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Extract and Analysis Different Features of Activation Area of the Fusiform Gyrus of Human Brain to Explore Autism

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Abstract: *Autism is a potential threat to the present world. A great number of individuals in the world have been suffering from autism.Recent studies show abnormalities in the various regions of brain in autistic persons. To investigate the causes of autism, fusiform gyrus of brain is responsible for face processing tasks has been studied for the control and autistic individuals. In carrying out the work, three categories of faces that is, familiar faces, stranger faces and combination of both familiar and stranger faces are considered of fusiform gyrus from functional magnetic resonance imaging (fMRI) images. In this experiment, required features of the fusiform facial area (FFA) are extracted from the functional mapping of fMRI images. Processed fMRI images of control and autistic brain has been taken as input for recognizing all, familiar and stranger faces. Then, these images have been preprocessed and extracted some features to calculate area, perimeter and eccentricity for further analysis. It has been observed that there are calculated different number of activated area (in pixels) in the autistic and control brain for all, familiar and stranger faces. A major outcome of the present study is that statistical features of the images have been calculated from which indicates more clear difference between control and autistic brain. From the different mean area, mean perimeter and mean eccentricity of region of interests (ROI), it can be said that there is a significant difference between control and autistic brain in the fusiform facial area (FFA) during face perception.*

Keywords -*autism, autistic spectrum disorders (ASD), fusiform gyrus, functional magnetic resonance imaging (fMRI), fusiform face area (FFA).*

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I. INTRODUCTION

Autism is an organic process disorder that occurs in the early age of a child defined by troubles with social interaction and communication. It also regards restricted and repetitive behavior. A significant damage occurs in social, occupational and other areas of functioning for these reasons. People who have facing autism can see, hear and feel the world dissimilarly to other people. They have reduced social communication ability and limited or iterative behavior or interest. Even so, the most axiomatic signs of autism tend to come out between 2 and 3 years of age. Autism Spectrum Disorder (ASD) are neurodevelopmental disorders of intricate archetype; they are distinguished byindicative difficulties in communication, social interaction, repetitive interests and behaviors [1]. Autism is an invasivedevelopmental disorder which includes abnormal development and function of the brain. The causes of autism remain unknown, many studies have concerned a variety of developmental genes, environmental factors such as exposures to viruses or toxins during pregnancy are hypothesized to contribute but none have been decisively identified [2]. The autisticchildren have complexities relating to and communicating with other people. When they're babies, they do not concernabout other people and do not respond to their name or smile at others at the age of two years [3]. Older children andteenagers with Autism Spectrum Disorder (ASD) typically have trouble with both verbal and non-verbal communication for social interactions. An older child or teenager with ASD might have difficulty taking turns in conversations – for example, she or he might like to do all the talking or find it difficult to protest the questions. They might talk a lot about afelicitated theme, but find it difficult to talk about a variety of theme. They also have an abnormal tone of voice, or use speech in an unusual way – for example, she or he might speak in a monotone or with an utterance. They make use of unusual eye contact, express few emotions in their face- for example they might not be able to tell if someone likes them inan impulsive way and also they employ very few postures to express themselves [4]. To perceive autism and their amends, a number of research papers [5]-[9] already have been published. Functional magnetic resonance imaging (fMRI) studies recognized that the fusiform gyrus is systematically active when normal humans view faces[10]. In the case of autistic people, they can perform face perception tasks but there is powerful evidence that the fusiform gyrus with other cortical regions bearing face processing in controls, is hypoactive [11]. It has been determined that the failure of making straight eye contact

may justify the determined hypo-activation of the fusiform gyrus in face representation tasks in autism [12]. This critical assessment will generally directs on face representation deficits in autism.

