Assessment of Morphological Markers from Autistic MRI

B.J. Bipin Nair, K. Sahith Kumar

Abstract--- Our proposed work we are predicting the earlier stage developmental disorder autism through morphological markers .it can be performed through the analysis of cortical thickness from MRI with various parameter like thickness, gyrification, volume etc. from our work we are considering the MRI data set from the age between 15 to 30 year .in our work we are using various segmentation technique to calculate the various parameters like cortical thickness, gyrification, etc. from brain MRI. Through the parameter we are predicting the autism in the range of age with the experimentation of morphological markers.

Keywords--- ASD -Autism Spectrum Disorder, MRI, Voxel Based Morphometry-VBM, gray matter-GA, white matter-WM.

I. INTRODUCTION

In our proposed work we are using the basic digital image processing to apply computer algorithms to perform image processing on medical images. The medical image processing has various benefits over MRI processing. It allows a much extensive series of algorithms to be useful to the input data and can avoid difficulties such as the build-up of noise and indication alteration during processing.

Medical imaging is the method and process of generating visible internal part of a brain for medical interfering and clinical analysis. The photographic classification and the functions of different parts of brain or tissues. Medical imaging also creates a database of standard physiology and anatomy which makes it possible to differentiate abnormalities in brain[2]. Though medical imaging of extracted tissues and organs can be analyzed for medical explanations, such procedures are generally considered part of medical image processing. It is division of biologic imaging and integrates radiology which implements the image processing technologies. ASD is a neuro developmental disorder which initiates in childhood and gets worselater on[5,8]. This makes it very difficult for the person to interact with others, to learn and to communicate. There is currently no good level of treatment for ASD. Treatments contain skills training, medicines to control the disorder and communication and behavior therapies [7]. ASD has no single acknowledged cause. The syndrome is very hard to cope up with and the indications and harshness differ. The possible reasons for the syndrome can beboth genetics or because of several situations. CT is a brain morphometric assessment used to describe the mingle thickness of the structure of the cerebral cortex [9]. The CT alters with varying ages. Unusual values in adult humans are between 1.5 and 3 mm frequently decided on the base of the GM set in segmented neuro imaging data, generally from the local or median space over the WM exterior and the pial surface. Procedure of creating typical overlaps in the Cerebral Cortex is called gyrification. The neurons of the cerebral cortex reside in a thin layer of GM only 2 to 4 mm thick at the surface of the brain. The largest part of the brain is cerebrum. Information receiving and reaction is dependent on GM and WM. Brain volume is related to the age and it varies according to the age. Generally, a human being's structure of brain volume is 350 to 450 cubic centimeters.

Most of all the project use machine learning techniques such as SVM[17], ada boost etc. But we are using a hybrid classifier to classify efficiently. In our proposed work we are using efficient prediction techniques to calculate the various morphological markers like thickness, volume, gyrification. But in existing system so many software tools are being used which have a lot of limitations.

II. LITERATURE SURVEY

Yang, D. Y. J et.al[1] says ADS is an extremely prevalent, strong genetic neuro developmental disorder, which results in societal and communication losses and results in restricted interest. The identification of the brain disorder through non-diffusion weighted, sMRI has produced fewer reliable results, therefore initial brain overgrowth occurs throughout the primary ages of lifespan. Tool used for image investigation is FreeSufer (FS), which uses VBM (voxel-based morphometry), as opposite to SBM (surface-based morphometry), that gather and separate key info of brain structure. It delivers the cortical marks than volume-based registering and does not results in age consistent bias among old and senior kids after processing teen-agers' brains to a normal space. FS software tool is used to calculate all parts of cortical structural procedures, they are CT (Cortical Thickness), CV (Cortical Volume), SA (Surface Area) and CG (Cortical Gyrification). MRI image is used. Data is collected from developmental neuroscience child study center -Yale university. Upcoming study should hire real-time PMC (Prospective Motion Correction) techniques through the sMRI. The use of PMC techniques can also avoid the difficulties of using depressant. It creates an additional possibility to be approved by most IRB for research purpose, and may be a better option than sedation for coming sMRI study that concentrates on reducing head surprise movements. Hyde, K. L. et.al [2] proposes pattern of brain alterations in a consistent category of people with autism for the 1st time ever by applying two-way diagnostic method, that is CT

