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Original Article

Study of Control and Autistic Brain Based on Corpus Callosum Analysis

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Abstract *— In the present world, autism is a potential threat to child development. It is a non-curable developmental neural disorder that is featured by inconvenieces in social interactions. It is marked by impaired communications, restricted and repetitive interests, and behaviours. The malfunctioning corpus callosum (CC) is the main culprit for autism. In this paper, we study CC to differentiate between autistic and control brains. To accomplish the study, image segmentation, edge detection, and morphological operation techniques are introduced. To note, comprehensive experiments on fMRI images demonstrate the efficiency of our work.*

Keywords — *Autism, Corpus Callosum, Image Segmentation, Edge detection, Morphological operation.*

I. INTRODUCTION

Autism is known as a complex developmental disability. It is a neural disorder that results in the abnormal rise of the child. The cells of brain growth are obstructed in autism outcoming in impecunious transmission and consciousness. The signs and prefix look at an early age, and if they do not appear well enough, they can outcome in an interrupted raise of the children. At the age of six months, the prefixes appear and can be fagot to the kid even in youth. Each individual with autism is unique. Autism spectrums have remarkable efficiency in music, visualizations, and scholastic skills. Most probably, 40% have mean to upon average metaphysical abilities. About 25% of the person with autism spectrum disorder are uncommunicative but can study to convey using other means [1].

ASD or Autism Spectrum Disorder can sometimes be mentioned as Autistic Spectrum Disorder. Autism Spectrum Disorders are any kinds of disabilities that have been caused by a brain unusualness. An ASD person generally has trouble with convivial and communication proficiency. Those people also prefer to stick to a set of characteristics and will defend any major and minor interchanges to daily activities [2].

The corpus callosum is the biggest cohesive way in the human brain. In the right and left portions of the brain, more than two hundred million nerve fibres are associated. If we dissection a brain, we would carve across the fibres. When seeing at the centre part of the brain, the corpus callosum looks the same as the dissection of a mushroom hat at the centre of the human brain. Each planisphere is learned to control deportment and sentiment in the converse partial of the human body. To figure out difficult information, the planisphere should link with each other. It is the one and only adapter that consents to that transmission. The corpus callosum evolves between twelve to sixteen weeks after impregnation in a child's brain. The entire structure improves before birth, and the corpus callosum fibres go on with to become effective and important into adolescence. Therefore, a kid is about twelve years of age, and the corpus callosum processes actually as it will in youth, benign quick communication between the 2 parts of the brain. At this age, it becomes progressively useful in their dynamic peers, the kid with agenesis of corpus callosum seems to drop backside developmentally cause the corpus callosum is missing.

The body includes various functionalities of the corpus callosum. They are:

- Transmission in brain planisphere
- Movement of eye
- Observing the equity of awaking and attention
- Localization of tactile

Many researchers were worked with autistic brains based on corpus callosum analysis. Renteria-Vazquez et al. (2021) correlated the capability of fourteen people with AgCC, thirteen very high-activating adults with autism spectrum disorder, and fourteen neurological mortifications to correctly feature communal context to the interconnections of buoyant triangles [3]. In 2021 Loomba et al. showed morphological variations in the corpus callosum in autism spectrum disorder association inequality. The missing of an important concern between architecture and useful homotopic comparability aligns with antecedent findings [4]. Guo et al. (2021) identified neuroimaging biomarkers with dysgenesis of CC by shortening neurological morbidities indicated in medical evolvements and matching them up against them with diffusion magnetic resonance imaging allowance from thirty-nine victims or controls, which mean age 5.30-11.08 [5]. Kim et al. (2022) applied ML classifiers to bounds from T-One weighted magnetic resonance imaging and DTI records of fifty-eight kiddies with autism spectrum disorder whose age was between 3 to 6 years old and forty-eight generally maturing controls. The classification results are an accuracy, specificity, and sensitivity of 89.0%, 83.8%, 93.0%, respectively. The most significant features were mean diffusivity of the midst CP (Cerebellar Peduncle) and nodal capability of the left PCG (Posterior Cingulate Gyrus) [6].