The fusiform gyrus is a part of the human visual system that, it is speculated, is specialized for facial recognition. It is located in Brodmann Area 37. It is also known as theoccipitotemporalgyrus [13]. Other sources have the fusiform gyrus above the occipitotemporalgyrus and underneath the parahippocampalgyrus [14]. There is still some dispute over the functionalities of this area, but there is relative consensus on the following:

- processing of color information
- face and body recognition
- word recognition
- number recognition
- within-category identification

Some researchers think that the fusiform gyrus may be related to the disorder known as prosopagnosia, or face blindness. Research has also shown that the fusiform face area, the area within the fusiform gyrus, is heavily involved in face perception but only to any generic within-category identification which is shown to be one of the functions of the fusiform gyrus [15]. It has also been connected in the perception of emotions in facial stimuli [16]. K. Pierce et al. [17] researched with fusiform gyrus and they revealed normal fusiform gyrus activity in children with autism when viewing a familiar and stranger faces. They found abnormalities in autism for face processing. Figure 2 shows the fMRI of fusiform gyrus of brain for the control and autistic individuals which clearly indicates the differences among them (Consider three types of faces of fMRI for control and autistic individuals - all faces, familiar faces and stranger faces)[17].

In this works, three categories of faces such as, familiar faces, stranger faces and combination of familiar and stranger faces are considered for examine of fusiform gyrus from fMRI images. The proposed approach has been implemented in Matlab. For the input image the fMRI images are taken. Images thresholding is used for detecting the activated area of these images. Then calculate the value of mean area,mean perimeter and mean eccentricity of images for both control and autistic individuals. The results compared to the control with autism based on the calculated value of these values of fusiform gyrus of brain.Figure 1 shows the block diagram of working procedure.

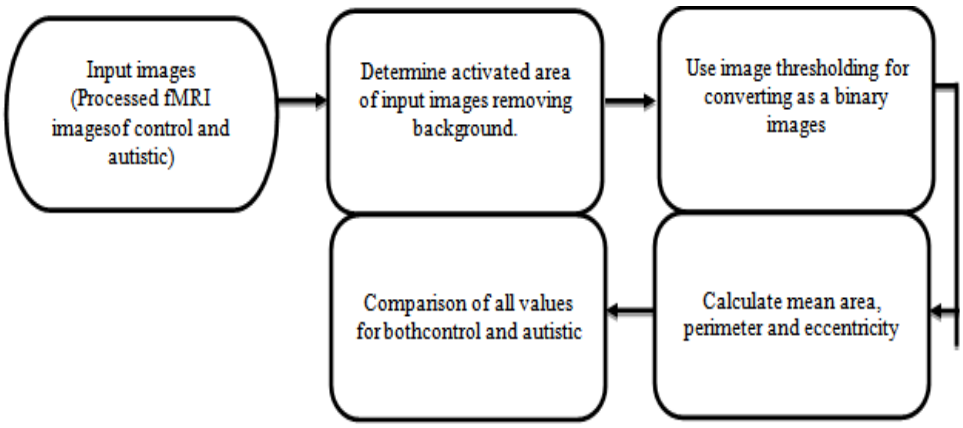


Figure 1: Block diagram of working procedure

II. METHODS AND METARIALS

In carrying out the work fMRI scan images of the fusiform gyrus of brain for control and autistic individuals are taken as input [17].K. Pierce et al. [17] worked with fusiform gyrus which is responsible for face and body recognition. There is an alternative and potentially stronger test of fusiform face area (FFA) function in autism that attempted to affect levels of FFA activity using all faces, familiar faces and strange faces. From this experiment, they find out the activation area of control and autistic brain by recognizing all faces, familiar faces and strange faces. In this work, there are used this processed fMRI images as input for analyzing statistical information to explore autism There are three categories of faces that are familiar faces, stranger faces and combination of both familiar and stranger faces are considered of fusiform gyrus from fMRI images as input. Two different sides view of brain such as sagittal and interior view are considered also.

