to visit a doctor. As The young autistic person matures without receiving the necessary care and therapy, this causes family, personal, and social upheaval because the majority of families are ignorant that their child has autism.

Many academics are for the development of computer-aided decision support systems that can recognize children with autism using machine learning approaches in order toaddress these problems. In order to create numerous ML-based prediction models approaches that might use to identify ASD in its infancy, they gathered information on children's behavior and activities using a variety of questionnaires and interviews.

None of these researchers identified autism in children using pictures of their faces. Innumerable time-consuming and error-prone questionnaires and interviews have almost universally used text and numerical data.This is because younger children may experience anxiety during interviews and surveys and may give inaccurate answers due to theirimmature cognitive development. Later, the prediction model will bebiased by these inaccurate responses, which will reduce prediction accuracy. These unreliable responses will later bias the prediction model, lowering forecast accuracy. We have developed a simple prediction model utilizing the face scans of 2940kids between the ages of 2 and 8 in order to address these worries.

In this study, we identified ASD from images of young children employing five categories' methods. Our chosen data set includes the faces of2940 child's. Once the preliminary step was complete, We contrasted results CNN was the most accurate of those five categorization systems performed better at identifying ASD in children.

II. IMPLEMENTATION

The modules incorporated in this project are:

- Dataset Collection
- Pre-Processing of Dataset
- Applying CNN Algorithm
- Evaluating the data

Each image that was extracted from the dataset had a particular size.All of the photographs were resized to their original dimensions usingthe Python Open CV resize function. Before converting the colour spaces, the size of each image was adjusted.. Each image's BGR colour space was changed to a grayscale representation. The pre- processing stage was completed by arranging all of the pictures into arrays for more work. The flow chart for our study project is shown in Figure 2.

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Figure 2. Examples of faces of children with autism and childrenwithout autism

