INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad-500 043

Project Based Learning

(Prototype / Design Building)

External Evaluation Report

Title of your Idea : **Image Processing System Using MATLAB Based Analytics**

Thrust Area / Sector : **3D Image processing**

Branch : **Electronics and Communication Engineering**

Year / Semester : **5th Semester**

S. No	Name of the Student	Roll Number	Mobile Number	Signature
1	SNEHA SAIPRIYA TULLURI	19951A04G7	9703839220	
2				
3				
4				

Team Members (Max. 4) :

1. **Background of the Idea (Min. 500 words):**

With the progressing software's we can see the everyday advancements in image processing applications which are expanding towards the various other operations. In the real time world we can observe that 2D and 3D image processing is available and its implementation is in wide range. Here, in this research paper we will be using MATLAB software analogy to produce and evaluate 3D images.

Image processing has developed over the years and the significance of it has progressed gradually in various fields such as medical, engineering, finger print detection etc. Image processing is the technique to convert an image into digital form and the output depends on the tasks and functions that can be implemented to mould the image. It describes a type of signal processing operation on an image in which the image (e.g. photo or video frame) is an input signal with output characteristics of the original/input image. Image processing has been described as a mathematical operation of computer on a two-dimensional as well as three- dimensional photos and videos.

MATLAB's signal processing application tools are designed to help scientists and engineers achieve their objectives. The following are some MATLAB-based application tools for image processing applications. Yang presented a MATLAB-based image processing system for use in medical engineering. He emphasized the importance of picture data in medical engineering as the primary means of communication, and claimed that while digital image processing in medical engineering has a high cost, it always generates effective results by reducing noise and improving image quality. Processed photos carry a lot of medical and pathological information about a particular condition in the medical engineering industry.

A MATLAB-based technique is used to perform a software simulation examination of an image recognition. The research focuses on a methodological approach that includes a MATLAB-based implementation of a software system for picture recognition analysis. Buksh et al proposed a MATLAB-based picture editing and colour detection system that uses the MATLAB toolbox's built-in functions to create a variety of image processing applications. The authors stressed the use of MATLAB as a computing platform and backbone of growing visual communication, appropriate for designing and testing a variety of applications. They also advised that it be used in the teaching of digital signal processing.

Image processing in MATLAB is very keenly heard but image simulation of videos, easy debugging, recording of the process used, numerical accuracy and code is effortless within it. MATLAB provides various tasks for image processing, there are functions written within MATLAB thus, leading to easy implementation and open to scrutiny, making it different from Photoshop. The image processing algorithms present under MATLAB are more advanced than many editing applications. The techniques that are being used are video reversal, 3D image restoration, slow motion video, rendered volumes, geometric transformations, image segmentation and video segmentation.

Our main objective is to process 3-Dimensional(3D) images with the most recent tools and provide an empirical based method using Three Dimensional Discrete Cosine Transform (3D-DCT) with MATLAB based analytics. Image processing for 2D images was taken place which is a boon to many applications in the real world whereas the majority of image processing human beings want at the moment would be mainly 3 dimensional images.

Here there are many complications to accomplish 3D image processing and to find the perfect software for image processing of it. There could be applications with only a few editing options and functions for 3D image processing and a vast variety of functions for 2D. With MATLAB we can perform these functions and tasks on three dimensional images without any haze. Hence, the results which will be decoded can have an accurate approach on 3D image processing.

2. Problem Statement (Min 100 words):

MATLAB is a high-level programming language with features that are fundamental to both the technological and engineering disciplines with numerous algorithms that have scope for a wide range of applications for real world applications. Seeing the rapid growth of technology being versatile scientists and engineers currently have omnipresent access to vast multimedia software and hardware devices that can run image processing applications with 2D and 3D visualizations. However, the vast applications we see in the real world need the aid of another application for its proper functioning. Thus, this study is aimed at bring forth the potentials of some of the novel features to inherent in MATLAB as an independent application tool for signal processing operations and functions with digital image processing.

3. Proposed Solution (Min 100 words):

Here in the existing method it was proposed that only image processing for 2D images was taken place which is a boon to many applications in the real world whereas the majority of image processing human beings want at the moment would be mainly 3 dimensional images. Here there are many complications to accomplish 3D image processing and to find the perfect software for image processing of it. There could be applications with only a few editing options and functions for 3D image processing and a vast variety of functions for 2D. Hence, here we are using three dimensional Discrete Cosine Transformation for image processing of 3D images in MATLAB.

4. Technology concept formulation:

Multidimensional variants of the various DCT types follow straightforwardly from the one-dimensional definitions: they are simply a separable product (equivalently, a composition) of DCTs along each dimension.[6]

The *3-D DCT-II* is only the extension of *2-D DCT-II* in three dimensional space and mathematically can be calculated by the formula:

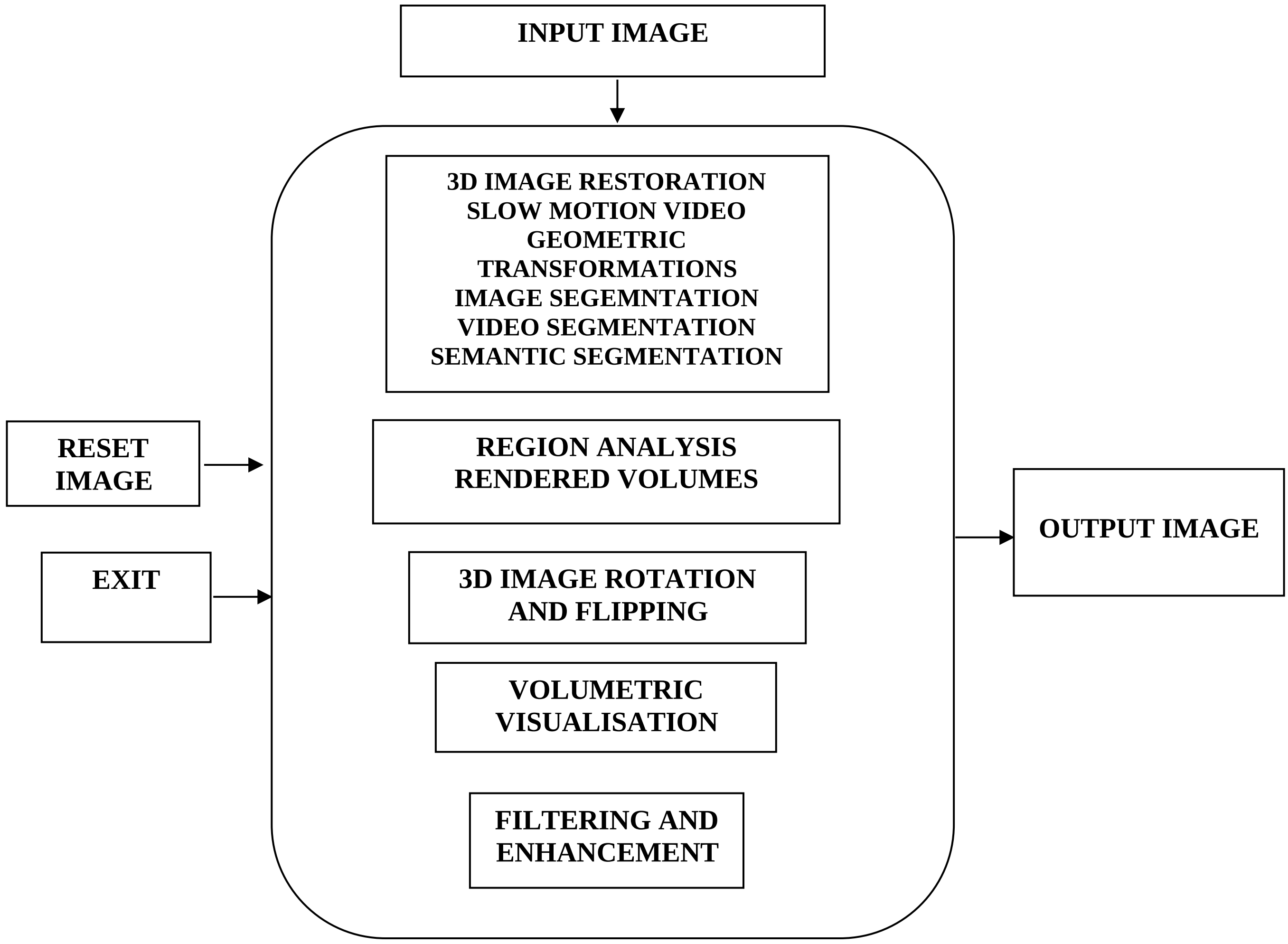
$$X_{k1,\, k2,\, k3} = \sum_{n1=0}^{N1-1}\sum_{n2=0}^{N2-1}\sum_{n3=0}^{N3-1} x_{n1,n2,n3} \cos\left[\frac{\pi}{N1}\left(n_1 + \frac{1}{2}\right) k_1\right] \cos\left[\frac{\pi}{N2}\left(n_2 + \frac{1}{2}\right) k_2\right] \cos\left[\frac{\pi}{N3}\left(n_3 + \frac{1}{2}\right) k_3\right] \text{ for } k_i = 0,1,2,\ldots, N_i - 1$$

The inverse of 3-D DCT-II is 3-D DCT-III and can be computed from the formula given by:

$$x_{k1,\, k2,\, k3} = \sum_{k1=0}^{N1-1}\sum_{k2=0}^{N2-1}\sum_{k3=0}^{N3-1} X_{k1,k2,k3} \cos\left[\frac{\pi}{N1}\left(n_1 + \frac{1}{2}\right) k_1\right] \cos\left[\frac{\pi}{N2}\left(n_2 + \frac{1}{2}\right) k_2\right] \cos\left[\frac{\pi}{N3}\left(n_3 + \frac{1}{2}\right) k_3\right] \text{ for } n_i = 0,1,2,\ldots, N_i - 1$$

5. Prototype of proposed system (UI screens / block diagrams / circuits / designs):

5.1) BLOCK DIAGRAM OF PROPOSED METHOD:



6. Detailed description of prototype / product / project (Min 1000 words):

As of now we have seen many two dimensional image processing applications in a wide range it has an extensive use in JPEG and various other two dimensional images. Here in our method we have proposed the three-dimensional discrete cosine transform (3D DCT) which has been used in many 3D applications such as video coding, geometric transformations, semantic segmentation of videos and compression. Many fast algorithms have been developed for the calculation of the 1D DCT. These algorithms are then used for the calculation of the 3D DCT using the row-column approach or through mapping it to 1-D and using other transforms.

However, 3D algorithms involve fewer arithmetic operations and can be faster. Where this is a multidimensional discrete cosine transform and has the coordinates x, y and z axis. Since there a less number of applications for 3 dimensional image processing here we are using MATLAB software as there are many applications within the software that can perform functions on the image or video. Simulink can also be used by using the tools within the library and building up a model for the method of image processing.

Volume rendering is the direct rendering of data sampled in three dimensions. By modelling each voxel (volume element) as both a source and attenuator of light, volume rendering allows the visualization of interior structure and its relations to exterior forms. There are two basic approaches to volume renderings: the object space approach and the image space approach.

In the object space approach, the contributions of voxels, cells, or kernels are projected onto the image plane, whereas in the image space approach ray tracing to perform the source-attenuation integral is carried out for each pixel on the image plane. Accelerated methods have been proposed including fast algorithms that build additional data-structure prior to rendering under the assumption that there is sufficient memory to hold the data-structure. [7]

Here, in my project I have chosen to take up Volume visualization and Volume Semantic Segmentation of Three dimensional Models. In these models we can have a clear picture and can identify an abnormality or deformation in any organ or body part.

6.1) Volume Viewer:

The volume Viewer in MATLAB is a combination of technologies used in computer graphics and scientific visualisation to build a 2D projection from a discretely sampled 3D data set is known as volume rendering it can be used to observe medical X-rays and models of the organs of the body in different contrasts and also can be useful for viewing a collection of 2D slice images from an MRI, CT or a Micro CT scanner for a 3D data set.

I have used a CT Chest models and have observed it in Volume Viewer in MATLAB. The opacity and Image Intensity of the model can be altered by the graph on the right hand side. There are many tools in MATLAB to see the Models in certain contrasts for clear visualization and identification of any discrepancies. In Volume Viewer in the rendering editor panel, we can change the rendering style of the model which are – Volume Rendering, Maximum Intensity Rendering and Isotropic Rendering. The Colour map of the model can also be changed for visualization of the model in different contrasts. There is free movement and rendering of the three dimensional models in MATLAB which makes it convenient for study of the abnormalities and organ.

6.2) Volume Semantic Segmentation:

Volumetric Semantic Segmentation is also a very useful Tool in MATLAB as we can point out abnormalities in the organs of a body, this can widely be used in the medical field but there are many diagnostic companies that prefer using other applications other than MATLAB for their identification of enigmas in the patients organs, but I can say that MATLAB is a very functional and less code input Software which leads to accurate and essential results. Its rendering is also very niche and compact in design for easily spotting out irregularities.

