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Interpretation of Autism Spectrum Disorder through Artificial Intelligence

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Abstract: Autism spectrum disorder (ASD) is a human developmental condition which affects the development of proper social interaction, speech and nonverbal communication, restricted/repetitive behaviours, and is characterised by some extent of impaired social behaviour, communication and language, activities among individuals. This project presents a software tool for autism disorder analysis that combines an advanced technique of artificial intelligence Multi Cascaded Neural Network Model with emotion analysis for generating an assessment report of patient, thus helping physicians to understand symptoms of Autism disorder and attributing for effective diagnosis of ASD during early stages. The project by using its state-of-the-art software model also briefly studies about the different emotional patterns outputted by a typical ASD patient while analysing the features of face, like the positions of different facial landmarks adding to various research aspects.

I. INTRODUCTION

Autism spectrum disorder (ASD) is a condition that impairs the ability of an individual to communicate and interact socially by hindering his/her overall cognitive development necessary for general socialization, wherein an individual suffering from ASD can struggles with focus, attention, transitions, organisation, memory, time management, emotional control and frustration, all of which helps a person to solve his/her daily tasks. People suffering from ASD although unable to perform daily tasks with ease, are known to excel in anyone hobby or task depending upon the exposure with recorded cases of proficiency in Music, Drawing, Artistry which could indicate a greater development of right side of brain and is often associated as a state of mind.

In this fast moving world it is certainly difficult for anyone suffering from such a condition as they take much more time to adapt in any external situation, for this purpose the most of the treatments provided concentrate on supporting them in acquiring new knowledge as there is no fixed cure identified for this condition. Identification of ASD in a early stage is necessary as it could improve chances of one to normalize simultaneously with aging much better than those who are not, for this purpose, it is necessary for a any physician to conduct good diagnosis methods based on clinical interviewing act as frontline methods that can help one understand the nature as well as other dynamics of the condition, the project here presents such a method that will help in carrying out effective diagnosis.

A. ASD in General Population and Problem Statement

ASD is known to considerably limit the capability of a person to conduct daily activities and participate in society. ASD usually negatively influences the person's instructional and social attainments and opportunities, ASD is also one of those medical conditions that is on a rise, WHO estimated that in whole of human population One in every 160 children suffer autism spectrum disorder (ASD). The occurrence of ASD begins simultaneously when the growth of an individual with the conditions associated being apparent within the first five years of life. Scientific evidences suggests that factors including environmental and genetic can make a child more likely to be affected by ASD. Studies suggests prevalence of ASD at 61.9/10,000 globally, while in India it has been estimated that more than 2 million people might be affected. Although some individuals with ASD are able to live independently with appropriate support and treatments, others have severe disabilities and require life-long care and Medication support.

Treatments for ASD is of higher importance as Individuals with ASD are often subjected to disgrace and discrimination, including unjust deprivation of health care, education and opportunities to engage and participate in their communities, as people suffering are much more vulnerable to such emotional pressure this could have an overall negative effective to their self-esteem, while making them more vulnerable to acquiring chronic non-communicable conditions because of behavioural risk factors such as physical inactivity and poor diet, and also being at a greater risk of violence, injury and abuse. Medical issues such as gastrointestinal (GI) disorders, seizures or sleep disorders, and mental health challenges such as anxiety, depression and attention issues commonly accompany someone suffering from ASD.

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Medicines for treating autism are most effective when used in conjunction with behavioral therapies, and are used mainly for treating three core symptoms of autism i.e. communication difficulties, social challenges and repetitive behaviour, this project has its scope in behavioural therapy aspects for ASD.