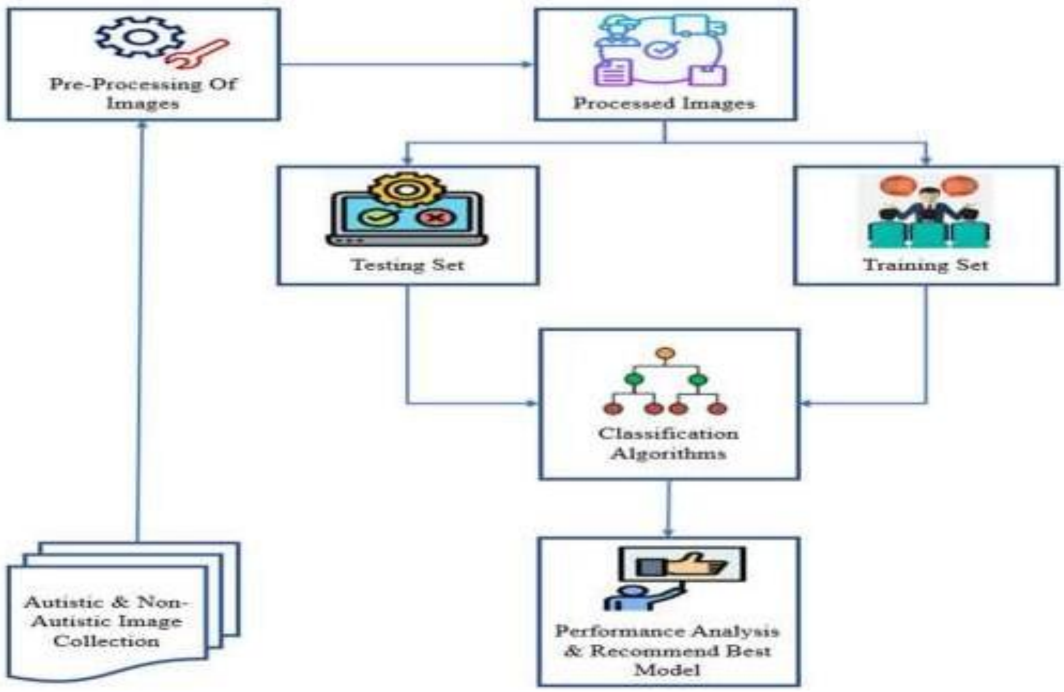

Fig. 3. Our Research Methodology's Workflow

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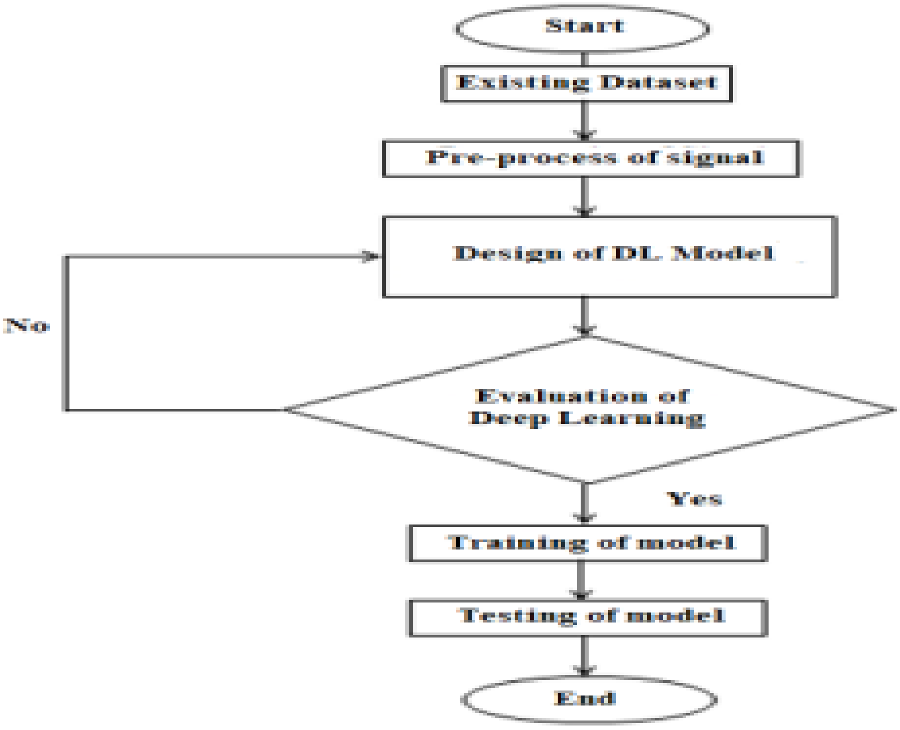

Fig 4 Flow Chart

2.1 TECHNOLOGIES USED

2.1.1 CONVOLUTIONAL NEURAL NETWORK(CNN)

Computer vision tasks that need categorization are commonly constructed using CNN, a subset of a deep neural network. a CNN structure is finished by Connection, pooling, and complete convolutional layer layers feature detector or kernel assists in the convolutional layer in extracting characteristics of the source image and producing the convolved image. The convolutional operation is represented mathematically by the following equation.:

$$(f * g)(t) = \int_{-\infty}^{+\infty} f(T)\, g(t - T)\, dT \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

ReLU gives the network nonlinearity after convolution is finished.
As an explanation, consider the function's output:
f= max(0,x) (0,x)………………………………..(2)
By removing characteristics from the deformed image, the pooling layer produces a mapped feature pool. It is a pooling feature map, subsequently provided as the artificial neural network's input.

An input layer, a number of hidden layers, and an output layer make up the fully connected layer. The final forecast is provided by the output layer, whose nodes are fully connected to all of the entirely linked levels.

2.1.2 EVALUATION MEASURES

To gauge how effectively the classification algorithms used in this work were performing, we used the well-known Cross-validation by K-fold method. The whole dataset is split up at random into groups of K numbers that are the same sizes for K-fold cross validation. When building a model, K-1 divisions of the data are first used to train classification algorithms. The outcome of the prediction is next tested against the remaining data. This procedure is carried out k times., and the average value of each independent test subset is used to determine themodel's performance.