A. Data Preprocessing

These processed fMRI images need to be preprocessed after the acquisition. Generally thefMRI images are generated withcombination ofred, green and blue (RGB) colors.It makes computational complexities and still does not make better results. Therefore in image pre-processing, grayscale images are considered. The

function rgb2gray (image) is used for conversion a RGB to grayscale image. So, there are used different image enhancement technique through removing the irrelevant information or noise to get better quality of the acquired images.

B. Image Thresholding

Image thresholding is one of the simplest powerful technique of image segmentation. From a grayscale image, it can be used to create binary images. It is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. Apply thresholding method for segmentation the activation area of brain.In this work, there have been used bilevelthresholding which is determined to segment images into two brightness regions correspond to background and object [18]. For a gray level image, f(x, y), bilevelthresholding is transformed into f(x, y) to binary image g(x, y) by a threshold T which canbe expressed as equation 1:

$$g(x,y) = \begin{cases} 0 & f(x,y) \leq T \\ 1 & f(x,y) > T \end{cases} \qquad (1)$$

C. Feature Extraction

Feature extraction is most important elemental tasks for recognizing images. There are different types of features to be used of image recognition such as visual features and statistical features of pixel. In this work, two features such as area and perimeter of pixel are calculated. They are very useful for the recognition of brain tumor images. Then, the experimental result shows that area and perimeter are calculated of detected brain tumor region from input images.

- **Area:** Area is the summation of detected areas of pixels. Detected areas are calculated using regionprops function in Matlab which is measured a set of properties of image regions for each connected object in the binary image. This image have only two values either black or white (0 or 1). In this work, 512x512 dimension is a maximum size of the image. The binary image can be represented as a summation of total number of white and black pixels. So, area of the image is the total number of the pixels present in this area.
- **Perimeter**: Perimeter is the number of pixels in the boundary of the detected object. It is measured as the sum of distances between every consecutive boundary points. Detected perimeters are also calculated using regionprops function in Matlab.
- **Eccentricity:** Eccentricity is the ratio of the distance between the foci of the ellipse and its major axis length between 0 and 1. It is also measured usingregionprops function in Matlab.

III. RESULT AND DISCUSSION

In this experiment, there are used different images of fusiform gyrus with activation area for both normal and autistic brain. Input images are gathered from K. Pierce et al. [17]. They are collected MRI images of face perception from two different side view of brain such as sagittal and interior view. Then, they processed these images to find activation area of face perception. There are used these processed images to compare fusiform face area (FFA) activity of control and autistic from calculating mean area, mean perimeter and mean eccentricity of activation area. Matlab means matrix laboratory which is a highlevel language and considered as a multi-diagram numerical computing environment to express computational mathematics. It has built-in graphics that make it easy to visualize and gain insights from data [18]. In this experiment, Matlab R2015b is used to manipulate different tasks. At first, collected image of familiar and stranger for both normal and autistic brain has taken as input images. The original activation area of fusiform gyrus (FG) is shown infigure 2.Figure 3 shows the sagittal view of brain with activated area is adopted from figure 2 for both normal and autistic brain. In this work, there have been removed background form input image which are done by color threshold apps. After using this apps, the activation area are totally separated from background that isshowed in figure 4.

