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3D RECONSTRUCTION AND MODELLING OF A BRAIN MRI WITH TUMOUR

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Abstract - *A 3D printed model of a brain with tumour is created using MRI dataset in the proposed work. The dataset is pre-processed in such a way that the tumour region is enhanced from the rest of the region of the brain and the brain is extracted from the rest of the head. The processed image is reconstructed into a 3D image which is, converted to suitable form and undergoes stages essential for 3D printing. Next to this, a coded version of the 3D image is fed to the 3D printer to create a model which replicates the brain of the patient specifying the location, size and position of the tumour in the brain. This model will essentially be useful for pre-surgery planning for the doctors in order to choose the best surgical procedure for the condition which finally results in successful surgeries, saving the patient.*

Key Words: - **Brain tumour, 3D printing, 3D reconstruction**

1. NTRODUCTION

The central nervous system comprises of the brain and the spinal cord, where majority of the body functions are controlled by the brain – which include movement, posture, speech, memory, sensations and many more. A tumour in such a complex organ is an issue to report. A central nervous system with tumour will affect the above mentioned body functions and can be fatal. 85% to 90% of the central nervous system tumour is accounted by brain tumour and it has be found to be affecting children below 15 years of age. The 10th leading cause of death for both men and women is the brain and other nervous system cancer.

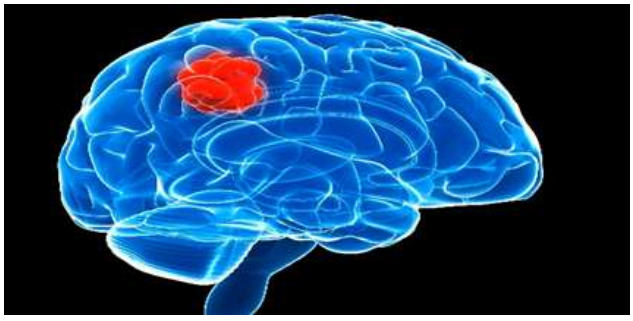

Fig.1 Depiction of brain tumour

The most common way of diagnosing a brain tumour is magnetic resonance imaging (MRI). Other than using x- rays, a magnetic resonance imaging uses a magnetic field to produce a detailed image of the brain, which is produced by the hydrogen atoms present in the body. In the presence of the magnetic field, the hydrogen molecules moves to an excited state and release RF waves that is captured by the detectors and the image is formed.

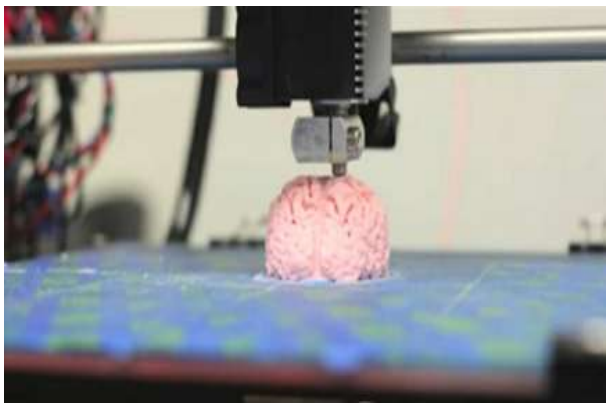

Fig.2 3D printing of brain

3D printing is an emerging field in various industrial applications, the recent use of 3D printing has revolutionised the medical field and has many applications – such as bio printing tissues, surgery preparation, printing of surgical instruments and prosthetics using 3D printing.

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2. METHODOLOGY

a. Image processing

The MRI dataset is of a male of 23 years of age with a tumour in the left lobe of the brain. Before the reconstruction step, it is essential to outline the tumour in order to easily visualize it when being modelled. The image processing of the dataset comprises of two steps – filtering and enhancement.

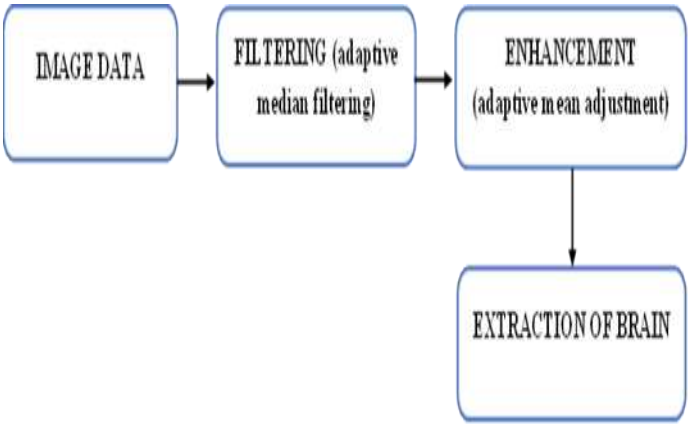

Fig.3 Block diagram of image processing

Filtering is a process by which the image can be emphasized in terms of features or remove unwanted regions. The filtering operation used in the proposed work is adaptive median filtering. The adaptive median filter is a noise filter which seeks to preserve details while smoothing and its filter size will vary depending on the neighbouring. The follow is the notation and algorithm for adaptive median filter.

