Analysis Paper: Detection of Autism by facial features and using identifying brain tumors using radiomics features

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***Abstract*— This is an analysis paper on identifying Autism in children by facial features and using radiomics features to identify tumors in the brain.**

Keywords—Autism, tumor, radiomics, features

I. Introduction

Autism is a neurodevelopmental disorder which majorly affects the development of the brain and physical appearance of the face. This paper focuses on studying the distinctive features of children with autism that differ them from children without autism and these facial features are used to identify autistic children.According the studies conducted earlier, autistic children have a broad upper face, including wide-set eyes, and a shorter middle region of the face, including the cheeks and nose. [1]

In the realm of computer vision, it might be difficult to identify developmental abnormalities from a face image. A neurological condition known as autism spectrum disorder (ASD) damages a child's brain from an early age. The verbal and social skills of autistic children are impaired, and they also have trouble focusing their attention on the right visual cues. Researchers are very interested in creating techniques to diagnose ASD and detect autism at an early age using various technologies as a result of the development of artificial intelligence, which has led to its increased use in the field of health and medical care.

Based on quantitative image features obtained from standard radiologic imaging, radiomics characterizes tumor phenotypes. When a child is affected by autism disorder, usually the amygdala part of the brain is affected and where the tumors majorly form. By using radiomics to identify the tumors in the brain we use MRI scans of the brain and extract features and deduce the presence of tumors.

II. Literature survey

A. Facial Features Detection System To Identify Children With Autism Spectrum Disorder: Deep Learning Models

By generating patterns of facial features and measuring the distance between facial landmarks, the CNN architecture has the right models to extract the features of facial images, which can classify faces into autistic and non-autistic. The dataset was subjected to three pretraining models—MobileNet, Xception, and InceptionV3—and the same layer and optimizer fine-tuning was employed to get extremely accurate results.[1]

B. Classification and Detection of Autism Spectrum Disorder Based on Deep Learning Algorithms

For ASD identification, the three pre-trained deep learning algorithms NASNETMobile, Xception, and VGG19 were used. Of the three pre-trained deep learning algorithms, the Xception model performed the best. A technique was created to assist health workers in identifying ASD using the eyes and faces. Several techniques have been used to validate and analyze the emerging system.[2]

C. Can Autism Be Diagnosed with Artificial Intelligence? A Narrative Review

In this study MRI/fMRI scans are used to give an overview of AI relevant to ASD. The classifier models and general radiomic features that are utilized to forecast the ASD images. Recent research demonstrates the informational nature of texture features. CNN has the best metrics when compared to other deep learning methods. However, additional research is required in relation to XAI. To predict early ASD patients, high-precision and high-transparency models can be created by quantifying the deep texture from CNN models.[3]

D. Brain imaging-based machine learning in autism spectrum disorder: methods and applications

Although several classification techniques have been used in MRI studies of ASD and have increased accuracy while showing multimodal brain abnormalities, additional focused experimental design, training, and validations are still needed to build a generalizable and trustworthy classification model, especially given the significant heterogeneity of ASD.[4]

III. implementation

Face images of autistic children are taken as input and a total of 68 facial landmarks are plotted. Predictive analysis is done by calculating the distance between these points and as discussed before, autistic children have a broad upper face, wide set eyes and shorted middle region. Simultaneously the points are plotted and the distance is calculated by using the points for facial feature analysis.

For the radiomics part a platform called Multimodal Radiomics Platform (MRP) & Machine-Learning Models is used. This is supported by Matlab, where we perform and import the MRI brain scans dataset into the platform. [5]

1.Interpolation of images

Where we resize images from one pixel grid to another. This helps when we need to increase or decrease the total number of pixels.

2. Apparent Diffusion Coefficient (ADC)

ADC is calculated by placing the smallest ROI. It measures the magnitude of diffusion within tissue. Higher ADCs indicate a low-grade astrocytoma, while lower ADC values indicate a malignant high-grade astrocytoma.

3. Coregistration

In this process the images are geometrically aligned so that the pixels representing the same objects may be integrated or fused.

4.Multimodality ROI

The simultaneous production of signals for multiple imaging techniques is referred to as multimodal imaging or multiplexed imaging. The purpose of multiplexed or multimodal imaging is to enhance cancer early detection and localization.

5.Plotting histogram

Histogram is plotted between the count and intensity of the image.

