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Detecting Autism Spectrum Syndrome using VGG19 and Xception Networks

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***Abstract*: Autism spectrum Syndrome (ASS) is an evolving disability caused by transformations in human brain. Patients having this disease have complications such as lacking of social communiqué and interaction, restricted interests to participate in activities. But for patients suffering from ASD, these physiognomies make life very complicated. Children with this, have divergent facial landmarks, from normal children. These landmarks can be identified using deep learning models which can be used to detect ASD. But they models should be able to extract and produce the proper patterns of the face features. Thus, for this task, two variants of CNN models namely Xception andVGG19 were used for this task. The dataset required for training and testing of the application was collected from the Kaggle platform and consists of 2,940 face images comprising equal number of healthy and autistic patient images. The results showed that Xception model has an accuracy of 86% while the VGG19 model gives an accuracy of 81%. The results indicated that the proposed system can be used for ASD.**

***Keywords*: Convolutional Neural Networks, ASD, VGG19, Xception.**

1. Introduction

Autism spectrum disorders (ASD) denote to compound neurodevelopmental complaints of the brain such as autism, infantile disintegrative disorders [1]. At present this ailment is incorporated in the "International Statistical Classification of Diseases and Related Health Problems" under "Mental and Behavioral Disorders" in group of Pervasive Developing Disorders [2]. Generally, the symptoms of this disorder became visible at the start of the child life [3]-[6]. The major symptoms may include less eye contact, lack of reaction, and not behaving properly with caretakers. These symptoms of autism became more prominent between 18 and 24 months [5]. These symptoms are regenerative patterns of behavior, a contracted range of interests, limited activities and less language expertise. These ailments affect how a patient sees and hangs out with others and become extremely introverted or aggressive in initial years of life. ASD appears more in childhood, but it inclines to persist into teens.

Diagnosing ASD is very complicated as there is no medical test, ex. blood test, to diagnose the disorder. To make the diagnosis doctors observe the facial expressions of the children. ASD may more visible at 18 months or more by patient. Many children however may not receive a final conclusion until they became old. But a few patients cannot find out the disease for major time in their life. This interval if it is very long can means can get affected terribly and might even can lead to death

Therefore, a tool for early diagnosing of ASD is extremely important, which can reduce the severity of the disease and also reduces the risk of the death.

The main scope of the proposed work is as follows:

- An application to detect the Autism Spectral Disorder was designed using two pre trained deep learning algorithms Xception, and VGG19.
- Training & testing the application with a public available dataset from Kaggle.
- Compared the performance of the two models.

The rest of this paper is structured as follows- Section 2 presents about the various methods existing, section 3 presents about the system design, section 4 gives the results & output screenshots of the application.

2. Literature Review

There have been many studies which have used several key features of autism to detect ASD. Some of the key features used are extracting features from the faces of patients [12], tracking of the eyes [13], recognizing the facial expressions from the face images and recognizing the voice of the patients [14]. Out of all these, face based detection has a very prominent role in detecting ASD than others. Processing of patient's facial images is a common method to verify whether they are healthy or autistic. It involves excavating relevant information to reveal behavior of an autistic patient [15], [16].

Yolcu et al. in [8] developed the basic convolutional neural network (CNN) model for extracting components of patient's facial lexes and detect facial manifestations for ASD detection.

Haque and Valles in [10], in the year 2018using deep learning approaches (ANN) to diagnose facial patterns of autistic children. They achieved a significant level of accuracy for ASD but the method was very slow.

Rudovic et al. in [11] proposed a deep learning model named as Culture Net to identify ASD from 30 videos they recorded. This method achieved very low accuracy.

Duda et al. in [17] presented an outline of manufacturing

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samples of differentials between autism and "Attention Deficit Hyperactivity Disorder (ADHD)" and use the differential to recognize the ASD. They collected 65values of differentials on facial images of patients as a dataset and trained deep learning model.

Some of the previous studies also developed models for ASD based on brain neuroimaging. In [19] parikh et al developed a model for autism spectrum detection using machine learning algorithms. They created a dataset comprising of 851 persons.

In [20], Thabtah and Peebles et al used a concept of "Rule based machine learning (RBML)" algorithm to detect ASD.

All the methods discussed in the previous literature suffered from a tradeoff between speed of the system and accuracy. Many have achieved acceptable accuracy levels but cannot be of practical usage as they are very slow and require complex procedures for a real time usage.