Therefore, the corpus callosum is situated underneath the cerebrum at the middle of the brain. The CC disorders are provisos in which it does not evolve in a general aspect. These are abnormalities of human brain architecture. It can be found by brain examination. Some people with these situations are normal. Many other people with abnormalities of the CC do recompense clinical mediation because of convulsion or any other clinical complications they have in adherence to the abnormalities of the CC.

II. OVERVIEW OF THIS WORK

In our work, the fMRI images are taken as the input image. The threshold method has been applied for segmentation. The segmented results are taken as input for edge detection operation. The output image is used for the morphological operation. The generated images upon morphological operation are used to compare control and autistic brain.

III. IMAGE ACQUISITION APPROACH

It is a method of detecting our ambiences and then presenting the testimony that is built in the model of an illustration. To focal point part of the optical status onto a sensor, the camera uses a lens. The monumental properties of a lens are:

- The power of magnifying objects and
- The capacity of conveying light.

The factor of magnification:

$$m = \frac{Size\ of\ Image}{Size\ of\ Object}$$

The distance is:

$$\frac{v}{u} = \frac{Size\ of\ Image}{Size\ of\ Object}$$

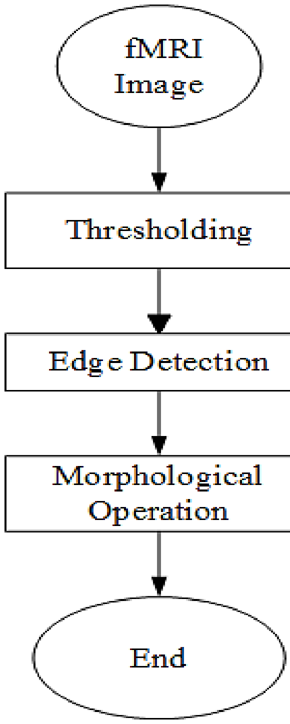


Fig. 1 Basic Steps of This Work

IV. FMRI APPROACH

Functional Magnetic Resonance Imaging (fMRI) is a magnetic resonance imaging algorithm that calculates human brain movement by identifying collective differences in blood outflow. The general form of fMRI uses the BOLD comparison, invented by Seiji Ogawa [7]. It is a particular human brain and body scan applied to map neural functionality in the spinal cord or brain of animals or humans by illustrating the variation in blood circulation concerned to power use by brain tissue. In the 1990s, functional magnetic resonance imaging has become subjugate brain calibrating analysis. So that it does not desire individuals to sustain shots, ingest substances, enucleation, or be disclosed to radiation. The procedure is the same as magnetic resonance imaging but uses the variation in maximization between oxygen-poor and oxygen-rich blood as its general dimension. This dimension is repeatedly ruined by distortion from different origins, and statistical algorithms are applied to suck the basic signal. The subsequent brain promptness can be represented by colour-coding the power of promptness through the brain, or the tangible location studied. The method can contain movement to within mm (millimetres) but, using sophisticated methods, no sophisticated than inside a window.

Functional Magnetic Resonance Imaging is used both in the clinical world and the research world. fMRI can be joined and integrated with another computer for brain analysis. The spatial and time verdict is being experimented with with advanced techniques. These are widely used biomarkers. Many organizations have exhibited profitable goods like as lie warner based on functional magnetic resonance imaging approaches, but the analysis is not trusted to be skilled adequacy for all over the place commercialization.

V. METHODOLOGY

In this work, the fMRI image of Corpus Callosum (CC) of the brain of autistic patients and control (normal) has been taken as input for applying different image processing techniques. Here Thresholding, Edge Detection, and Morphological operations are used for analysing the images. Finally, the output has been compared between a normal brain and an autistic brain.

A. Thresholding

The thresholding approach is referred to as the component of the image [8]. It prefers appropriate thresholds T values to partition image pixels into various classes. It partitions the main objects from the background. Suppose any point (x, y). For this point, f (x, y) > T is said the main object point, and a background point is f (x, y) < T. The thresholding method here is used as a moderated way in the proposed method. In a binary image, a T value is exposed to take all of the values to lower the T to 0 value and another all to consider the value as the actual image. It aids to find the abscond object more accurately. As we did not generally use the thresholding method, instead, we are trying to consider objects within appropriate pixel values.

$$g(x,y) = \begin{cases} f(x,y) & if\ f(x,y) > T \\ 0 & if\ f(x,y) \leq T \end{cases}$$

A threshold value T is selected, which is shown in the above equation. The value below T is 0 and other areas like as actual image f (x, y). So, it gives vary the necessary part easily.