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analysis and VBM. The mixture of these dual methods in the similar example of people with autism delivers corresponding data on both CT and sub CT. But WM and GM structural changes occurs in this area. The joining character of the VBM and CT helps to detect GM changes as well as facilitate to create powerful assumptions concerning physical brain changes in autism. Here they used the minor size of data sets. 3-T Siemens scanner is used to collect MRI. The participants' behavior and communication skills are evaluated using ADI-R and ADOS. VBM is volume analyzing technique for GM and WM concentration. The layers of GM and WM regions were smoothed by applying Gaussian smoothing. Shi, F. et.al[3] Says that CT is assessment of a median over all vertex in an area. Graph based technique is applied to analyze the brain connectivity. Data set is collected from online repository NDAR and six to fifteen-year-old children's MR Images are used for experiments. The deformable surface algorithm was used to evaluate GM and WM from the brain areas. ROI is also used to calculate for regional CT correlation. The thickness of the CT ranges from zero to five. This paper clearly specifies the consequences on the brain areas related to characteristic of kids with autism. Enlarged correlation strength was originated inside frontal regions while lengthy range of association is related to limbic lobes, frontal and other lobes and decreased correlation strength. The normal outcomes established that autism altered inter-location of correlations.MRI images is used to perform image processing and a tool named FS is used. Dierker, D. L. et.al[4]says in ASD, several studies have verified such abnormalities using sMRI through VBM or SBM. Through different investigation approaches, physical abnormalities have been recorded in several brain regions, with the parietal, frontal lobes, temporal, and cerebellum. VBM or CT dimensions have described several communal abnormalities related by ASD, but some discordant findings were also found. The brain portions enlarge GM size in the temporal lobes and frontal, whereas WM volume is reduced in the temporal lobes. Participated kids are 32 typical autistic and 34 adolescents with simplex autism. The valuation test they used is ADOS and ADI-R. For MR Imaging purpose they used scanner named Siemens 3T-Trio. Date is collected from Washington University. Sulcal depth changes were calculated by using a cluster created thresholding. A TFCE (threshold-free cluster enhancement) was used for several evaluations for modification. Segmentation for Sulcal Depth calculating and Registration is done using a tool named is FS. The ANOVA is complex to an inconsistent set of figure differences than those sensed by using sulcal depth calculation. This method can find the alterations for which sulcal depth is not sensitive. Mak-Fan, K. M. et.al [5]says that cortical growth and organization follows a brain volume abnormality in adolescent with ASD. The clinician specialist helps by ADI/ADOS assessment. Here in the clinical research work23 ASD children and 63 typical developing children have participated. In this paper they have selected male adolescents only. The vertex-by-vertex analysis predicted regional specific changes in CT area. This kind of analysis have exposed changes that happened in the parts of wider cortex. That part is left occipitotemporal gyrus, left superior temporal sulcus, and right inferior orbitofrontal cortex. The measures of CT of each edge over the cortex, surface area and total volumes were assessed for the whole brain. This was segmented by using Atlas Statistical Analyses. The behavior result have no important change in age among the ASD and TD. Brain volume was enlarged for the ASD set corresponding to the TD set at adolescent, but was Particularly reduced for the TD set at adults ages. Zubiaurre-Elorza. Et.al[6] This paper discussed about result of prematurity and PVL (Periventricular Leukomalacia) on CT in adolescence and the reported effect of the later on behavior and cognition. This concept is that head injuries and preterm born such as PVL might have an impact on CT and that these cortical abnormalities may be related to cognitive-behavioral outcomes at minor stage. Dataset are collected from Barcelona, Spain (Hospital Universitari Vall d'Hebron). Entire candidate was cognitively judged with the WISC-IV (Wechsler Intelligence Scales for Children – 4th Edition). Behavioral information was collected by means of the CBCL (Child Behavior Checklist). The checklist is a parent description which assess teenagers' behavior. Statistical analysis used FS application. CT maps were registered to the normal template and smoothed with a Gaussian kernel of 15 mm. Outcomes are represented by figures tables. The major limitation of paper is its minor sample size of MRI. Simon S. Keller et.al [7] discussed about a wide group of software packages that are existing for observing and evaluating MRI, for reformatting the images in three magnitudes, therefore as to get parts by a specific positioning over the body and for constructing together informal and additional sophisticated calculation of regions of concentration, dividers and discrete structures. This paper defines the application of quantifiable image investigation procedures to obtain a brain size evaluation from MRI. In this paper for automated segmentation and MRI analysis, EASYMEARSURE, FS software and VBM is used. The advantage of this research is that the mistake is very fewer from MRI, that means noise content is less. The dataset is collected from The Wellcome Functional Imaging Laboratory. Disadvantage of the research is that the execution time is less. Philip S. Lee1 et.al [8] discussed about longitudinal structural studies of distinctive growth demonstration. Amount of variations increased WM in the prefrontal cortex from baby over initial middle age. This lengthy growth of the prefrontal cortex had been imagined to contribute to the ongoing progress of intellectual developments, with response reserve. ANCOVA and ANOVA test is implemented in this paper using fMRI image processing. Dataset is collected from kids with ASD aging from 8 to 12 years. Current going studies did not methodically deploy age, and therefore, the age-related analysis characterizes ASD in general. M. R. Herbert al.et [9] says that brain abnormality is changing the entire size of the brain which was found using VA (Volumetric Analysis) through MRI of the autistic children.