In this study we propose a transfer learning based Deep Learning model to perform ASD based on image recognition. The model can act as diagnostic test with aid of high specific cameras available in the mobile phones. The model achieves an acceptable accuracy and can be reliable. Thus, proposed system is more useful practically than the existing methods.

3. System Design

The architecture of the proposed system is as follows

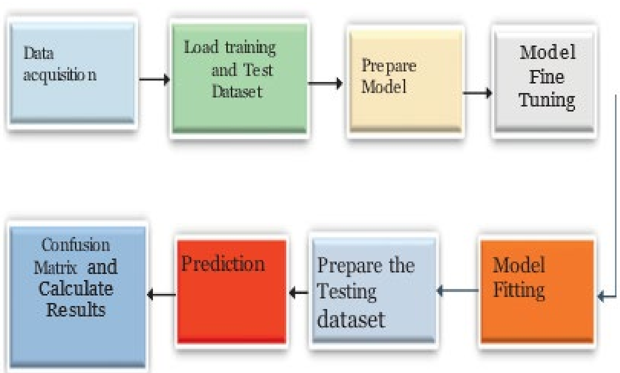

Fig. 1. Architecture of proposed system

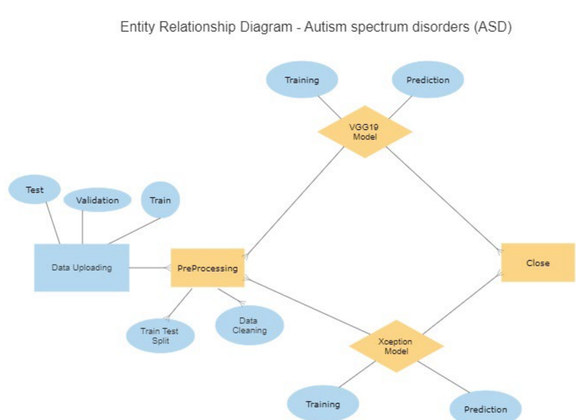

Fig. 2. ER diagram of the system

A. *Data Set Description & Analysis*

In this project the dataset used is taken from an online Kaggle platform comprising of images of the face of children affected by autism and normal child patients. This has 2,940images, out of which 50% are autistic and the rest are of healthy. The details of the data are presented in Figure 3.

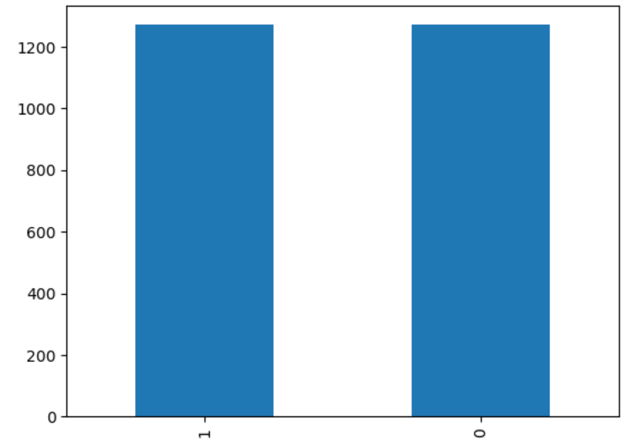

Fig. 3. Details of the data set

B. *Preprocessing*

The data used in project is collected from various online resources by Piosenka [34]. These images are of different sizes, compression standards and comprising of impurities. Hence these are to be preprocessed. Thus, the preprocessing involves the standardization of images and filtering these images.

The next step is to split the data set into three groups- training set of 2540 images, validation set of 100 and testing set of 300 images. The splitting can be shown as in the image below.

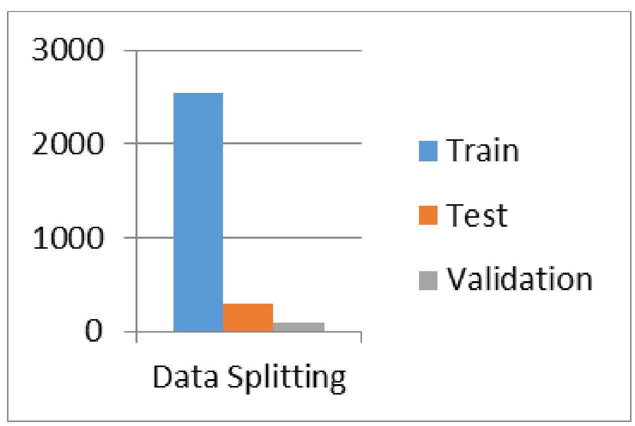

Fig. 4. Splitting of the dataset

The next step is to scale the pixel values from [0,1], for this, the method of regularization is applied. The dataset is then rescaled on all the parameters of all the images from the pixel values [0, 255] to [0, 1].