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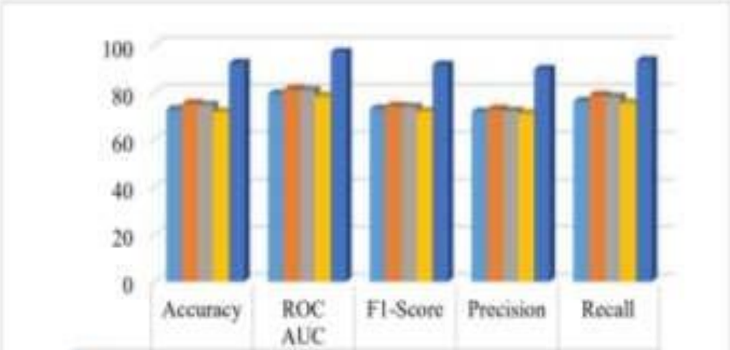
Ten-fold cross-validation was utilized in this work to reduce the biases and variance in our prediction model. We also applied five assessment measures to examine the performance ofthe classification algorithms: recall, precision, F-1 score, accuracy, and ROC AUC.



	Accuracy	ROC AUC	F1-Score	Precision	Recall
RF	72.78	79.33	72.97	71.67	76.19
GBM	75.23	81.2	74.12	72.89	78.73
AB	74.56	80.84	73.86	72.1	78.09
MLP	71.66	78.42	71.87	71.02	75.48
CNN	92.31	96.95	91.54	89.72	93.45

Figure 5, Performance Evaluation of ASDDetection Classification Algorithms.

III. EXPERIMENTAL RESULTS

Python-3 was the programming language we employed for this work, and Google Collab [18], a an online service from Google, served as the environment. The execution of classification algorithms has been sped up using Google Collab's Virtual Tensor Processing Unit (TPU). After the preparation of data stage, the total 80:20 is the ratio used to divide the dataset [19], with 80 percent of the information used as instruction batch and the final 20% was preserved for testin . cross-validation by ten strategy is suggested to reduce bias toward a particular class and avoid being either over- or under-fit[19] when building and testing classification algorithms. In this investigation, five classification schemes were used. A dataset of autistic children's performance is evaluated using methods to differentiate between children with autism and children without autism. Results of the five different classifications used in the research

There are algorithms for categorizing children with autism, as seen in Fig. 4. Our research revealed that the accuracy of CNN, RF, GBM, AB, and MLP was 72.78%, 75.23%, and 74.56%, respectively. The accuracy rates were 71.66% and 92.31%, respectively. It is obvious that the most accurate description of autistic youngsters (92.31%) comes from CNN. With a ROC AUC score of 96.95%, CNN has the greatest value when compared to other classifiers. According to an analysis of the F1-score and precision data, CNN classifier once again received the highest F1-score and precision values, 91.54% and 89.72%, respectively. CNN also outperformed other machine learning algorithms in terms of recall rate, scoring 93.45%, compared to 76.19%, 78.73%, 78.09%, and 75.48% for RF, GBM, AB, and MLP, respectively. The recall percentage 93.45% shows that the accuracy of the CNN algorithm's diagnosis of autism in 93.45% of autistic positive children. Using face photos, CNN has outperformed other deep learning systems in diagnosing autistic youngsters. across all evaluation metrics, according to the aforementioned experimental analysis.

IV. DISCUSSION

This section briefly describes our proposed CNN architecture. In classification effectiveness for detecting children with based on facial imagery, autism spectrum disorder, it is evident from the analysis of the experimental data that the The CNN algorithm already surpassed other standard machine learning methods. The complete design of our recommended CNN model is depicted in Fig. 5. Since this dataset's original pictures had a variety of shapes, they were converted to a uniform 64*64 shape.