B. Existing methods used for Diagnosis and their Shortcomings

Evidence-based psychosocial interventions, such as behavioural treatment and parent skills training programmes, can reduce difficulties in communication and social behaviour. The early signs and symptoms of autism vary widely. Some children with ASD only have mild symptoms, and others have severe behavioural problems relating to communication (verbal and nonverbal), social interaction, repetitive behaviour. To assess such problems currently physical and neurological examination has been used, however the behavioural aspect is known to be time consuming and can be subjected to human errors. For autism diagnose, a combination of many tools is used in autism diagnosis these include Ages and Stages Questionnaires (ASQ), Autism Diagnostic Observation Schedule (ADOS), Childhood Autism Rating Scale (CARS), Autism Diagnostic Observation Schedule—Generic (ADOS-G), Pervasive Developmental Disorders Screening Test—Stage 3, Parent's Evaluation of Developmental Status (PEDS), Gilliam Autism Rating Scale, Screening Tool for Autism in Todd. Physicians play a crucial role in ensuring best practices in autism evaluations, through initial identification, selection of a referral, and discussions with parents and caregivers about what to expect and how to get the most from a diagnostic evaluation. Paediatricians in particular, given their more frequent contact with children compared to most specialists, are in the best position to monitor the needs of children with ASD over the course of development and within the context of their overall physical health. The project here also opens a possibility in developing a single reliable method tool rather than a combination.

C. Deep Learning and its Application for ASD Diagnosis

Deep learning is a type of artificial intelligence-based software technique that replicates the workings of the human brain in processing data while creating patterns for use in decision making. Deep learning excels on tasks where the inputs and outputs are analog. Thus, proving efficient for doing training and analysis on images, pixel data, documents of text data or files of audio data. Deep learning techniques include architectures and methods based upon neural networks such as Convolution Neural Networks (CNN) and others.

Diagnosis and treatment of disease has been a focus of AI since the 1970s, with initial applications focusing on applications such as diagnosis of blood-borne bacterial infections. Early Deep learning rule-based systems showed promise of accurately diagnosing and treating disease, but were not adopted for clinical practice as at the time they were not limited compared to human counterparts, due to lack of development in technology and poor integration with clinician workflows and medical record systems.

By the late 90s and with advent of the 21st century, there were significant development in technologies with better hardware providing much more improved software optimizations, which added to a significant shift focus of AI applications in precision medicine, particularly cancer diagnosis and treatment. Deep learning models are trained for specific image recognition such as nodule detection on chest computed tomography or haemorrhage on brain MRI. With increasing applications in other diagnosis-based methods, AI-based systems have become part of nearly considerably decreasing human errors and increasing efficiency, thus proving reliable in healthcare applications.

II. TECHNIQUE

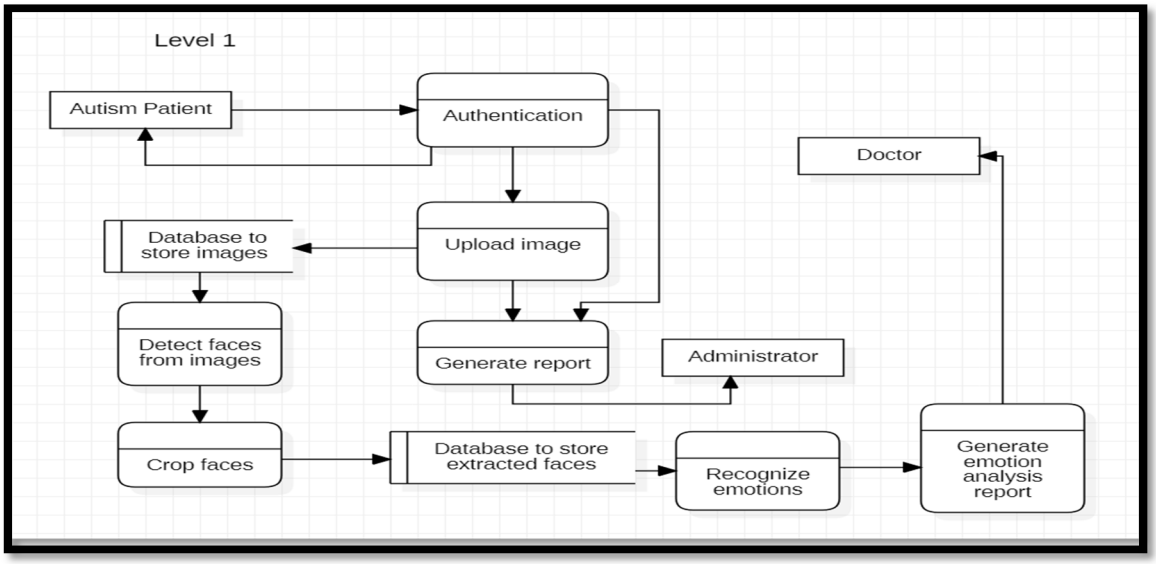
This project uses the method of deep learning, extensively concentrating on a software platform based on Neural networks. The project uses Multi Cascaded Neural Network Model MTCNN (Multi-task Cascaded Convolutional Neural Networks) for the purpose of making analysis of autism disorder, the algorithm consisting of 3 stages is used here, which detects the bounding boxes of faces in an image along with their 5 Point Face Landmarks. Each stage gradually improves the detection results by passing its inputs through a CNN, which returns candidate bounding boxes with their scores, followed by a process called non max suppression. The three main contributions for performance improvement are carefully de- signed cascaded CNNs architecture, online hard sample mining strategy, and joint face alignment learning.

