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Exploring AI Robots-based Visual Strategy in Training Children with Autism Disorder

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Abstract

Children with autism spectrum disorder (ASD) exhibit deficiencies in the socio-communicative domain and commonly struggle with emotion perception and expression. Robots are becoming increasingly prevalent in our lives, notably in the medical field. Some therapists at therapeutic centers are beginning to experiment with techniques such as computer games, Online exchanges that are available and robot-assisted therapy. Robot-assisted therapy has been widely proven to provide a reliable and effective intervention for enhancing communication and social skills in children having ASD. The humanoid robot may grab the attention of young children and later draw the interest of researchers. This study is accomplished through the use of a revolutionary technique based on deep learning algorithms that comprises essential data and understanding about patients, diagnostic procedures, and medicines. A robot therapist can transmit the results responsibly using this paradigm. Here parameter tunned CNN based model are used and the model is achieved with an accuracy rate of 96% in ASD detection.

Keywords: Autism Spectrum Disorder (ASD), Robots, Deep Learning, CNN.

1. Introduction

Computer Vision (CV) has assisted doctors in diagnosing fractured bones, blood clots, as well as malignant tumours. This can also be utilised to assist specialists in diagnosing autism. Autism Spectrum Disorder (ASD) is a term used to describe a variety of neurodevelopmental disorders. ASD children show deficiencies in the socio-communicative domain and commonly struggle with a sense of emotion and expression [1]. Over the last two decades, the frequency

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of ASD has progressively increased, with estimates currently reaching a maximum of one in 36 children [2]. Significant advances have been achieved towards the globe more accessible to persons with ASD. The ethical and social effects of the rising usage of artificial intelligence in neurological disorders must be recognized and addressed in order to enable appropriate clinical diagnosis. In the fields of human-robot interaction and affective computing, emotional contact with robots has garnered a lot of interest. The goal was to offer a synthesis of current research and to improve our knowledge in computer models through emotional intelligence developed for AI robots utilized for interactions with children, particularly those with special needs such as ASD. Children having ASD have difficulties in recognizing, interpreting, and reacting to mental and emotional states. As a result, individuals struggle with recognizing emotions through facial expressions, verbal pronunciation, physical expressions, and physiological signs, as well as comprehending emotions and responding emotionally while engaging with others [3].

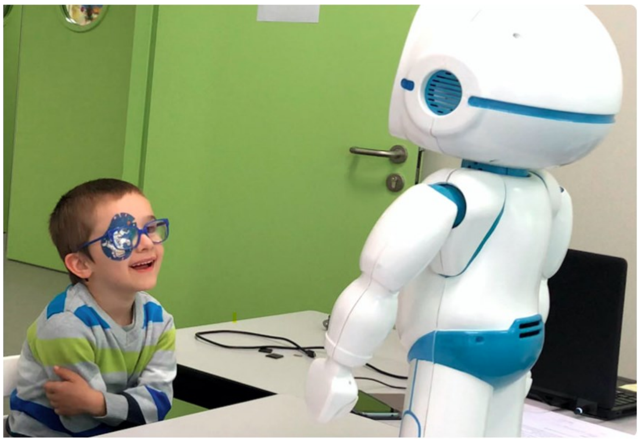

Figure 1. Robotic Therapy for ASD Children's [4]

The traditional method used is behavioural management therapy and questionnaire protocols. Behavioural methods are concerned with modifying behaviours through comprehending what occurs prior to and following the behaviour. The greatest evidence supports behavioural techniques for addressing ASD symptoms. Questionnaire protocols are simple, effective, and lead towards an accurate diagnosis. However, attendees cannot provide accurate data all the time or accurately complete the questionnaire forms [5]. Humanoid robots solve this by learning skills independently and interacting with struggling kids. The proposed system can determine whether a child has autism by analyzing his image using deep learning algorithms which is the most commonly used technique in image processing. This approach will be used for a database containing images of children with ASD.

2. Related Works

In [6] a method for evaluation of social robots using human psychology methods to better human-robot interaction is proposed. As a result, the robots achieve precise social reactions, which may be a superior method for autism therapy. Furthermore, applying of fuzzy signal detection theory (FSDT) to social skills can be an improved technique for building social robots. To validate the notion, a semi-autonomous socializing robot was developed.