B. Edge Detection

It is the method of detecting and finding keen disruptions in an image. The disruptions are sudden diversity in pixel intensity that differentiate the boundaries of objects. There are many edge detection methods. But we use Sobel and Canny operator methods. The Sobel operator computes the acclivity of the intensity of the image at a certain point. By allowing the guidance of the greatest potential rise from dark to light and the movement of diversity in that guidance. The output outcome shows how suddenly or fluently the image interchanges at that point. That part of the image illustrates an edge. The magnitude computation is better feasible and simple to explain than the superintendence measurement.

The steps of the Sobel edge detection technique are:

Step 1 : Read the Input Image.
Step 2 : Identify the Centre Cell.
Step 3 : Apply Image Dilation.
Step 4 : Internal Gaps are Block.
Step 5 : Linked Objects are Eliminated on Outskirt.
Step 6 : Flatten all the Objects.

Another edge disclosure operator is a canny operator that applies a various step algorithm to identify a vast area of boundaries in images. John F. Cannyin invented it in 1986. The algorithm has some separate steps:

Step 1 : To eliminate the noise, blur the image.

Step 2 : The boundaries must be identified where the acclivity of the image has extensive consequences.

Step 3 : Individual local superlatives must be identified as boundaries.

Step 4 : Possible boundaries are decisive by thresholding.

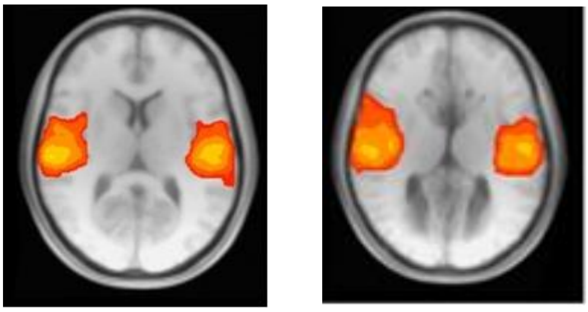
Step 5 : Ultimate boundaries are determined by suppressing all edges that are not connected to a very certain (strong) edge.

C. Morphological Operation

The morphology is to examine an image with a plain and predefined architecture which concludes how this architecture fits the shapes in the image. A probe is a structuring element. The image is greyscale and binary image. In the recommended method, the erosion approach is applied to eliminate unnecessary or little parts of the image. We have stated before that the erosion method in our proposed technique is not often used. The process will consider whether or erosion method is essential or not. According to image quality, this decision is taken. How much the image is complicated, or how much short rubbishes appear in the image after employing the thresholding method. The erosion method is needed to wince an image. After employing the thresholding method, the image has some little removable elements, which are also essential to remove in the study. A little size-structured element is envisaged in erosion. So, the actual element of the image is not ignored [9]. Dilation makes the objects richer and can merge various multiple objects into one.

VI. RESULT AND DISCUSSION

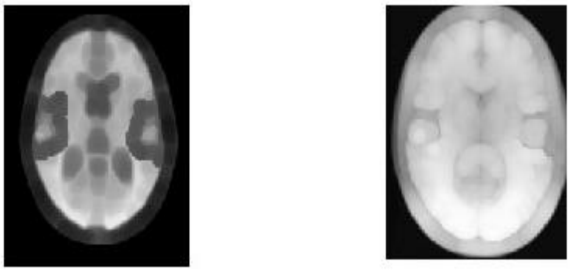
The technique discussed above is applied to fMRI images. The outputs of the thresholding technique on the normal and autistic brain are demonstrated in fig 3. Next, fig 4 represent the result of the edge detection technique. Finally, the outputs of morphological operation on the normal and autistic brain are shown in fig 5.