In stage 1, the input image is scaled down multiple times to build an image pyramid and each scaled version of the image is passed through its CNN. In stage 2 and 3, we extract image patches for each bounding box and resize them 24x24 in stage 2 and 48x48 in stage 3 then forward them through the CNN of that stage. Besides bounding boxes and scores, stage 3 additionally computes 5 face landmarks points for each bounding box. Dataset for emotion recognition used is "fer2013.csv" from KAGGLE.

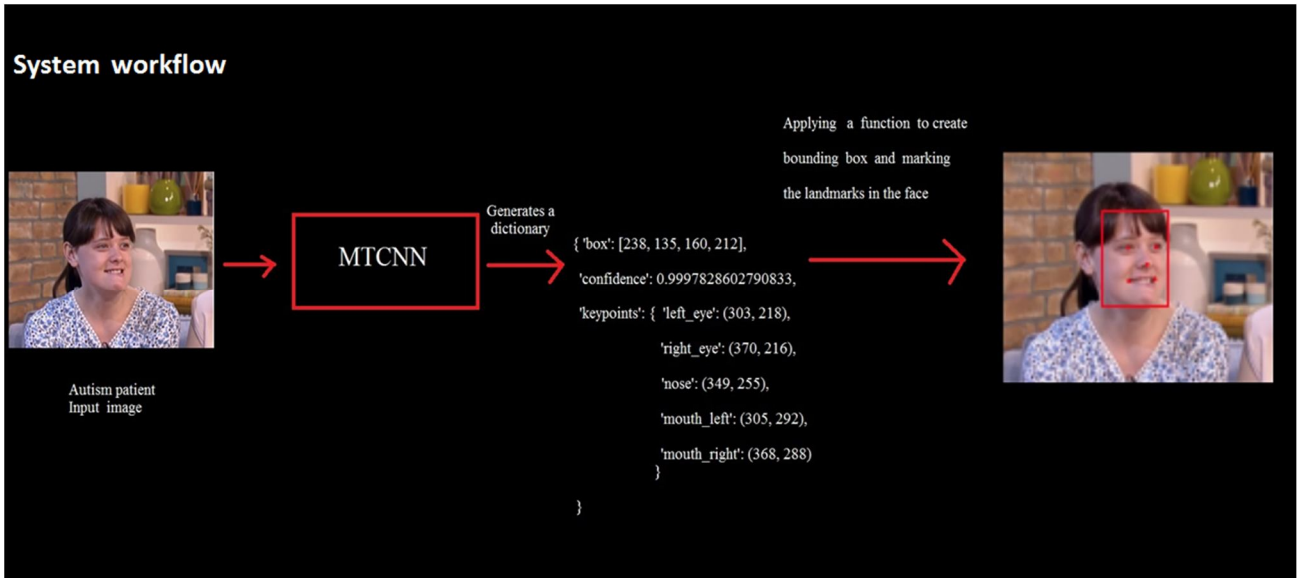
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In terms of workflow, firstly a session is enabled so that we are able to generate result and thereby producing necessary graphs using matplotlib. Then the dataset is retrieved for the training purpose of model. Image input given is then converted into desired pixel values and then converted into NumPy arrays which is required as a input in the model. Then information of these inputs is first passed through a function which detects faces first and then generates a nested dictionary for each face detected in given image storing information about the coordinates of window around face and the keypoints or features of face namely left_eye, right_eye, nose, left_mouth and right_mouth. This function generates output as an image by adding patches like rectangle around face and dots on the features of face.

