# Identification of Autism in Children using MRI Images

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**Abstract—** *The objective of this work is to develop a system to identify Autism Spectrum Disorder(ASD) in terms of the changes seen in MRI images of brain. The work consist of 3 modules. First to segment the region of interest(ROI) from MRI brain images. Otsu's thresholding method is used in the image in order to segment the region of interests followed by forming the clusters by selecting the initial cluster values of k-means algorithm. Then the distance based algorithm is used to accurately segment the gray and white matter of the brain. Finally different shape and size based features of gray and white matter are extracted for the parts segmented in step 2 for different patients and the presence of Autism is identified by applying a two level rule based classifier for the data features extracted, we concluded by making the algorithm to comparatively result in healthy and ASD hit brains differentiation . We are trying to emulate the clinical diagnosis into machine through our work.*

**Keywords—***MRI,Autism Spectrum Disorder,Gray Matter(GM),White Matter(WM),Otsu's,K-means clustering.*

## 1. INTRODUCTION

Autism spectrum disorder (ASD) is a complex developmental disability usually found to develop in children.Autism, or autism spectrum disorder, pertains to a set of conditions where challenges lie with social skills, repetitive behaviors, speech and nonverbal communication, along with physical differences.The signs that show up during early childhood affect a person's to communicate, and interact with others.Autism is one of the worst disorders accompanied by multiple abnormalities questioning social interactions and communication and highly repetitive behavior.Some of the figures about Autism are as follows: 1.7 – 2 million children are affected by autism in India(source:Indian Scale Assessment of Autism,2016) which is 0.9 million more than the year 2013.1 in 66 children affected in India are between 2-9 years of age.(Source:India today).An estimated 50,000 teens with autism become adults – and lose school-based autism services – each year.Around one third of people with autism remain nonverbal and also have an intellectual disability.Certain physiological and mental health issues most probably come with Autism and they are seizures, irregular sleep, attention deficit and hyperactivity disorder (ADHD), anxiety and phobias.

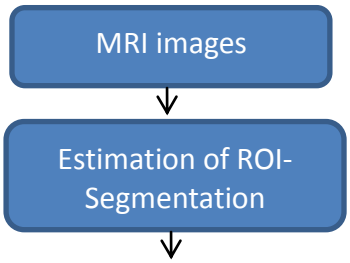
Autism is a kind of developmental disorder that significantly is seen to affect the children mainly due to the genetic carry over and the gene set determines the mental strength and developmental order of brain.This disorder,as in practice has a clinically acclaimed process of diagnosis and is not done with the help of any scan on the first hand itself.

Over years,Autism has been significantly developing in children and increases the need to be addressed.Various works abroad have been carried out to identify Autism in children. In the work of Anibal Sólon Heinsfelda[1], deep learning was applied to ABIDE dataset.Kenneth Hugdahl, PhD,[3] in his paper has concentrated on fMRI and concluded with the recordings from resting state fMRI.The recordings were observed and accuracy of finding autism was also recorded with SVM as classifier.

## 2.PROPOSED MODEL

In this paper, the differences or deviations in brain are recorded and they are taken up for further processing classified from the static images with frontal viewed brain images. It mainly consist of various modules face segmentation , different facial parts segmentation , feature extraction and developing classifier.The proposed model is a new trial because that this deals with MRI images based identification and the usual medical practice is clinically acclaimed.The model adds strength to the usual diagnosis.

Because the existing Functional MRI ( fMRI ) model that checks the patients' based on the oxygenated blood getting pumped in the brain regions by subjecting them into actions and because it cannot be deployed for reading individuals state of mental health,it is not used currently in India.



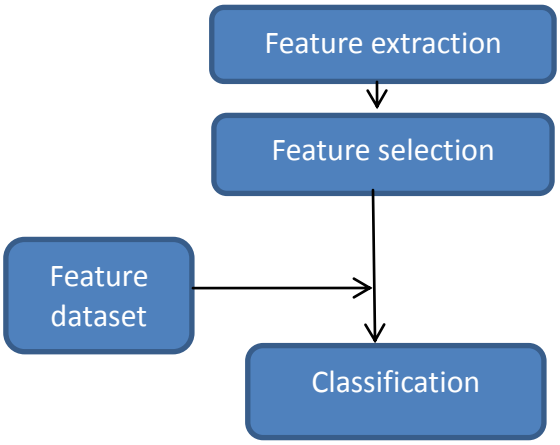



Fig 1. with the flow of the entire working of the proposed architecture.

As shown in fig 1, initially the gray matter is segmented from the frontal viewed brain image.The initial processing is done by using Otsu's thresholding method. Then k-means clustering is used to segment different regions of brain. Thirdly different shape based features are extracted for the parts segmented in the previous step. Finally a two level rule based classifier is developed with the help of the extracted features.