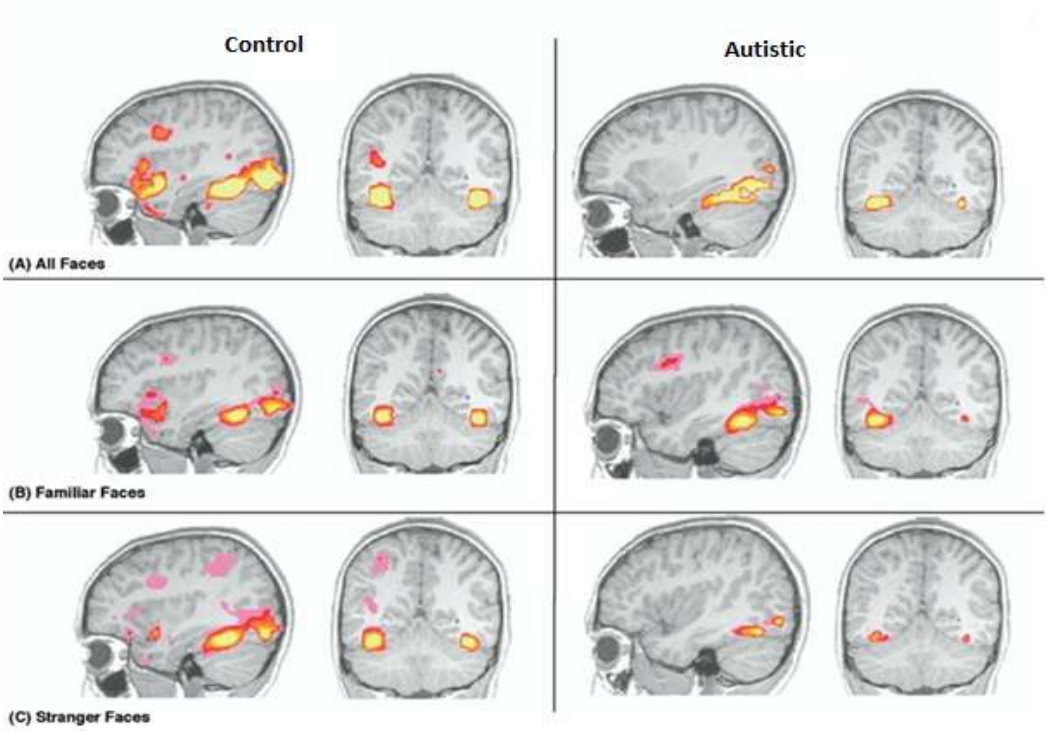


Figure 2: fMRI offusiform gyrus both of control and autistic for a) all faces, b) familiar faces and c) stranger faces.

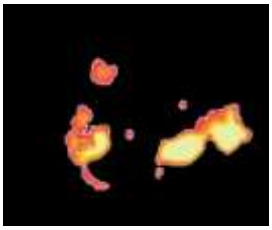
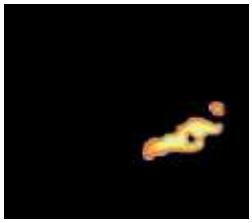
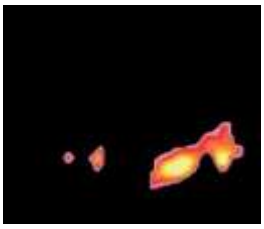
	Control	Autistic
All Faces		
Familiar Faces		
Stranger Faces		

Figure 3: Extract activation area of sagittal view of brain after removing background.

Then, there have been used image thresholding for converting the separated activation area as a binary image in figure 4. These can be distinguished between control and autistic fusiform face area (FFA) for applying

this method. In figure 4, it is represented input image after thresholding. After that, there are applied feature extraction method called regionprops for showing statistical analysis of detected activation area.