The output of this function is taken as input to another function to extract faces from the given input image for further analysis. In here, this cropped face images will be used for emotion analysis purpose. After this, the image information will be passed in a sequence of Convolutional Neural Networks for training purpose of the model and then model will be able to recognize emotions. The function "emotion_analysis(emotions)" is used for plotting emotion analysis graph by using the information of cropped face. The function "EMOTION_ANALYSIS(image)" will display the final output of the project which will provide information of each cropped face from given input image and their corresponding emotion analysis graph. By checking the graph, we conclude that the program is able to recognize Seven emotions correctly.

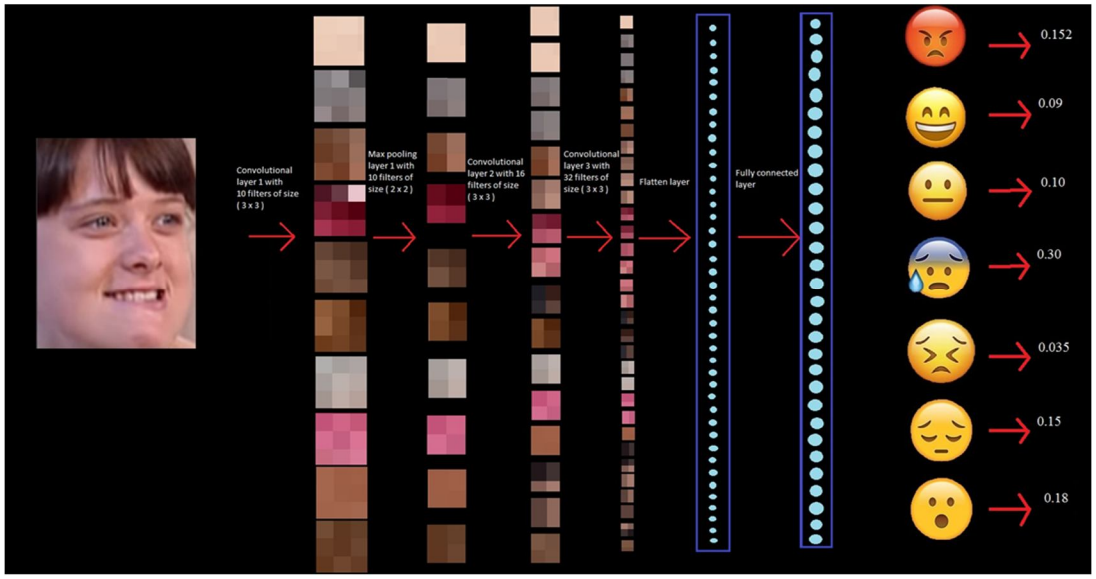


III. TEST SAMPLES



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In dark background, the system fails to work properly for patient.



The system doesn't work if it locates more than one patient. It means it only works for one patient.



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The system does not able locate the face of patient, if rotation or augmentation operations are applied.