C. *VGG19 (Visual Geometry Group) model*

This is a deep Convolutional Neural Network (CNN) comprising of 19convolutional layers.

VGG Architecture:

The VGG networks are constructed with convolutional filters of small size (size of 3 X 3 used in this work). The Proposed network comprises convolutional layers in the first 16 layers followed by 3 fully connected dense layers. The brief architecture of VGG can be given as

Input Layer: The input layer takes an image of size of 224×224for standardization.

Convolution Layers (15 Layers): The convolution layers use windows of 3×3, which captures all the features of the image. Along with these 1×1 a convolution filter is used for which it performs a linear transformation of the input. After convolution ReLU function is then applied to create the non-linearity.

Hidden Layers: The VGG network uses ReLU activation in the hidden layers. They process the features extracted and assist the final stage of the network.

Fully Connected Layers: The final stage of the network is a combination of three fully connected layers. These layers use 4096 channels in each stage. The primary task of these layers is to make the output decision.

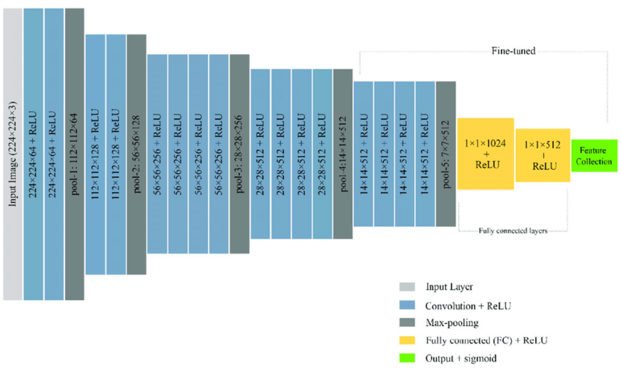

Fig. 5. Architecture of VGG19 model

D. *Xception Network*

The network is a deep convolutional neural network with an architecture that comprises of repeating structures known as inception modules.

The model uses very small window of 1 X 1 for convolution operation. Xception network is a special type of network which performs the reverse operation to that of a conventional Convolution Network. The network initially filters on a depth map first and then reduces the level to 1.

The Xception network comprises of three levels of information flow – entry level, middle level and exit level.

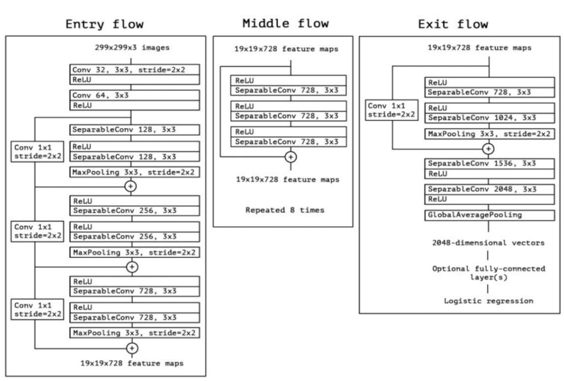

Fig. 6. Architecture of Xception model

4. Output Screenshots

The Screenshot of the Graphical User Interface of the proposed system is as shown below.

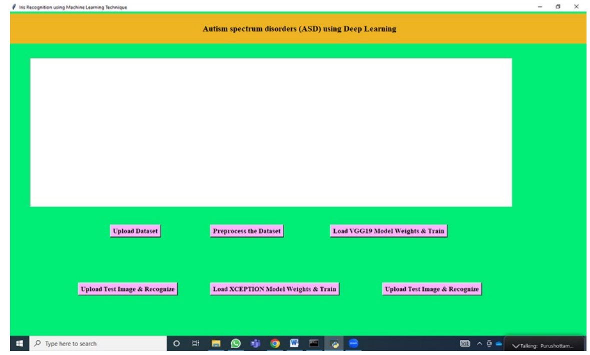

Fig. 7. GUI of the system

The testing of the models is done by giving the various images.