In [7] a feature extraction architecture is proposed then a classification to forecast the patient's response to stimuli in the CNN-FEBAC framework. Performance criteria such as the confusion matrix, accuracy, and F1 scores were used to evaluate the suggested model. The suggested model has the highest accuracy of 91%.

In [8] describes a multimodal interface that is based on a multilevel therapy procedure that is tailored to promote direct eye contact, collaborative focus, and imitation. Six high-functioning children having participated in a system evaluation. The trials conducted allow for the evaluation of the children's behavioural responses during an eye contact exercise.

In [9] enhanced CNN making it suited for sequential input with broad temporal receptive fields. The experimental findings indicate that ECNN obtains up to 80% accuracy. These patterns demonstrate an anticorrelation of activity in the brain between the both posterior and anterior parts of the brain; that is, disruption in brain connection is one of the key indicators of ASD.

In [10] the proposed framework is for Individuals with (and without) ASD have facial emotion information stored in their brain signals. Thus, documented issues in behavioural FER linked with ASD are most likely the result of problems decoding or deploying emotional facial information in the neural signal.

In [11] to distinguish between ASD and non-ASD participants, a convolutional neural network must be trained using a face image dataset. This study uses pre-processing and synthesis of the training dataset as part of the data-centric strategy. AI approaches provide doctors with useful and readable insights into the ASD diagnostic model's decision-making process.

3. Proposed Model

Recent study indicates deep convolutional neural networks' (CNNs') outstanding capability for visual data categorization with an exceedingly high accuracy rating. Face recognition as well as image classification algorithms extract information from an object, allowing them to distinguish between autistic and non-autistic faces by learning from a large range of images.

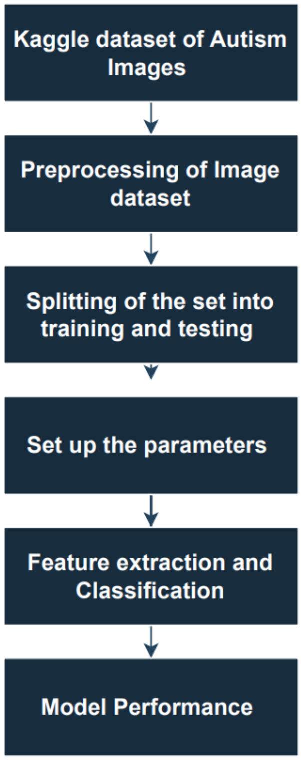

Figure 2. Block Diagram of the Proposed Model

3.1 Dataset

The proposed model uses Concerns with 'Detect Autism' dataset of autistic" and "non-autistic" images from Kaggle and then process them to ensure uniform size and face alignment. It consists of 2940 training images of 224*224 pixel.

Figure 2. Source of Dataset used in the Proposed Research Work

[https://www.kaggle.com/code/cihan063/autism-cnn-vgg16/notebook]

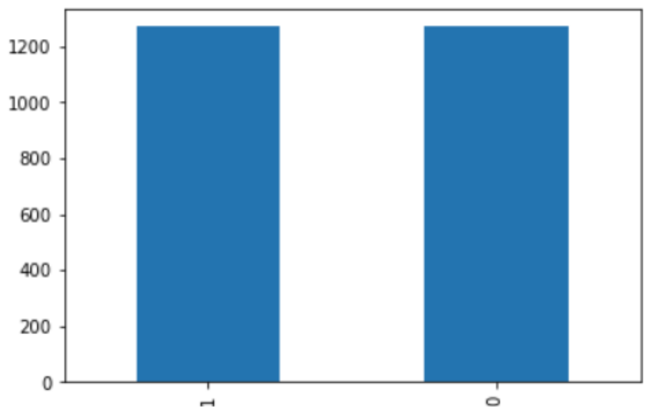

Figure 3. ASD and Non- ASD Images of Considered Dataset

The above figure represents the Classification of Autism and Non- Autism images

3.2 Pre- Processing

The images contained in the data set files are of varying sizes and contain some noise. The proposed work uses several methods of preprocessing on the images to reduce noise and smooth out the dataset." ImageDataGenerator" is used for preprocessing that in return helps the model in increase of performance measures.