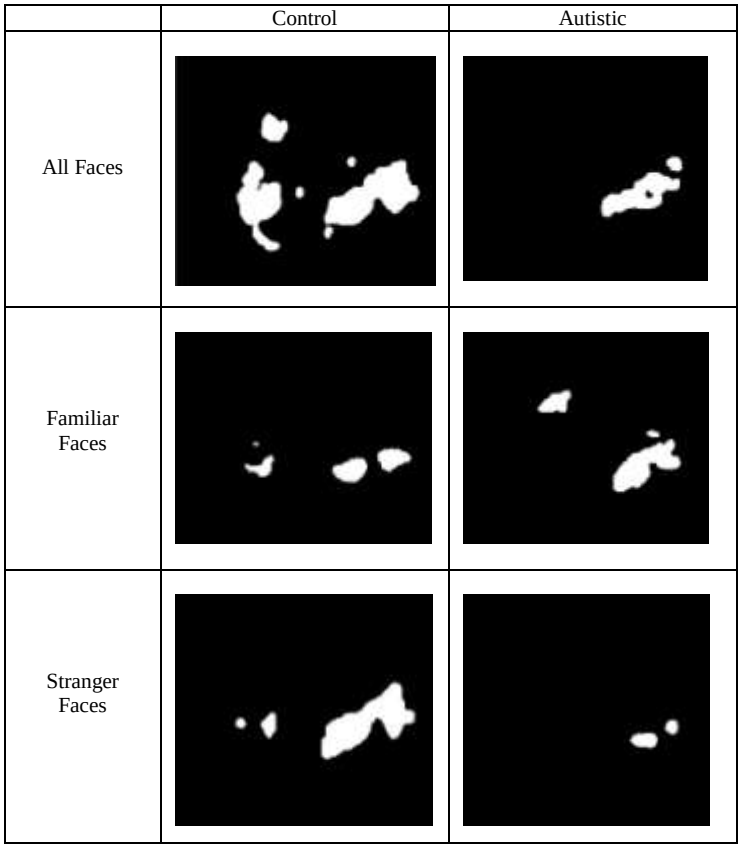
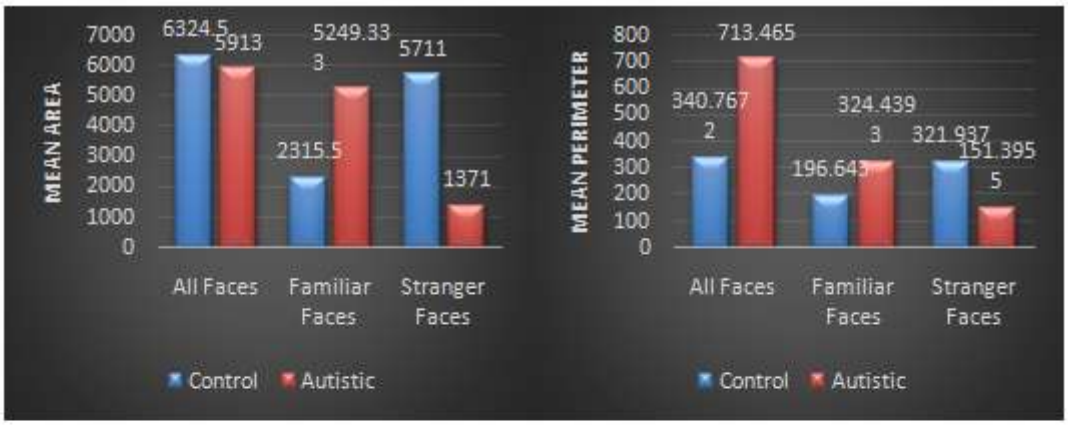


Figure 4: Segmented images of sagittal view of brain of control and autistic for all faces, familiar faces and stranger faces.

Table no 1: Calculating mean area, mean perimeter and meaneccentricity

	All Faces		FamiliarFaces		StrangerFaces	
	Control	Autistic	Control	Autistic	Control	Autistic
Mean Area	6324.5	5913	2315.5	5249.333	5711	1371
Mean Perimeter	340.7672	713.465	196.643	324.4393	321.937	151.3955
Mean Eccentricity	0.637	0.7782	0.791375	0.8941	0.746067	0.557

Table no 1 shows mean area, mean perimeter and mean eccentricity in this work. From this graphical representation in figure 5, there have been found significant FFA activity in response to all faces, familiar and strange faces both control and autistic. For recognizinga stranger faces, the activation area of control brain (5711) is much wider than autistic brain (1371). But for familiar faces, the activation area of autistic brain (5249.333) is much wider than normal brain (2315.5). So, individuals with autism also showed fewer fusiform face recognition activity in response.