Normal Brain **Autistic Brain**

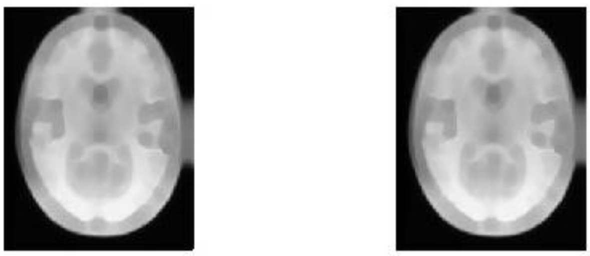
Fig. 2 Input Image

Original Image **Threshold Image**



Normal Brain

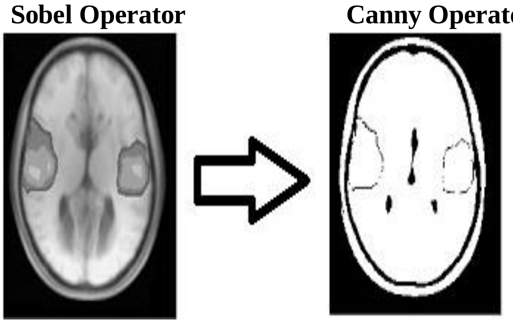
Original Image **Threshold Image**



Autistic Brain

Fig. 3 Image Thresholding

Sobel Operator **Canny Operator**



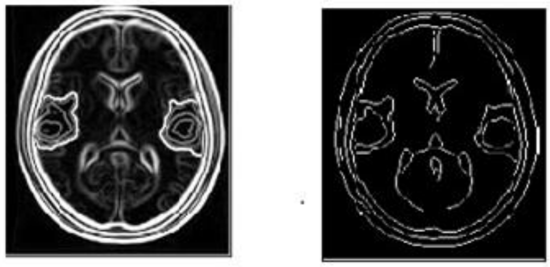
Normal Brain

Sobel Operator **Canny Operator**

Autistic Brain

Fig. 4 Edge Detected Image

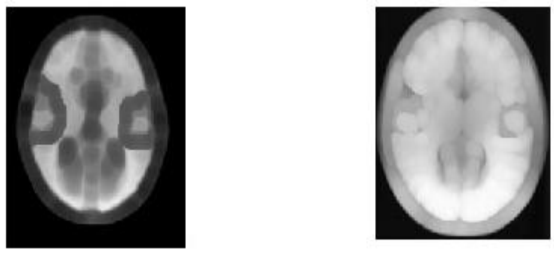
Erode **Dilate**



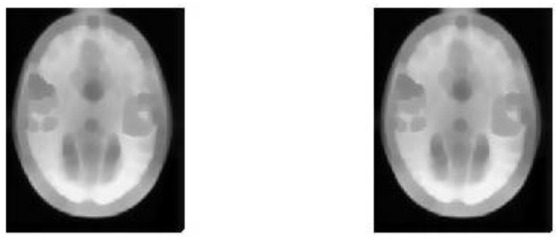
Open **Close**

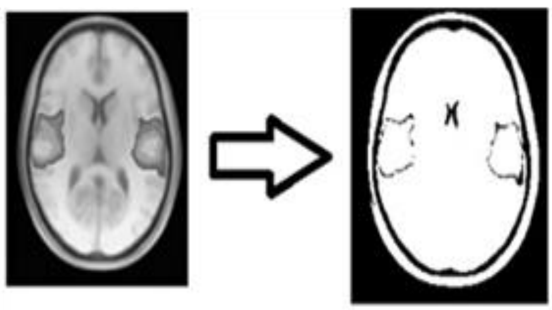
Normal Brain

Erode **Dilate**



Open **Close**





Autistic Brain

Fig. 5 Morphological Operation

In the output, we see that thresholding is used to identify whether the malfunctioning is present in CC or not. Comparing the edges between control and autistic, it is observed that the neural pathways do not appear very sharp in autistic patients. It also shows that various edges are disabled in the autistic brain compared to the control one. At last, the segmented results are taken as inputs for morphological operation. The generated images of morphological operation have been compared based on the activation of CC and other neural pathways of the brain. It has been observed that CC and other neural pathways are more hypoactive in patients with autism than in controls.

VII. CONCLUSION

In our research, we study the anatomical structures of the corpus callosum of brains of autistic and controlled individuals. We take the fMRI image and then apply different image processing techniques. We see that the CC part of the autistic brain and normal brain are significantly different from one another, which is one of the causes of autism.

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