### 2.1 Reading of MRI images

The MRI images are read directly as dicom image in order to take the input in proper format.Other formats like JPEG are not entertained in order to avoid pre processing problems.If JPEG format is utilized for the input it is mandatory to make the images to undergo preprocessing by applying various filters.It is avoided now.

## 3.FINDING AND SEGMENTATION OF ROI

### 3.1 Threshold Selection

The basic thresholding method denotes to replace each pixel in an image with a black pixel if some fixed constant T is greater than the image intensity otherwise with a white pixel if the image intensity is greater than that constant. The threshold required for distinctly differentiating the regions from one another,can be selected either manually or automatically. In manual threshold selection 'imtool' command is used to find the threshold value between the interested region. and the background.

### 3.1.1 Otsu's Method

Otsu's method is being taken up since it automatically perform clustering-based image thresholding or, the reduction of a gray level image to a binary image. The algorithm presumes that the image consists of two different classes of pixels following bi-modal histogram , where it calculates the optimum threshold so that the two classes are separated and their combined spread is minimal, or far equal , so subsequently having the inter-class variance as maximum. By using this method the machine is made to select the threshold value automatically. Since in Otsu's method the threshold is found for the binary images the pixel value range from 0 to 1. So in this method threshold value found was of the value 0.5.

## 4 EXTRACTION OF REGIONS OF BRAIN

The primary module of this work is to eminently cluster or group the regions of brain distinctly in order to visualise the changes or deviations in the fundamental regions of brain.

- Thresholding methods such as Otsu's method.
- Colour–based segmentation such as k-means clustering.
- Transform methods such as watershed segmentation.
- Texture methods such as texture filters.
- In this paper, k-means clustering techniques is used.

### 4.1 K-MEANS CLUSTERING

In this project k-means clustering used with the number of clusters is taken as two. Here,the complete segmentation and the visualization of the segmented regions take place Considering two points namely the maximum value in every single row and also the minimum value in found out at the first place along with its average as the base, the pixel values closer to the calculated maximum average value are grouped together to form a a cluster and the pixel values closer to the minimum average value are grouped together in order to form another cluster.

Based on the clustering result, Two is the total number of components calculated from an MRI image. Based on these number of components, the person's brain images are segmented first by using bounding box function into two important regions of gray and white matter. There is no strict rule to start clustering the white matter or gray matter first because the abnormality in brain differs.

## 5 DIFFERENCES FOUND IN THE BRAIN IMAGES

### 5.1 Structural differences in gray and white matter

The image shows the distinct difference in the brain regions as recorded in MRI brain scan.The brain of an 8 year old without Autism is seen to have proper distribution of gray and white matter as seen from this temporal way.It is evidently seen to have a well-defined build of both these important regions in brain.The brain of autism affected child suffers an improper connections between the regions mainly between the white and gray. This confirms the abnormality that an autism hit child lacks healthy build of gray and white matter leading to all functional anti-correlations and physical challenges.The reason for this loss of texture is because the regions lose the nature of connecting with each other while carrying out a function.

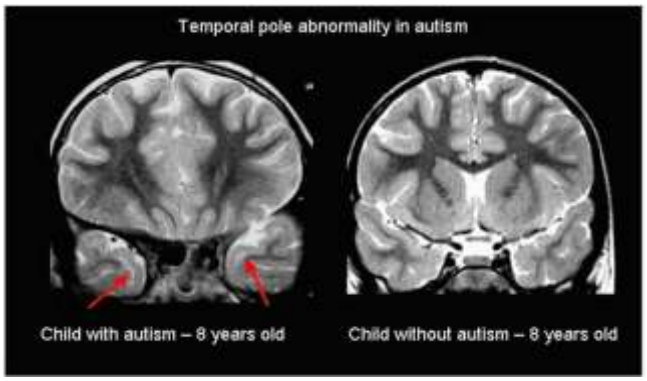



fig .2 showing the recorded differences between a 8 year old with and without Autism

### 5.2 Volumetric differences-a comparison.

Typically Developing Children (TDC) as they call the healthy children medically,were tested for recording of the comparative analysis between them and the ASD affected.Out of the volumetric analysis conducted,the graph was plotted and the differences was visually analysed.The volume of TDC brain increases correspondingly over years.The ASD children are seen to have a considerable reduction in the volume though the initial volume is higher.It clearly concludes that as ASD continues to develop the volume disintegrates adding to the reasons of regions' anti-correlation and deviating from its intended actions.Here,the volumetric analysis is carried out in terms of $cm^2$. But the volume comparison is taken into account as a secondary parameter because as the age increases there is no much deviation in volume and the graph denotes they both meet at one at a particular age. So volume of the brain is taken for analysis only.