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Each image's first two convolutional layers were subjected to a total of 64 filters of three-by-three-pixel sizes, with as the ReLU selected activation process, so as to extract features. Then, in order to shrink the size of the feature map or convolved feature, Max Pooling of Size 2 * 2 was designed. Convolution layers had 128 kernels in 3*3 sizes compared to the Max Pooling layers' 2*2 sizes. We added two sets of Max Pooling and convolution layers. The conversion of all data to vector form will serve as the input for the next artificial neural network.

ReLU was once more utilized as the activation function in the ANN, which included three hidden layers with a combined total of 256 neurons.

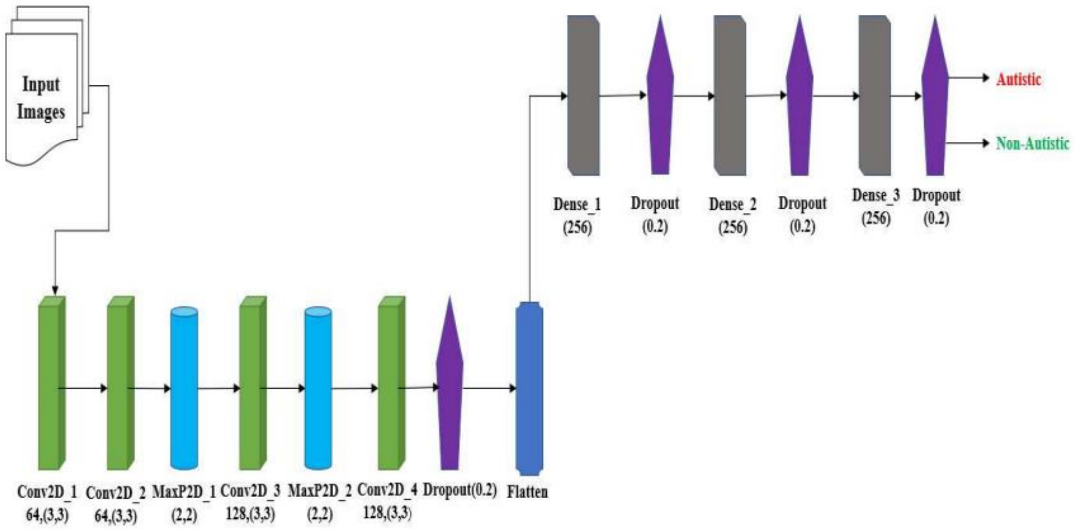

Fig 6 Composition of the Proposed CNN Model

Dropout layers were put in between those covered layers to prevent the model from fitting too tightly. The Sigmoid used as a means of activation in the last layer since classifying ASD was categorized using a simple binary system. As an optimizer and loss function, we used Adam and binary-cross entropy. 60 epochs of training and testing were conducted with a batch size (hyperparameter of gradient descent) of 16 to be able to increase the robustness of the proposed CNN model also avoid overfitting and underfitting issues.

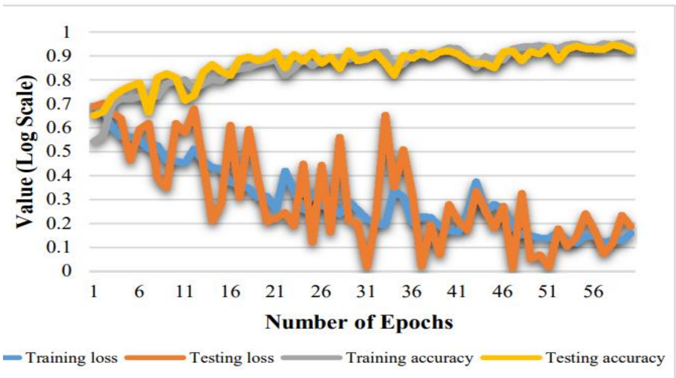

Fig 7 Accuracy Curves for the Proposed CNN Model inTraining and Testing,Training and Testing Loss

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As seen in Fig. 6, accuracy was likewise subpar and training and testing losses were both very high at the start of the epochs. Each step involves transmitting the weights to the network and continuously modifying them based on the batch size. With the passing the loss value continuously reduced throughout each era as accuracy rose. At finishing the 60 epochs, the suggested CNN model had testing precision of 92.31 in identifying children with autism. The suggested CNN model's overall training and testing results for identifying children with autism from facial photos are shown and contrasted in Fig. 7.