6.Obtaining radiomics features

Features that are obtained: Energy, Entropy, Kurtosis, Maximum, Mean, Mean absolute deviation, Median, Minimum, Range.

A. Abbreviations and Acronyms

ASD : Autism spectrum disorder

ROI: Region of interest

ADC: Apparent Diffusion Coefficient

MRI: Magnetic resonance imaging

B. Equations

Euclidean distance: To calculate distance between two points.

$$d(P,Q) = \sqrt{\sum_{i=1}^{n}(p_i - q_i)^2}$$

Radiomics features and their formulas [6]

- Energy: The magnitude of the voxel values in an image is evaluated by energy.

$$energy = \sum_{i=1}^{N} (\mathbf{X}(i) + c)^2$$

- Entropy: The image values' degree of unpredictability and uncertainty are described by entropy.

$$entropy = -\sum_{i=1}^{N_l} p(i) \log_2 \big(p(i) + \epsilon\big)$$

- Kurtosis: The "peakedness" of the distribution of values in the picture ROI is measured by kurtosis.

$$kurtosis = \frac{\mu_4}{\sigma^4} = \frac{\frac{1}{N}\sum_{i=1}^{N}(\mathbf{X}(i) - \bar{X})^4}{\left(\frac{1}{N}\sum_{i=1}^{N}(\mathbf{X}(i) - \bar{X})^2\right)^2}$$

Where $\mu 4$ is the 4th central moment.

- Maximum: The region of interest's (ROI) maximum gray level intensity.

$$maximum = \max(\mathbf{X})$$

- Mean: the ROI's mean average gray level intensity.

$$mean = \frac{1}{N}\sum_{i=1}^{N}\mathbf{X}(i)$$

- Mean absolute deviation: The average distance between each intensity value and the average value of the image array

$$MAD = \frac{1}{N}\sum_{i=1}^{N}|\mathbf{X}(i) - \bar{X}|$$

- Median: The ROI's median gray level intensity.

- Minimum: The ROI's minimum gray level intensity.

$$minimum = \min(\mathbf{X})$$

- Range: The ROI's range of gray values.

$$range = \max(\mathbf{X}) - \min(\mathbf{X})$$

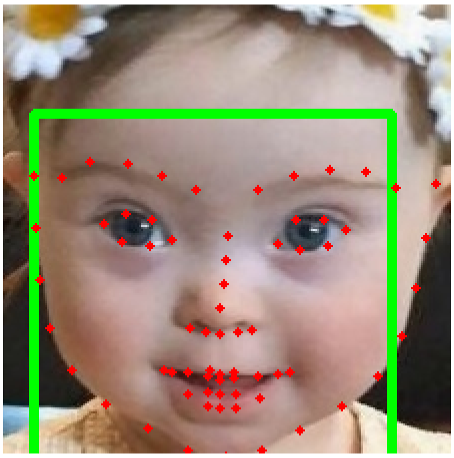
IV. RESULTS AND DISCUSSIONS

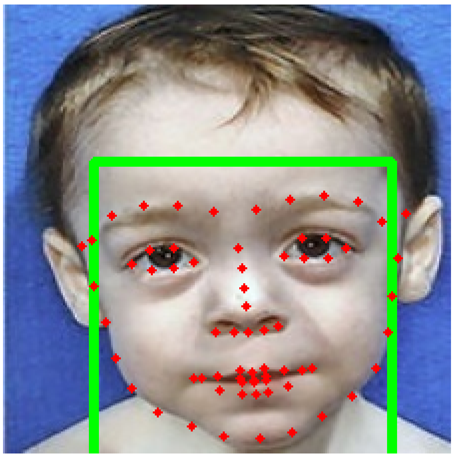
After completing the implementation process we obtain the facial landmarks, where further euclidean distance can be calculated and prediction of autism with facial analysis can be done.

Radiomics features which are obtained can be analyzed as per each feature and predict the presence of tumor or its development.