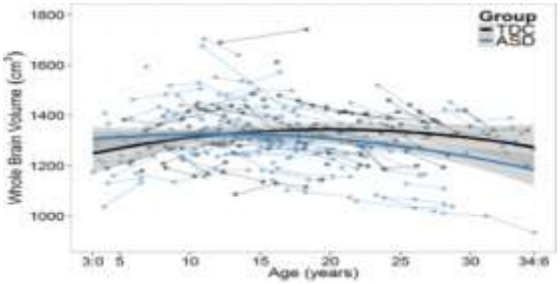



Fig 3 denoting the change in the brain volume as the age increases.(between TDC and ASD)

### 5.3 Clinical diagnosis and MRI diagnosis

The current medical practice in India pertains to clinical claiming of the symptoms oriented with ASD like inability to communicate etc.But when an MRI image is read and the gray matter ,white matter is studied in detail that would be an apt handle. The major difference is the help that this work will extend to the autism diagnosis now made easy.

## 6 RULE BASED CLASSIFIER

Based on the feature extracted above,the classifier is made to develop to attain the results. The variations in the size,shape and texture of Gray Matter(GM),White Matter(WM) are the main input factors considered for the classifier.The volume reduction is also considered. Thus a two level rule based classifier with the first level of classification depending on the size and texture differences of gray and white matter and they are checked to have distributed evenly and to have no harmful enlargements. Only if this deviates from healthy brain,the volume of the brain is taken into picture.Hence, the second level of classification is made based on the volumetric deviations that the autism hit brain could possibly have,usually reduction in volume is observed. The classifier is shown below

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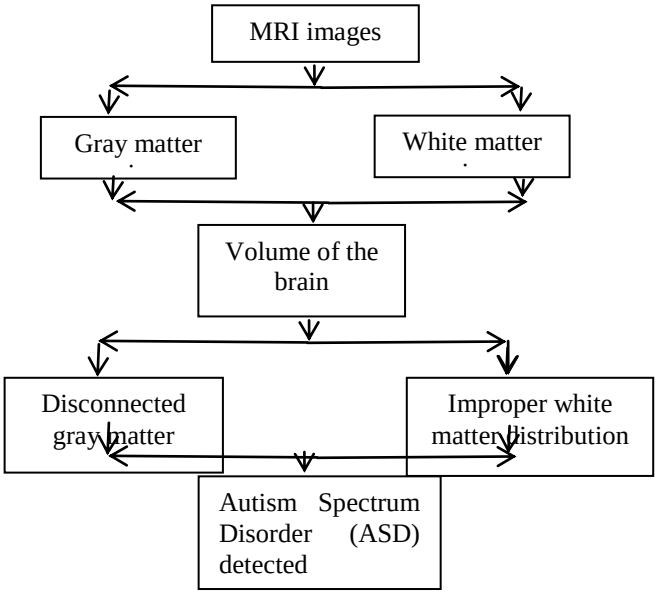


Fig 4. showing the level based classifier of SVM.

There are no stipulated values for gray matter white matter distribution and it cannot be restricted to one particular pattern regarding the brain health.So,this work is mainly useful in particular detailed study of the main regions of brain and then visually leading to confirmation.

## 7. DISCUSSION

The motive of the project was to efficiently develop a method to identify ASD in children with Autism being the worst developmental disability that is ever diagnosed as they hit at very early age.Usually,in India this Autism that is accompanied by various symptoms like reduced communication,sub-hyperactivity,abnormal body movements etc.But such symptoms don't directly pertain to Autism as they can be out of Asperger's syndrome too.So the proposed model keenly states that ASD can be steadily identified using the MRI brain images of the suspected easily with two

important regions taken into account,the Gray Matter(GM) and the White Matter(WM) accordingly with their deviations recorded and observed.Precisely,there will be evident discontinuities seen in ASD hit children's MRI than in TDC MRI and it is because of the fact that GM and WM are the two default regions of brain that show significant changes and distortions causing the challenges socially and mentally for such children.There will be uneven distribution of these regions and they will be segmented and then clustered using Otsu's and K-Means clustering technique in order to differentiate healthy and ASD hit brain. There won't be any connect between the regions as discussed earlier leading to functional disconnectivity.The volume is also considerably seen to decrease overall because of the loss of regions' size and shape.The difficult task is to compare with a healthy brain and conclude directly because there are no stipulated values for GM and WM.The segmentation is done and the clusters as GM and WM are formed and taken into analysis.The volume is a secondary parameter as ASD doesn't cause volumetric reduction in brain every time.The fMRI though yields region specific differences,it cannot be put in practice here because it is not cheap and cannot be taken every time for individual diagnosis.

## 8 RESULTS

An effective algorithm using MRI brain images was developed and implemented in this work.Entirely automatic segmentation algorithms (Otsu's and auto cluster K-means) were utilized in this work to segment the different parts of brain regions from the MRI images. The differences or variations in shape and size were used to define the segmented regions quantitatively. Finally a two level rule based classifier was developed to classify the patients as healthy and unhealthy. Now,the focus is completely on MRI brain image's study and its regions to identify Autism in children.The future development will be focused on each region of the brain and its corresponding contribution in the challenges that autism children face including social,physical and mental challenges. Precisely,it will be region-specific and function-specific detection and diagnosis probably extended to fMRI.

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