IV. DISCUSSION AND SCOPE OF STUDY

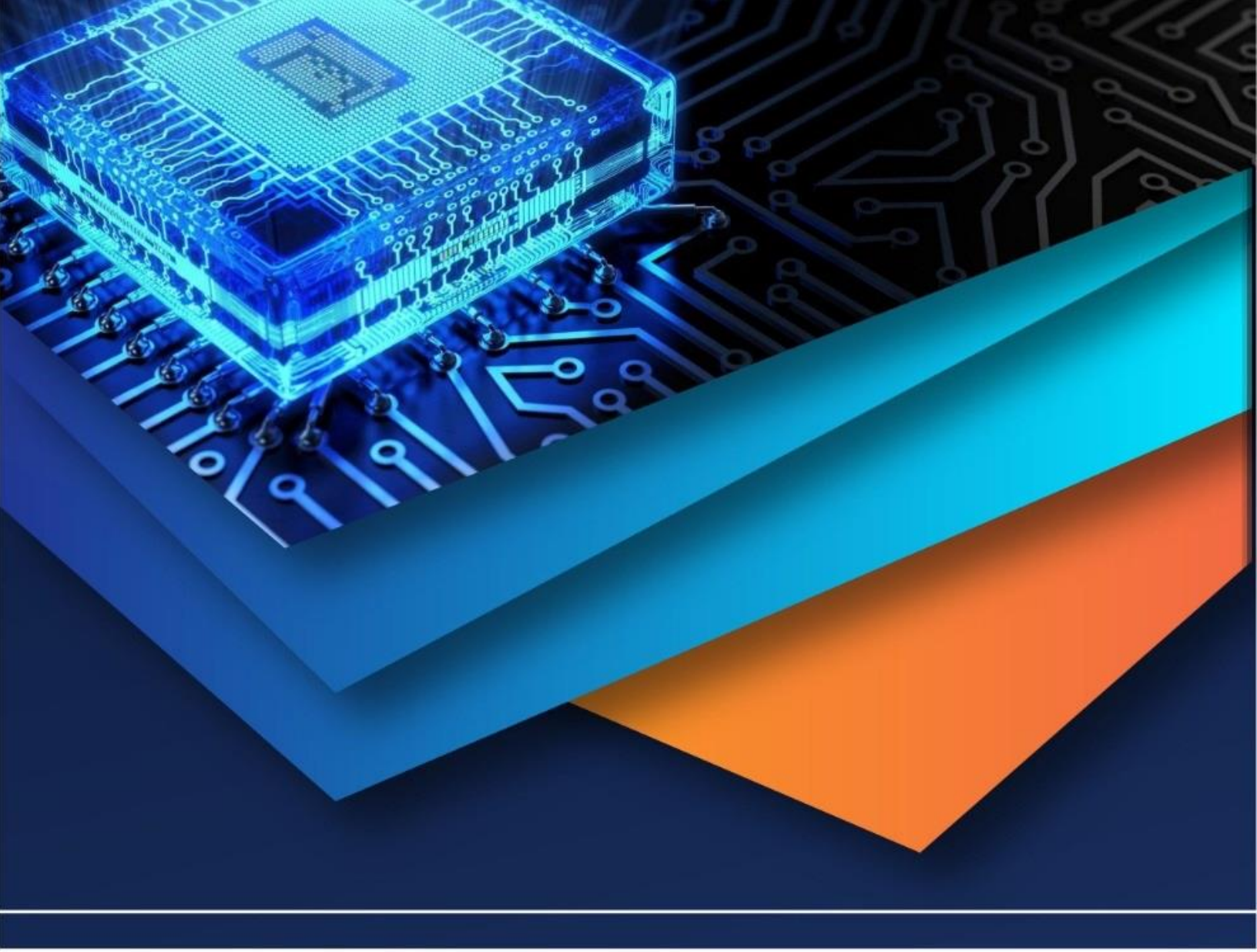
In this project, we propose a possible software-based solution for effective diagnosis of ASD condition, for which we use a multi-task cascaded CNN based framework for joint face detection and alignment. We use Multi Cascaded Neural Network Model for the purpose of making analysis of autism disorder which in turn will detect symptoms for it and understand those symptoms which will help for detecting autism. We have succeeded to identify positive, negative and neutral feelings to the entity under consideration 96.07 % accuracy based on various algorithm, unigram features augmented with linguistic features, thus demanding more training images. In addition, our experiments give us insights into the portability of the learned models across various images. The project also explores the possibility of developing a single reliable method for ASD diagnosis.

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