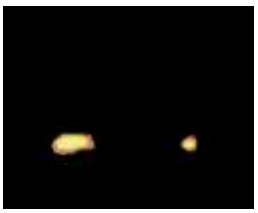


a) Mean area b) Mean perimeter

c) Mean eccentricity

Figure 5: Bar graphs for mean area, mean perimeter and mean eccentricity both for familiar and stranger faces between normal and autistic (two different color)

There are also represented sagittal view of human brain which is collected from figure 2. In this work, same methods are used as previous used for removing background. After using this method, the activation area for sagittal view are totally separated from background which is showed in figure 6.

	Control	Autistic
All Faces		
Familiar Faces		

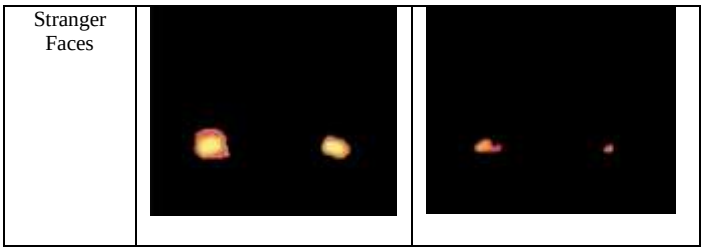


Figure 6: Extract activation area of interior view of brain after removing background.

Then, there have also used image thresholding for converting the separated activation area as a binary image in figure 7. For applying this method, these can be visualized differentiation between control and autistic fusiform face area (FFA) activity which is showed in figure 7 after thresholding.

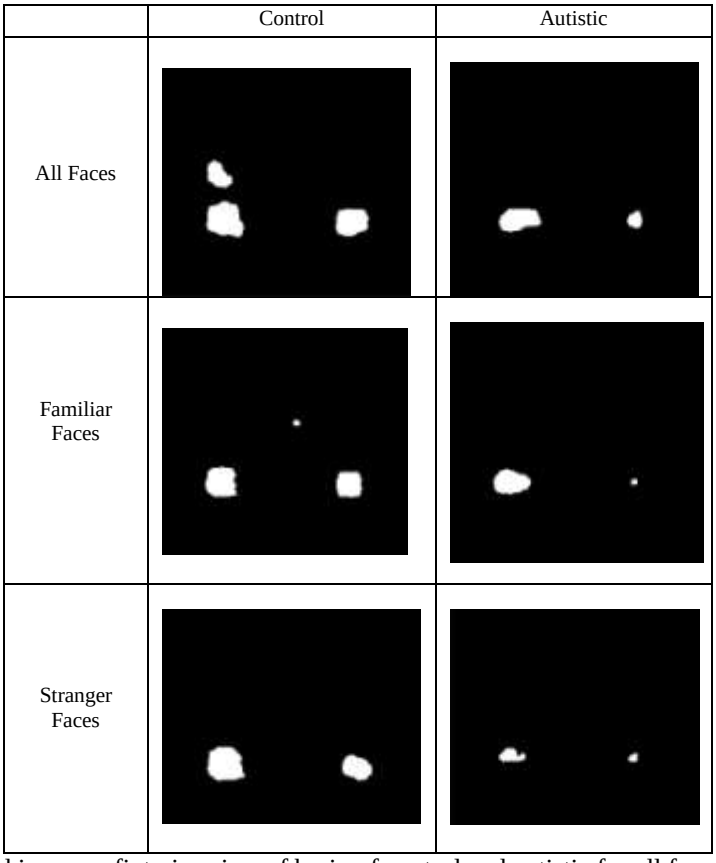


Figure 7: Segmented images ofinterior view of brain of control and autistic for all faces, familiar faces and stranger faces.