The MRI is used to analyze total brain volume and segmentation of main brain areas. Image acquisition makes use of MRI. The image intensity-based segmentation techniques are used in this analysis. Here they have used semi-automated algorithms based on differential intensity contour mapping algorithms. Segmentation was done on coronal images and separated the brain into GM and WM sections. Here autistic boys' MRI was used for the analysis. Result of the experiment predicted that the whole brain size was increasing. Christine Ecker, BSc, MSc, PhD et.al [10] study about changes in CT, CV and SA with relationship in a large and categorized sample of men with ASD. This research the author says the frontal lobe of CT was increased and same SA is reduced in the posterior cingulum and orbitofrontal cortex. MRI images is used in image processing and analyzing purposes. FS image analyzing tools is used to find CT, segmentation and skull tripping. Heather Cody Hazlett et.al [11] says that brain volume increasing has been perceived in two-year-old children with autism. This longitudinal MRI study examined timely thickening oriented in brain size and CT. Image acquisition was designed to expand GM and WM tissue difference for 18 to 35-month-old children. The segmentation uses the EMS (Expectation Maximization Segmentation) to implement segmentation. The EMS segmentation tool is fully automated. The future step describes initial brain volume variations in people with ASD. This paper's main limitation is failure to assess surface area in young children. Armin Raznahan et.al [12] discussed about cortical anatomy in ASD. An image acquisition is done using MRI scanners and FS software tools are used to calculate CT and image segmentation processes. Data analysis used MANOVA. In this paper segmentation algorithm, classification and deep learning is not discussed. Wei Cheng et.al [13]discussed about ICA (Independent Component Analysis), seed-based analysis, or parcellation-based analysis regions and found out that they have some limitations. MRI data is used for image analyzing. MRI time-series underwent low-pass temporal filtering (0.08 Hz) and high-pass temporal filtering (0.01 Hz). The brain's pair-wise voxel-level was analyzed and the time sequence was extracted and their correlation was analyzed for each subject followed by z-transformation. The Liptak-Stouffer z-score technique was then used to associate the results. Patten classification used SVM. Heather Cody Hazlett et.al [14] discussed about Total Brain Volume (TBV) effected by CT and SA of brain. The deep learning analysis use machine learning classification algorithms. Amount of cortical surface area growth from 6 to 12 months was particularly increased in persons identified with autism at 24 months. MRI image are used to analyze the assessments. Cynthia M. Schumann et.al [15] classify toddlers who had shown signs of developing autism and use sMRI at different time points between initial growth and noted which cortical regions display aberrant thickening patterns. The MRI scan imaged data is used. The anatomist has done GW seg-based segmentation using FS software tool. FS tool is also used to segment and analyze cortical GM. ANCOVA analyzing method is also used. Imaging study of brain growth on huge populace may begin to address the various syndrome and, in the future, will likely report clear subtypes of autism, each with a particular related neuroanatomical phenotype. Yongxia Zhou et.al [16] says about the machine-learning algorithm and multi parameterized MRI matrix used to predict the ADS. If the assessment is 500 ADS MRI should be used. Image and data analyzing are done using AFNI (Analysis of Functional Neuro Images) and FMRIB Software Library software packages. Volumetric analysis of total regional subcortical volumes, WM volumes, supratentorial volume, and cortical GM volumes are found using FS software tool and graph theory is applied in small areas in this paper. Classification is donein order to choose imaging features, a whole of 67 obtainable classifiers, including SMO (sequential minimal optimization), RBF (Radial Basis Function), BayesNet and SVM algorithms, were tested with batch-mode scripts developed in WEKA software. Nastaran Pardakhti et.al [17] says that the SVM classification approach is used to categorize the age into nine classes based on MRI images. Feature extraction introduces 2 ways single layer network on k-means and another complex network. That is SVDD (Support Vector Data Description) to transfer the centroid of SVDD ball to the center of k-means, while paying attention to distribution and density of data. SVDD is an approach for clustering which attends not only to the midpoint of data, but also to its distribution. Classification is done using SVM. Tzu-Wei Huang et.al [18] says that method is used in segmented GM image by applying RVM (Relevance Vector Machine) to predict the age. The dataset is collected from Aoba-brain image research center. They used deep learning models which require large GPU memory to hold the neural network. The size of the GPU memory is 650MB. Later practically all user GPUs are efficient of running it. The time required to train the network is 12 Hrs for best accuracy. To balance with further approaches (MAE 4.3), the network only needs 0.5 Hrs to train. Entire experimentations are performed on a PC with Nvidia TITAN X GPU and Intel i5-4460 CPU. Bipin Nair BJet.al [19] saysin this paper about drafting the biological construction of suppressor medicine for ASDby means of a computational device. The three molecular composites like Risperidone, Fluoxetine and Melatonin are conniving. Configuring the suppressors, outlining the aromatization and closeness of the useful clusters are done with fundamentals similar to Nitrogen, Oxygen and halogens. Here computational procedure for sketching the construction of suppressor drug declares the ASD suppressor's molecular method as glowing as organizational formulation. N Shobha Raniet.al [20] says in the present state-run of procedures are skillful in info recovery through writing type information and to the achieve success rate 99%. But the data repossession founded on hypermedia information similar images wants extra reviews thus as to find the predictable result. In this paper, the investigation neutral is to organize the images constructed on the figure and area features. The groups of images well-thought-out contain fruits and vegetables.