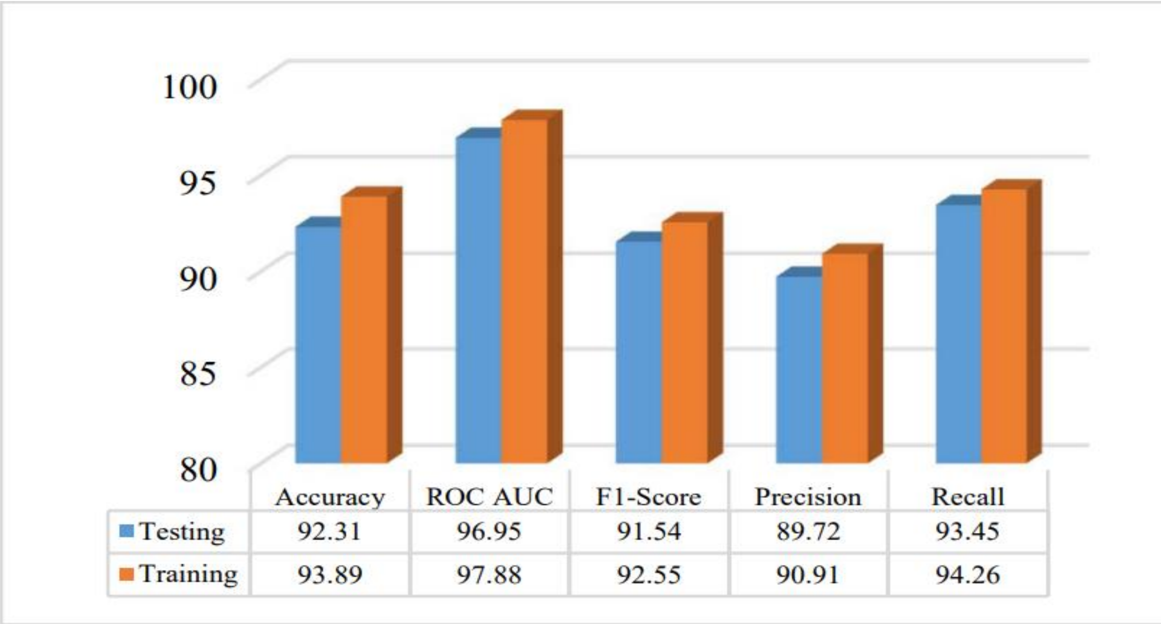

Fig8 Performance Comparison Between Training and Testing

V. CONCLUSION

It's already happened mentioned because zero medical test exists to diagnose in autism youngsters. It is hard to detect if a child has autism merely by looking at them, according to specialists. Therefore, before making a decision, medical professionals conduct extensive evaluations of children's behavior and activities. This issue can be greatly helped by artificial intelligence technology, which can categorise photographs of youngsters and tell apart those who are autistic from those who are not.The images might not be able to identify autism in people. Artificial intelligence is able to recognize it because it can recognize and classify images with delicate and nuanced characteristics. The most accurate model for diagnosing autism in early children was determined by comparing five classification algorithms in this study. We compared many evaluation metrics and found that the CNN algorithm performed better than all of them. As a result, a doctor or other qualified medical professional can employ this forecasting tool as assistance in addition to customary medical treatments Additionally, because it takes so little time, they can quickly and effectively detect autism in children. 2940 images of kids were utilised in this investigation. Our prediction model will get more precise and capable of producing identifications that are more exact as the number of images grows. This model can be saved on the cloud to enable clinicians to quickly diagnose a new newborn. So that medical experts can promptly diagnose a newborn child, this model can be kept in the cloud.

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