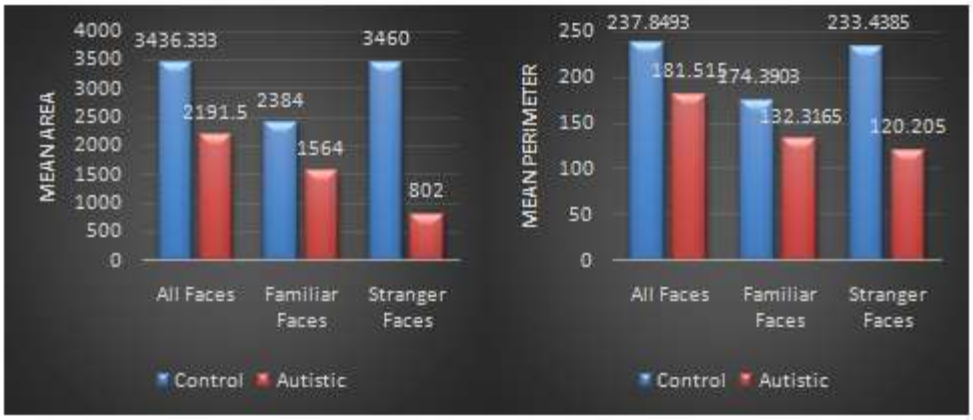
Table no 2: Calculating mean area, mean perimeter and meaneccentricity

	All Faces		FamiliarFaces		StrangerFaces	
	Control	Autistic	Control	Autistic	Control	Autistic
Mean Area	3436.333	2191.5	2384	1564	3460	802
Mean Perimeter	237.8493	181.515	174.3903	132.3165	233.4385	120.205
Mean Eccentricity	0.6021	0.71545	0.4371	0.52635	0.55495	0.73435

Table no 2 shows mean area, mean perimeter and mean eccentricity in this work. From this graphical representation in figure 8, there have been found significant FFA activity in response to all faces, familiar and strange faces both control and autistic. For recognizing a familiar, an activation area of control brain (2384) is much wider than autistic brain (1564). On the other hand, for a stranger, an activation area of control brain (3460) is also much wider than autistic brain (802).

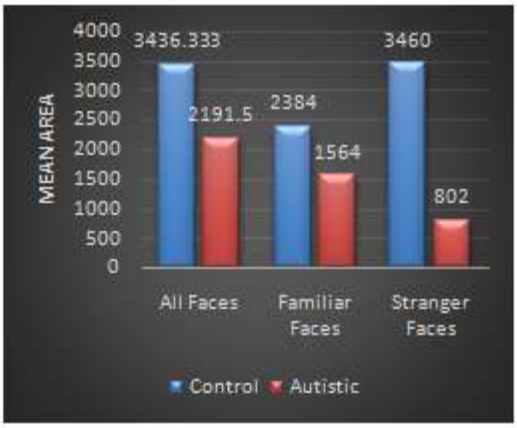
After that, there are applied feature extraction method in Matlab for showing the analysis of detected activation area. Table II shows mean area, mean perimeter and mean

From this graphical representation, there is an also significant FFA activity of sagittal view of brain in respons



a) Mean area

b) Mean perimeter



c) Mean eccentricity

Figure 8: Bar graphs for mean area, mean perimeter and mean eccentricity both for familiar and stranger faces between control and autistic (two different color)

In this experiment, there are described two view such as interior view and sagittal view of human brain for calculating the fusiform face area (FFA) activity in both control and autistic people. By observing all these statistical analysis, it can be said that autistic brain sometimes works as a better performance than normal brain for face perception.

IV. CONCLUSION

By using feature extraction method of fusiform gyrus of brain area, it is very clearly visualized that there are some significant differences in calculation of activated area, perimeter and eccentricity for all, familiar and stranger faces between control and autistic brain in the fusiform face area (FFA) during face perception. From these differences, it has been observed that the activation areas in fusiform gyrus are hypoactive in patient with autism than in control. It is a simulation model to understand the risk of autistic child. The causes of these differences needs to be investigated in details which demands further-study.

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