The method for watershed transforms is used for segmentation and it is directed for classification using Naïve Bayes, KNN and SVM classifier. Bipin Nair BJ et.al [21] puts up efforts to reform the drug's 2D structure over many predicting methods and to visualize drug-protein collaboration over molecular dynamics and molecular docking techniques. In this paper the drug id of Melatonin, Fluoxetine and the protein SHANK3 is gathered form drug bank.

III. PROBLEM DEFINITION

Assessment of Morphological Markers from Autistic MRI

- Collect the dataset from ABIDE.
- Preprocess the MRI image using Median filter, Histogram Equalization and Sharpening methods .
- Segment the MRI image using Thresholding, edge based and ROI.
- Assessment of the morphological parameter are Cortical thickness, Volume and Gyrification.

IV. METHODOLOGY

In our proposed work we are taking 1000 data set of brain MRI of ASD collected from ABIED but here we are used between 1st and 15 year of age MRI. This type of new born baby to 15-year-old baby MRI image collection is very difficult. Above figure depict that collecting the images from repository and proceeding with preprocessing after that we are performing segmentation techniques for the the preprocessed image then calculating the morphological parameters like CT, GA and Volume. Then performing the assessments.

Here we are used the pre-processing techniques are Median filter which remove the noise from image and histogram equalization will give the intensity value of the image through equalization. Also we performed sharpening to the image for region of lower local contrast to get a higher contrast, contrast adjusting is done through the overall image pixel brightness and darkness for regulating and sharpening of image, its used to highlight the edges of images.

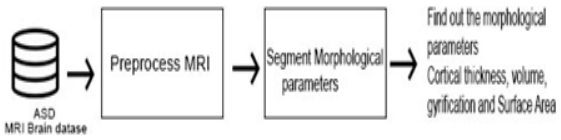

Figure 1.1: Flow diagram

The above the figure 1.1 state that the working of proposed work

V. MATHEMATICAL MODEL

In our work we are using MRI Brain image for preprocessing and segmentation as dataset

Preprocessing

In preprocessing techniques, we are using median filter and sharpening method as well as histogram equalization for removing the noise from brain MRI and increase the intensity value of the pixels:

• *Median Filter*