In my project I performed Volumetric Semantic Segmentation on a three dimensional model where Volume image segmentation is a manual or automatic procedure that can be used to section out large portions of the volume that one considers uninteresting before rendering, the amount of calculations that have to be made by ray casting or texture blending can be significantly reduced.

Here, I have identified a tumour in a human brain three dimensional model. In this tool the images of the model will be in the form of slices. There are a total of 155 slices in the 3-D brain model. In this model each and every slice shows an image of the brain in detail, all the 155 slices are continuous shots of the brain under a MRI scan. In this tool, we can paint out labels of the tumour and brain observed in the slices. Label 1 can be named as brain and Label 2 can be named as tumour, both can be drawn out accordingly with the pain tool.

Once we have identified the tumour and brain we can manually interpolate then and merge the two different labelled slice regions together and interpolate them. After interpolation the part from beginning slice to ending slice shows the tumour highlighted. With this we can identify the tumours in the brain and highlight them for further study.

For example: Using the elements within the library and preinstalling toolboxes for image processing. Here, the code used is MATLAB code which is easy to understand and execute.
Further in our proposition, we have considered video reversal, transformation of a 2D image into 3D images, semantic segmentation in videos, 3D image restoration and slow motion video.

6.3) EXPERIMENTAL SETUP:

- Firstly open MATLAB and in the command prompt you can type your code. But before running your code, import an image into MATLAB by using import command and directory of the image preceding it. Which you can process with the functions in MATLAB.
- Certain functions can be accessed within the apps section in MATLAB and the process can be executed.
- Firstly image must be imported then determination of the size of the image using "*imshow(V(:,:,100),[])*". Further we must determine the App we want to use in MATLAB by specifying the app name and project file variable name inside brackets.
  Ex: "*volumeSegmentation(V)"*.

6.4) Source Code of Three- Dimensional Volume Viewer:

```
>>load(fullfile(toolboxdir('images'),'imdata','BrainMRILabeled','images','vol_001.mat'));
>> imshow(V(:,:,100),[])
>>volumeViewer(V)
```

6.5) Source Code of Three Dimensional Image with Volume Semantic Segmentation:

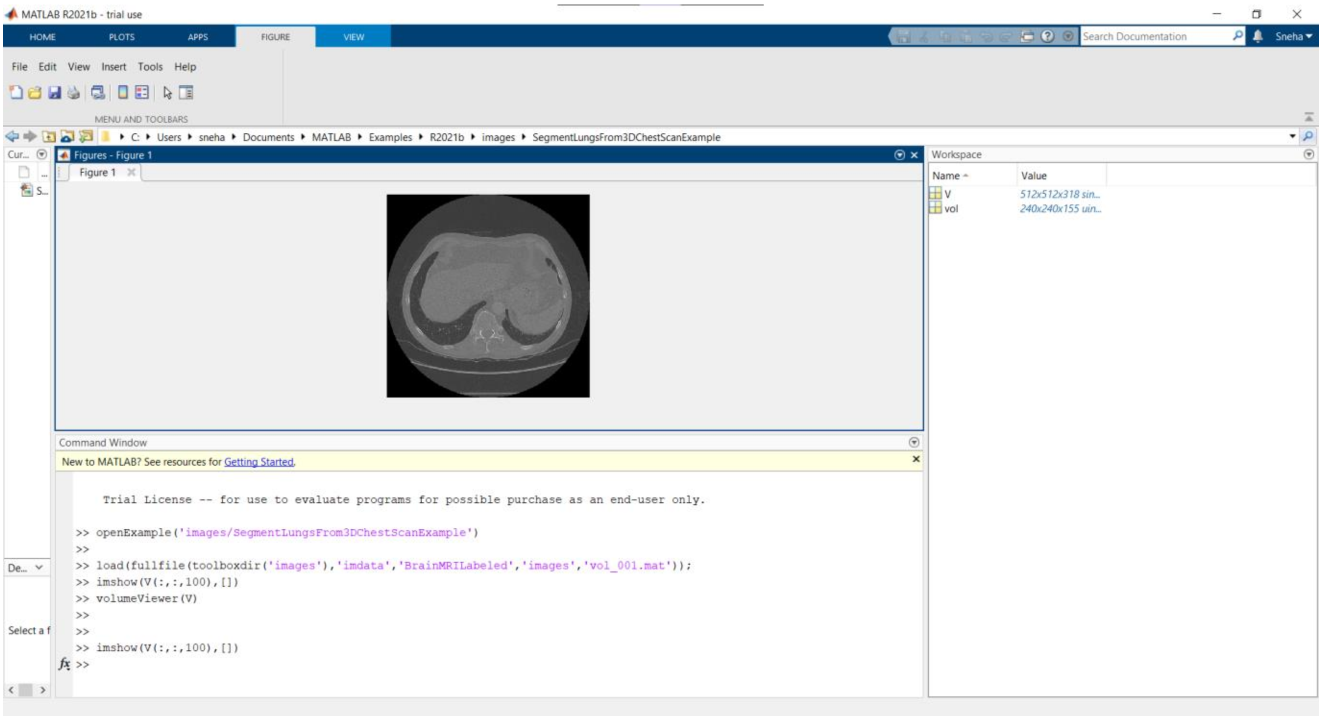
>>load(fullfile(toolboxdir('images'),'imdata','BrainMRILabeled','images','vol_001.mat'));

>>volumeSegmenter(vol)