3.3 Model Training for ASD Diagnosis

The suggested model comprises of four convolution layers and two fully connected layer. The vectors obtained after combining from each filter are feature vectors. To generate a combined convoluted feature map, the (Local binary patterns) LBP feature map must be fused with this feature vector. Furthermore, the convolution layer contains weights that must be taught, while the pooling layers transform the activation using a fixed function. Leaky ReLU is utilized to give the entire network non-linearity. Leaky ReLU functions remain monotonic. Furthermore, the derivatives of them are monotone.

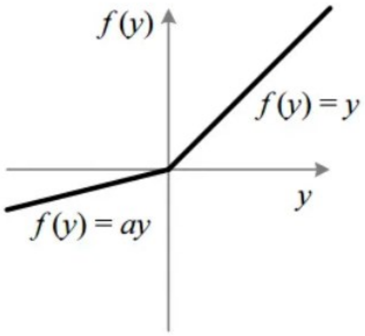

Figure 4. Leaky ReLu

[https://towardsdatascience.com/activation-functions-neural-networks-1cbd9f8d91d6]

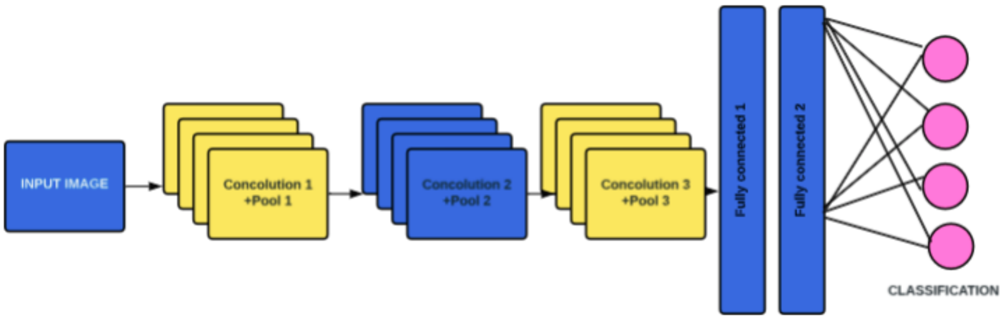

Figure 5. Model Architecture

Further, the model's outcome is generated on a training dataset having the loss feature, as well as learning parameters (kernels & weights) are modified by loss back-propagation. This effort requires the incorporation or deletion of particular layers throughout training phases, such as the Max Pooling as well as Convolution layer, in order to create something unique and helpful for the output of the model under specified kernels and weights. The outcome is pooled, so it's essentially a non-linear spatial downsampling technique. As a consequence, a pooled map of features has been "flattened." This feature vectors serves as a typical Fully linked layer to provide classification.

4. Results and Discussion

The programs were written in Python and ran on the Google Colab platform. This section describes the various steps of the ablation study that we carried out to improve the accuracy of ASD detection using face image data. In this study Kaggle images are used as a dataset for the proposed model.

The models were trained several times with collection of data, and the result was assessed using a range of hyperparameters. Furthermore, we employed numerous optimizers as well as split ratios of the test-train data to get the high accuracy setting required for detailed analysis and evaluation of various deep learning models.

To validate the performance of proposed algorithms, many measures such as accuracy, F- score, precision, as well as recall are employed.