The median filter is a preprocessing method in which we are taking a median value to preprocess the MRI image. we have to substitute a pixel by the median, in its place of the regular intervals of all pixels in a region v

$$A\,[p, q] = median\ \{\ b[r, s], (r, s) \in v\ \}$$

everywhere *v* characterizes area definite by the manipulator, positioned round place [*p, q*] in the image.

•*Sharpening*

The unsharp filter is a modest sharpening operator which originates its designation after the detail that it improves boundaries through a technique which detracts the image. Products of the edge of an image *g (i, j)* from a input image *f (i, j)* via.

$$g(i, j) = f(i, j) - f_{smooth}(i, j)$$

where $f_{smooth}(i, j)$ is smooth form of $f(i, j)$

• *Histogram Equalization*

It is a method aimed at altering image intensities to improve contrast.

$R_{m=}m\ /tp$

m – Number of pixel intensity

tp – Total number of pixels

Let f be assumed as a$\boldsymbol{A_r}$ by $\boldsymbol{A_c}$ matrix. The intensities ranging 0 to L – 1 (integer pixel). The histogram equalized image $\boldsymbol{k}$ definite by

$$\boldsymbol{k}_{a,b} = floor\ ((L-1)\sum_{m=0}^{Fa,b} Rm)$$

anywhere floor() slices dejected to the adjacent digit.

Segmentation

It is a procedure of separating into a many part. The area of segmentation is the shorten and alteration of illustration of an image into approximately that is additional expressive and cooler to investigate**.**

•*Thresholding*

Segmentation contains extrication of an image into areas equivalent to stuffs. We typically stab to segment areas through finding communal assets.

$$p(g) = ng/n$$

ng – No. of pixel, Gray scale intensity – *g*, and Total No. of Pixel – *n.*

•Here we are used boundary based and ROI segmentation

Segmentation processing, we are used edge based, ROI and thresholding techniques

Step 0: Preprocessed the MRI.

Step 1: Converted into Binary image using thresholding (The GW area is changed to black and WM area change to white)

Step 2: Applying edge-based segmentation technique (black and white area is segmented)

Step 3: The particular area segmented applied by ROI

Step 4: stop

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VI. EXPERIENMENTAL RESULTS

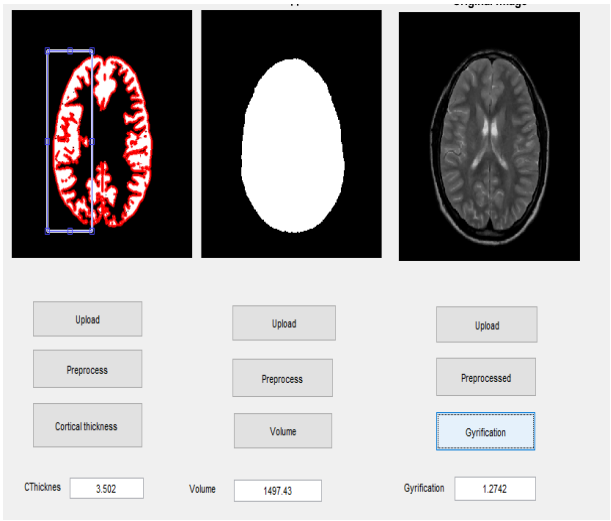

Figure 1.2: Selected MRI after the preprocessing region-based segmentation algorithm used to segmented Morphological parameters.