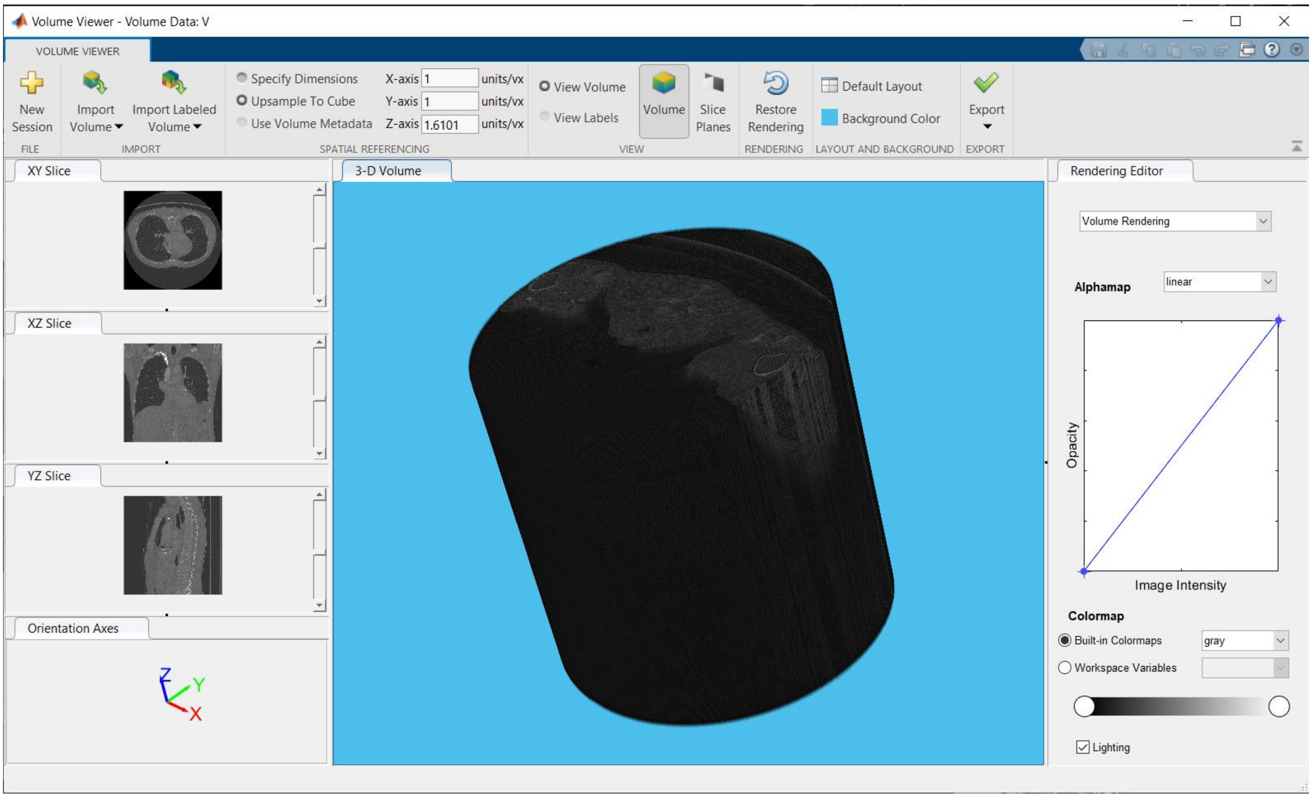
7. Final version of prototype / product (only images):

<u>7.1) Rendered Models of Three dimensional CT Chest using Volume Viewer:</u>

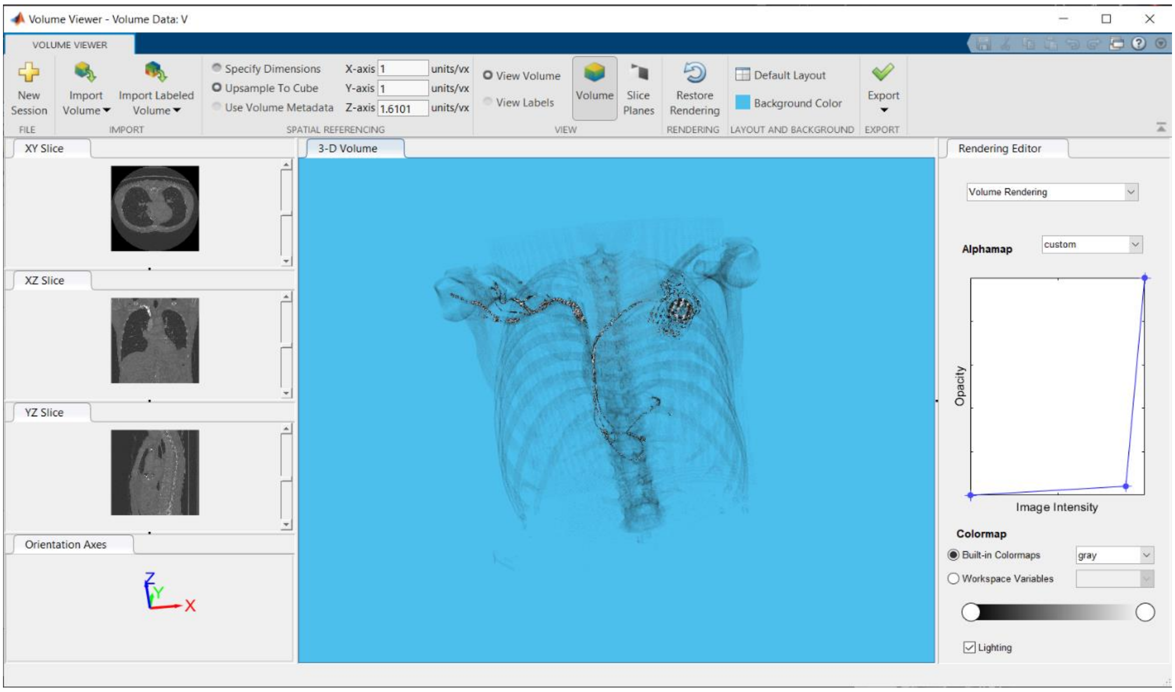
7.1.1) Figure Obtained using 'imshow' command:



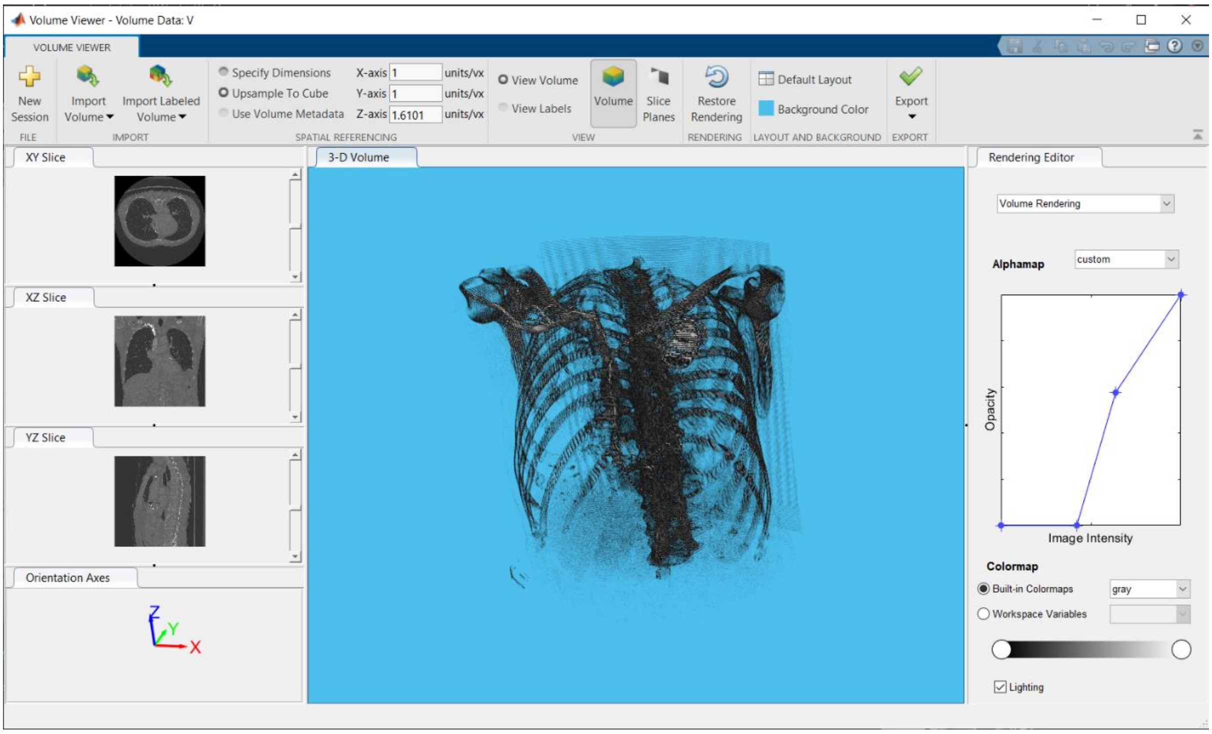
7.1.2) Volume Rendering with Alpha map: Linear and Color- map: Gray:



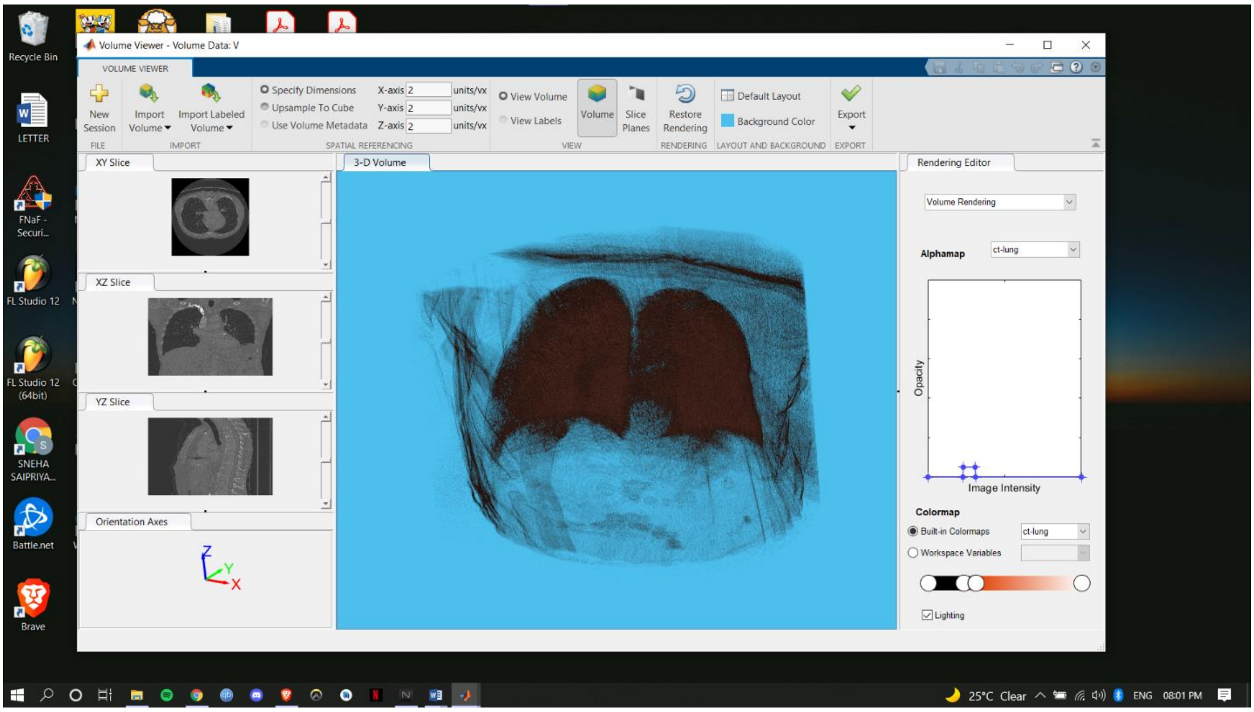
7.1.3) Volume Rendering with Alpha map: Custom and Color-map: Gray:



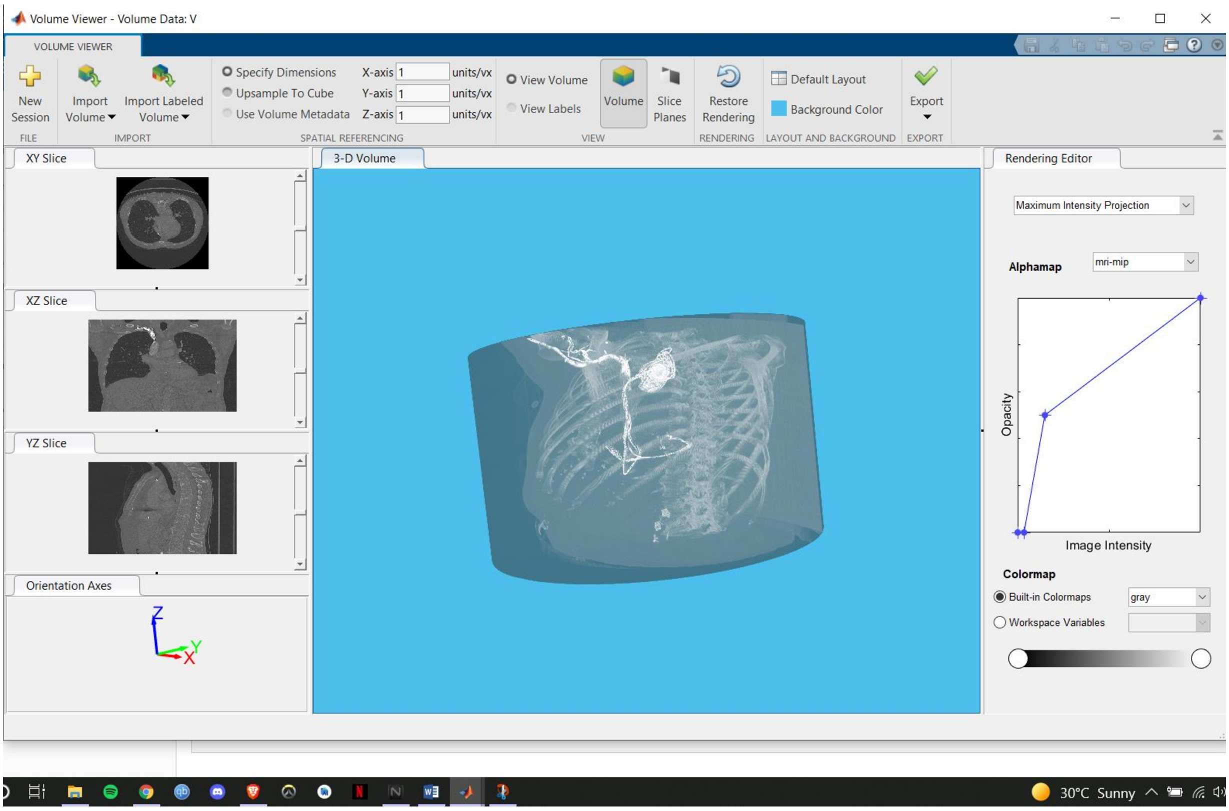
7.1.4) Volume Rendering with Alpha map: Custom and Color-map: Gray:



7.1.5) Maximum Intensity Rendering with Alpha map: MRI-MIP and Color-map: Gray:

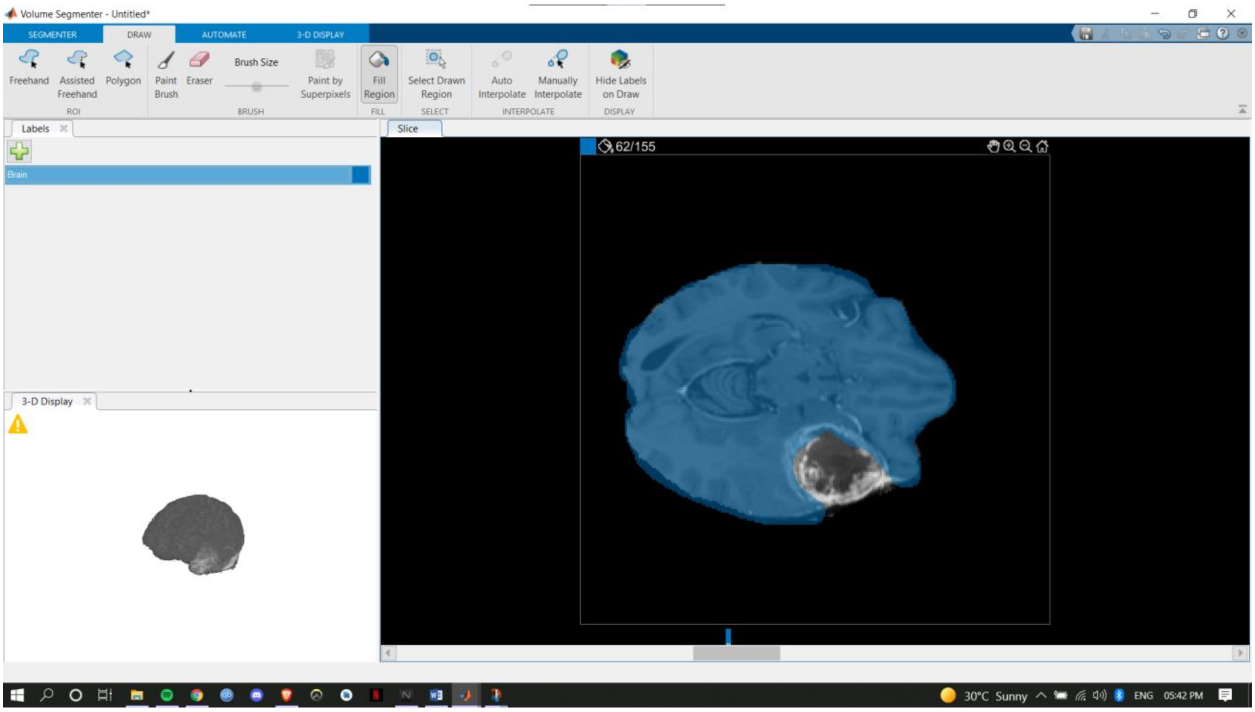


7.1.6) Volume Rendering with Alpha map: CT- Lung and Color-map: CT-Lung:

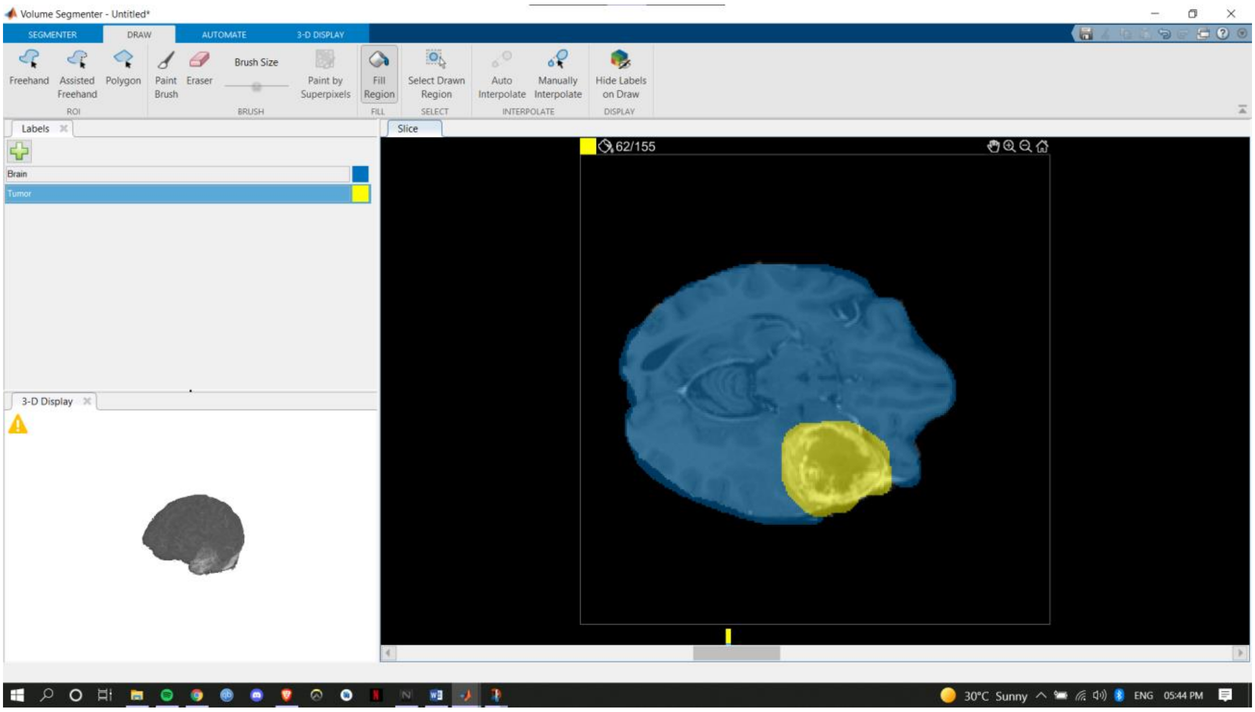


7.2) Segmented Models of Three dimensional MRI using Volume Segmentation:

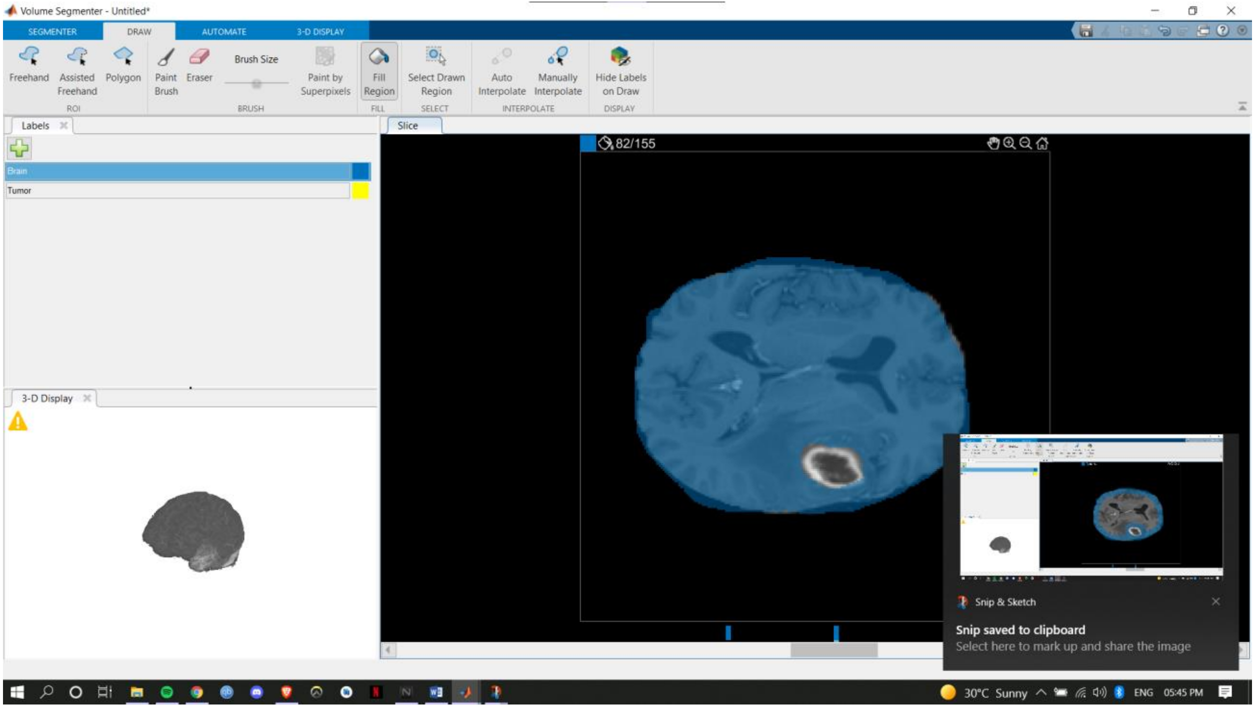
7.2.1) 62/155 Slice Brain Label (First ROI):



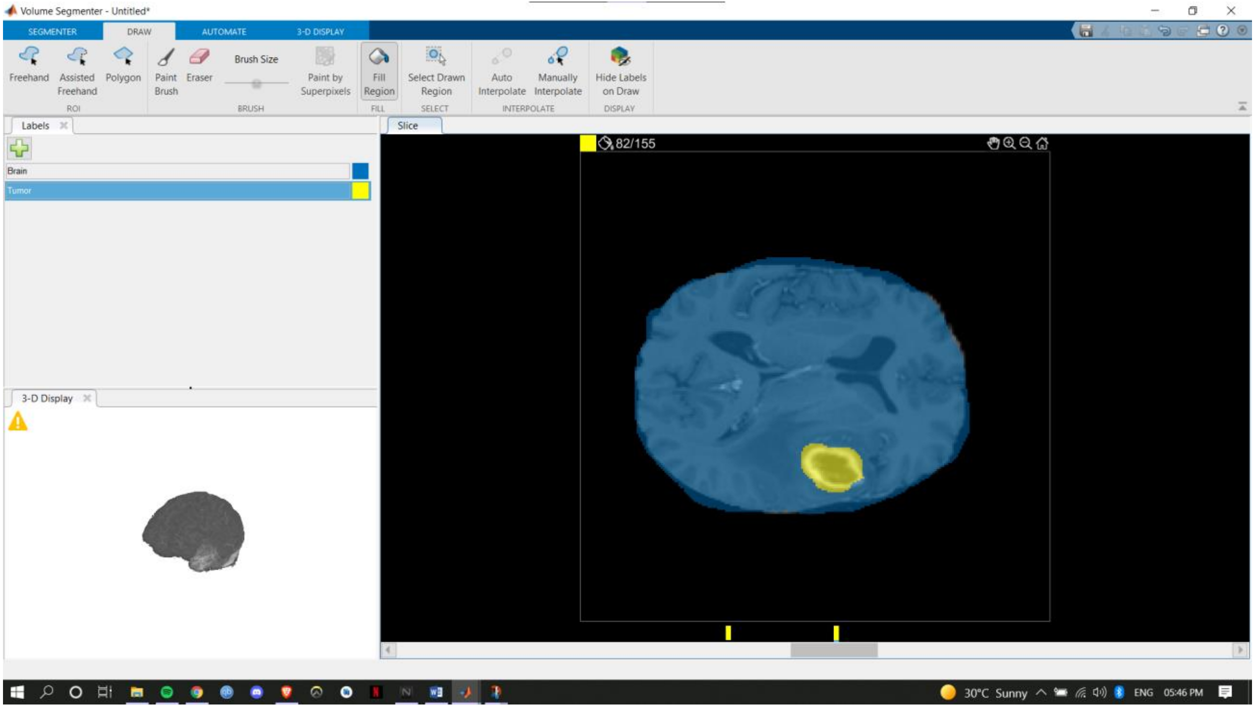
7.2.2) 62/155 Slice Tumour Label (First ROI):