4.1 Performance Metrics

To reflect and compare our study findings, we employed some of the most often used statistical measures, including as accuracy, precision, and recall. The following formula may be used to determine the formula of Accuracy, Precision, and Recall. The Table.1 shows the performance score of the proposed method.

$$\text{Accuracy} = \frac{Tp+Tn}{Tp+Tn+Fp+Fn}$$

$$\text{Precision} = \frac{Tp}{Tp+Fp}$$

$$\text{Recall} = \frac{Tp}{Tp+Fn}$$

$$\text{F1 score} = \frac{Presion*Recall}{Prescision+Recall}$$

Table 1. Performance Score

	Precision	Recall	F- Score	Accuracy
Autism	89.2	88.4	90.5	95.7
Non- Autism	92.1	90	91.4	96.3

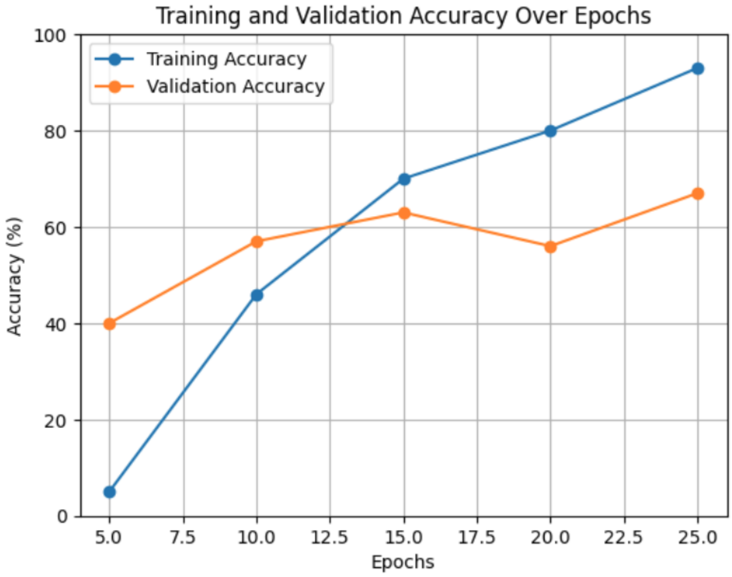

Figure 6. Training and Validation Accuracy

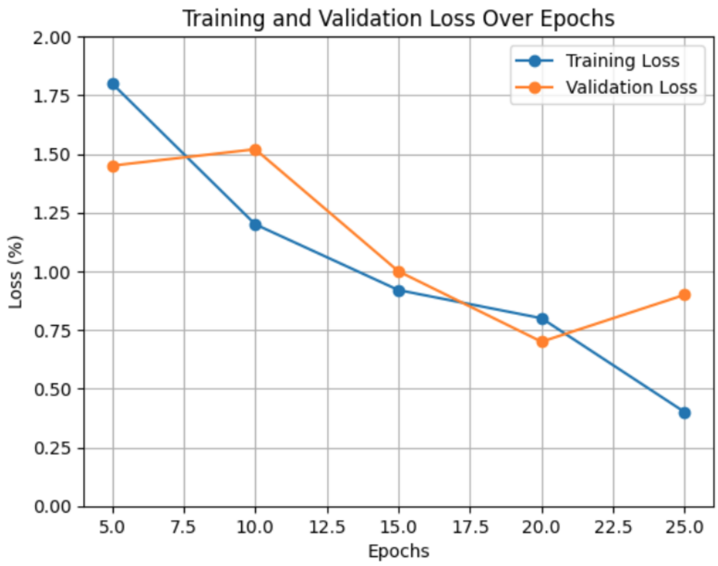

Figure 7. Training and Validation Accuracy

As the model has extended layers and finally incorporated a few additional convolution layers and many fully related levels, the network became both larger and broader with an accuracy of 96% on an average as illustrated in fig.6. This indicates that as the time frame expands, the training loss decreases but the validation loss rises. Furthermore, when the weights are adjusted, the validation results are always predicted to decrease. As the epoch rises in higher order, we should predict a smaller amount of validation loss then the training loss, as seen in the final phases of the figure 7. As a result, this model has adjusted well to the training data.

5. Conclusion

Autism diagnosis is a time-consuming and costly process. Fortunately, because of the link between facial traits and autism, a model may be taught to identify it. The detection of children having ASD was done using a deep-learning classification system, which depends on convolutional neural networks and has an accuracy of 96%. As we continue to integrate AI robots as well as visual methods, it is critical to evaluate the moral consequences and guarantee that these developments are applied properly. Collaboration between educators, therapists, artificial intelligence developers, and families is critical for improving and customising robot-based solutions to fit the different requirements of children with ASD.

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