Our proposed work we are performing preprocessing through MATLAB environment, after removes noise from the MRI. Then we are proceeding with segmentation process to assess various morphological parameter finding. In our work, we are examining the brain MRI of patients from the range of age between 15 and 30 .examination result can analytically differentiate with ASD since panels founded on CT, and this representations consume better precisions. image study method is a kind of image subdivision that separates stuffs by converting grayscale images into binary images.

In the MRI after preprocessing, applying thresholding and ROI to detect the boundary region for white matter and gray matter.

From ROI segmentation we are calculating the value of various parameters like gyrification, CT and volume based on the intensity of the image. Brain MRI Volume are relating to among patients through syndromes and controls to govern if the size changes are associated to pathogenesis .in ASD patients, from MRI we are removing the noise and stripping the skull using a method like to remove outer lining brain area from MRI and that particular areas white pixels are used to analyze volume. For calculating gyrification of the brain which characterizes the folded region to distinguish from the cerebral cortex. In what way the brain cortical gyrification varies from baby to childhood stage in healthy human

The mathematical model for gyrification is

$$G = I/O$$

I-inner area of brain MRI

O-outer area of brain MRI

G-Gyrification

The below table is describes about the experimental result of the morphological parameters of brain MRI

The following table which gives an inference about three morphological parameters like cortical thickness, volume and gyrification of ASD patients from 15 to 30age. From the table we can come to a conclusion like what will be the magnitude of the disorder.

TABLE I. MORPHOLOGCAL PARAMETERS VALUES

Age	Morphological parameters and values		
	Cortical thickness(mm)	*Volume (Cubic cm)*	*Gyrification(mm)*
15	3.09	1554.67	0.62
15	3.02	1493.3	0.61
18	3.26	1694	1.21
20	3.21	1530.84	0.7
20	3.04	1599.93	1.16
21	3.114	1548	0.83
22	3.20	1580	0.92
23	3.12	1507.3	1.30
28	3.22	1599.93	1.16
30	3.13	1636	1.08

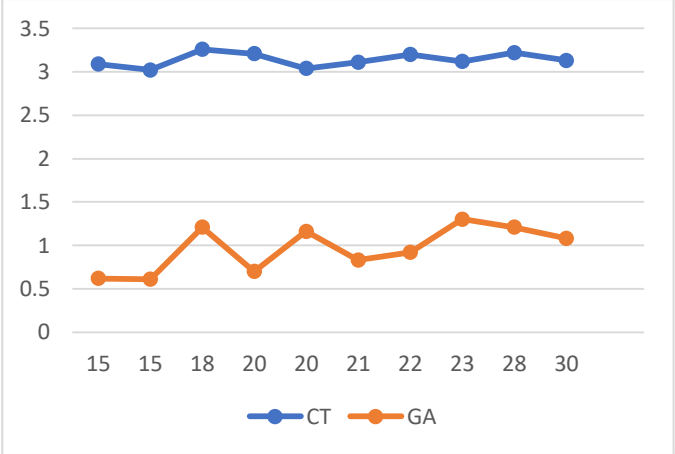

Figure 1.3: Represented as the variation of the CT and Gyrification.

The above graph depicts the variation between cortical thickness and gyrification according to age. The age is proportional to gyrification and cortical thickness, from the graph we can conclude in case of autistic patients' morphological markers like gyrification and cortical thickness will increase according to age increases

VII. CONCLUSION

In the present work we are calculating the morphological markers like gyrification, volume and cortical thickness from Brain MRI at the range of 15 to 25 age. but in future we can add more morphological markers not only for 2D images but also for 3D images also to get highest accuracy in a bulky of data set. The three morphological parameters assessment procedures define a very clear indication of the magnitude of ASD affected or not.

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