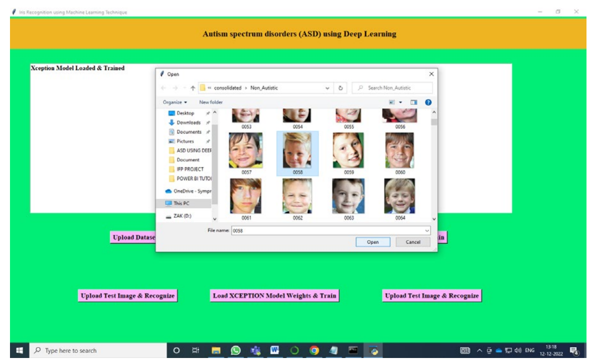

Fig. 8. Selection of input screenshot

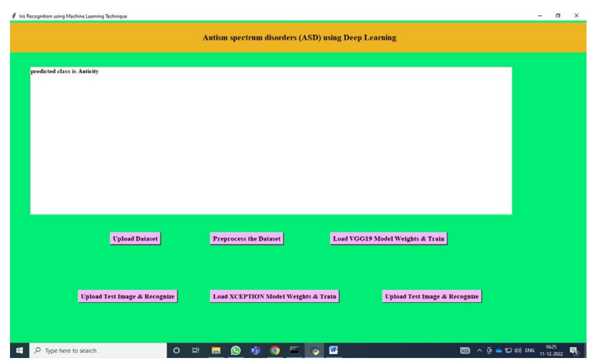

Fig. 9. Output of VGG19 model

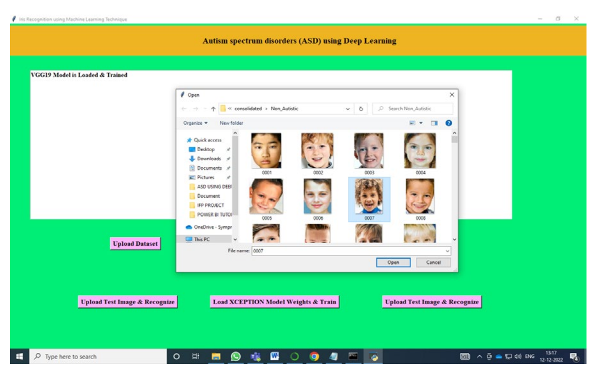

Fig. 10. Selection of input

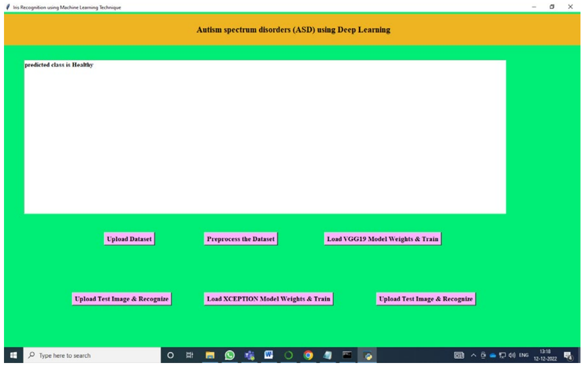

Fig. 11. Output of Xception model

5. Conclusion

In this project a system for autism spectrum disorders (ASD) using the inspection of facial images of the children has been presented. The system uses the concept of Convolutional Neural Networks (CNN) as the base principle. Two pre trained versions of the CNN namely VGG19 and Xception have been used for the pattern recognition from the images.

A Graphical user interface was designed for using of the application. The models were trained with the dataset available publically given by Kaggle platform.

The results gave an accuracy of 81 % for VGG19 model and 86% for Xception Model. Thus, Xception model achieves the better accuracy of the two.

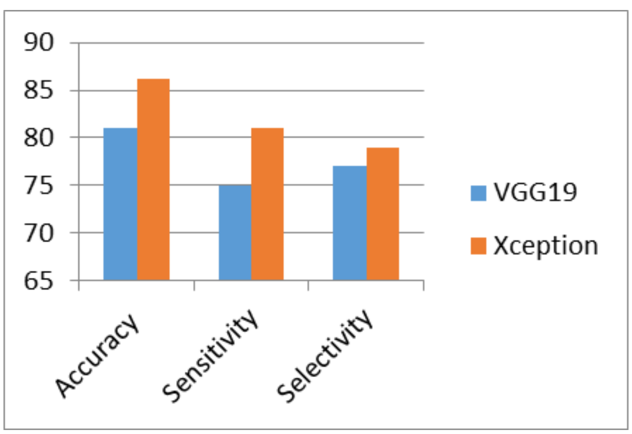

Fig. 12. Comparison of two models

Also, the system was tested by applying new images of both healthy and autistic patients. The prediction results were matched with actual classes which show that the proposed system can be used in real time applications which could help the physicians in diagnosing the patients early.

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