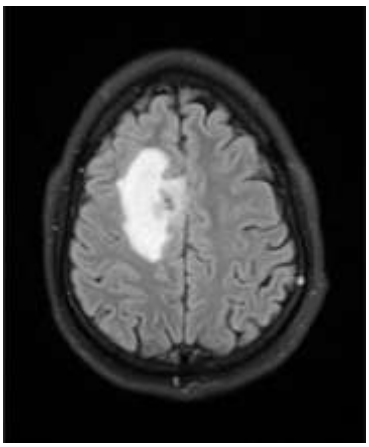

Fig.4 Input image

Zmin and Zmax = minimum and maximum gray level value in Sxy
Zmed = median of gray levels in Sxy
Zxy = gray level at coordinates (x, y)
Smax = maximum allowed size in Sxy

Level A: A1 = Zmed - Zmin A2 = Zmed - Zmax
If A1 > 0 AND A2 < 0 Go to level B
Else Increase the window size
If Window size <= Smax Repeat level A
Else Output Zmed

Level B: B1 = Zxy - Zmin B2 = Zxy - Zmax
If B1 > 0 AND B2 < 0 Output Zxy
Else Output Zmed

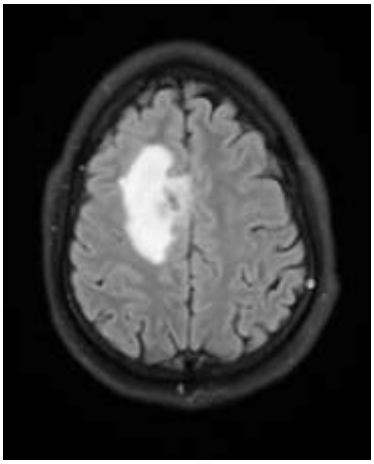

Fig.5 Image after filtering using adaptive median filter

Enhancement is the process that has been done to precisely highlight the required region when compared to the rest of the image. In our work, we have enhanced the region of the brain containing the tumour.

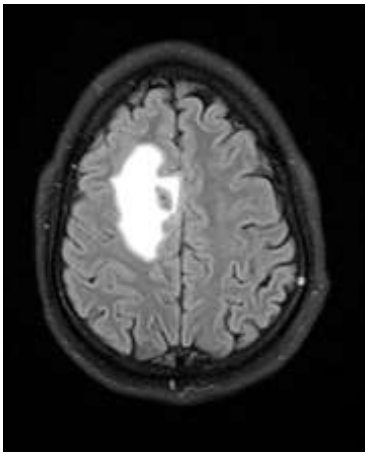

Fig.6 Enhanced image done by adaptive mean adjustment

In case of reconstruction and modelling it is specifically important to isolate the brain from the rest of the head (skull). Extraction is the process by which we can do the above mentioned step.

b. 3D reconstruction

Once we are done with the image processing, it is essential to stack the MRI slices to create a 3dimentional image with coordinates (x, y, z). In order to create a 3d image we have converted the processed image to a suitable format (.stl) to manipulate the image.

Fig.7 Conversion of image to stl format

Further, the image is fed to a slicing software where the requirements for the 3d printer-such as the position, the number of layers, the material used for printing and the method are chosen. Finally, the image is converted to a code (.gcode) which is the binary representation of the final image to be printed.

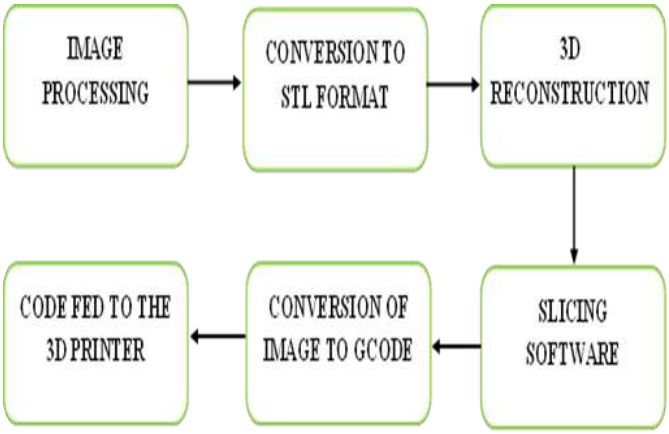

Fig.8 Block diagram for 3D reconstruction

c. 3D printing

The model of the brain with tumour is printed using the SLA (stereolithography) method and the material used is carbon fibre. The model is created in such a way that, the tumour is differentiated from the rest of the brain using colouration.

3. RESULT AND CONCLUSIONS

The expected output of this project is to produce a 3D model from 2D images of brain MRI with tumor by reconstruction. The 3D reconstructed image is converted to a suitable format for it to be accepted by the 3D printer. Finally, the 3D reconstructed image is fed into the 3D printer, and a model replicating the patient's brain is developed. The usage of 3D printing will be replaced by virtual reality in the future and hence it will be useful for study purpose and waste of material can be reduced.

4. APPLICATION

The 3D model created will replicate that of the patient which is utilized for pre surgery preparation which helps the surgeon to select the best surgical procedure to treat the condition. The model can be beneficial for study and simulation purposes for students. 3D models of organs will play a vital role in virtual reality applications.

5. ACKNOWLEDGEMENT

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