A. Screenshots

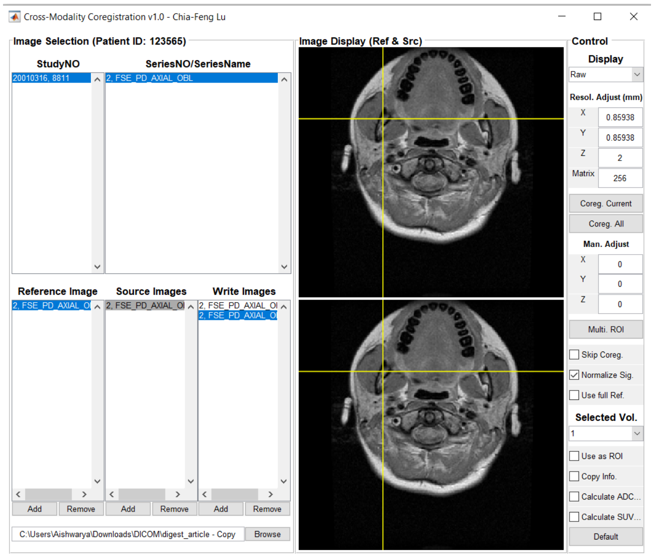
1. Facial landmarks



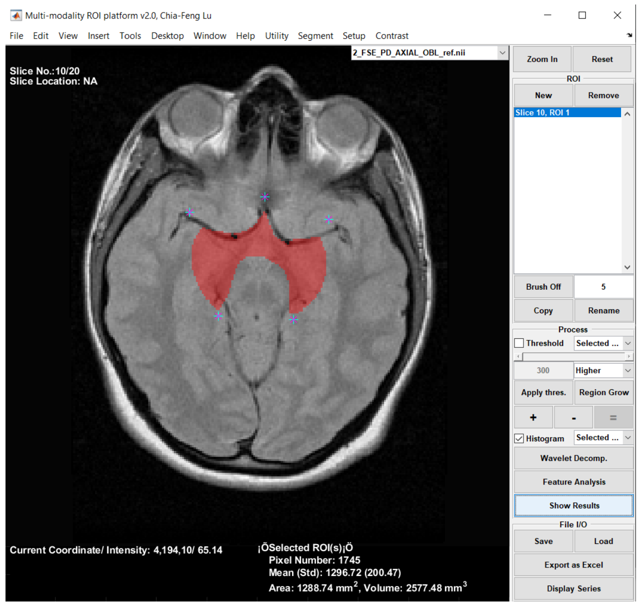


2. Dicom image processing platform

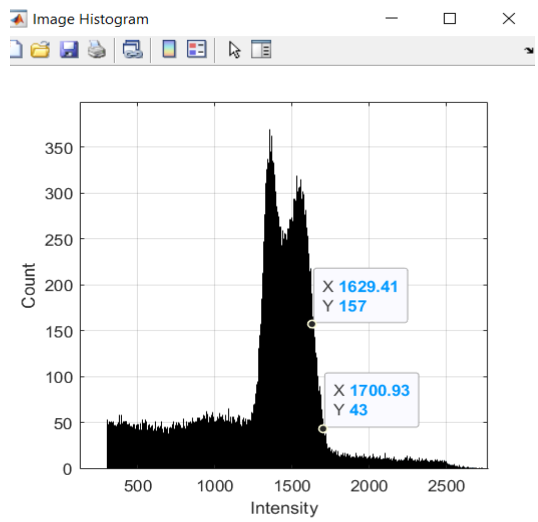
3. Cross modality Coregistration



4. Multimodality ROI [amygdala]

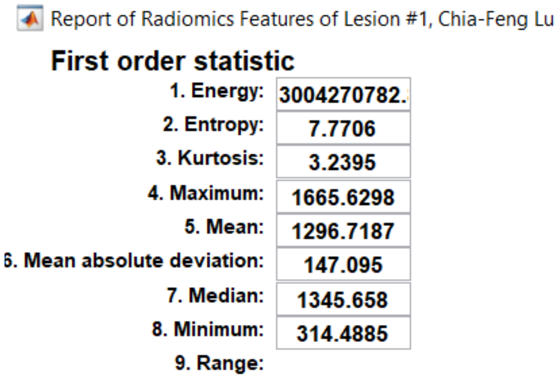


5. Histogram



B. *Figures and Tables*

Radiomics features:


Report of Radiomics Features of Lesion #1, Chia-Feng Lu

First order statistic

1. Energy:	3004270782.
2. Entropy:	7.7706
3. Kurtosis:	3.2395
4. Maximum:	1665.6298
5. Mean:	1296.7187
6. Mean absolute deviation:	147.095
7. Median:	1345.658
8. Minimum:	314.4885
9. Range:	

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