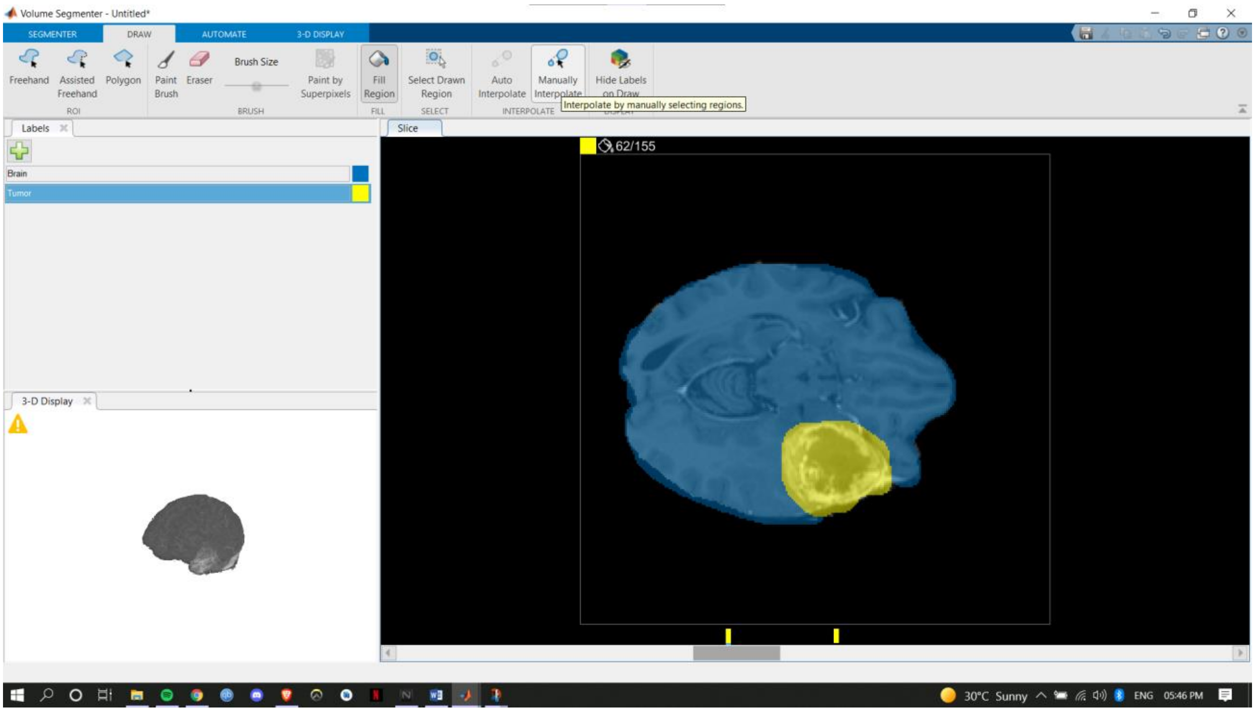
7.2.3) 82/155 Slice Brain Label (Second ROI):



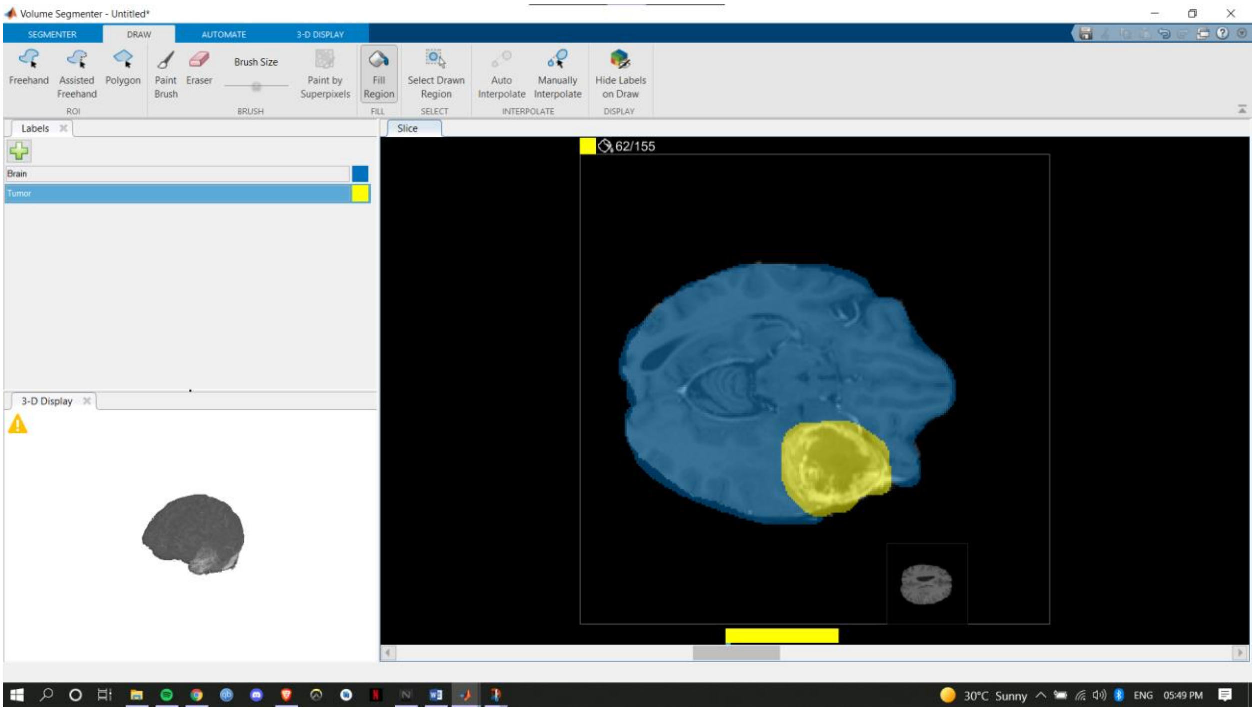
7.2.4) 82/155 Slice Tumour Label (Second ROI):



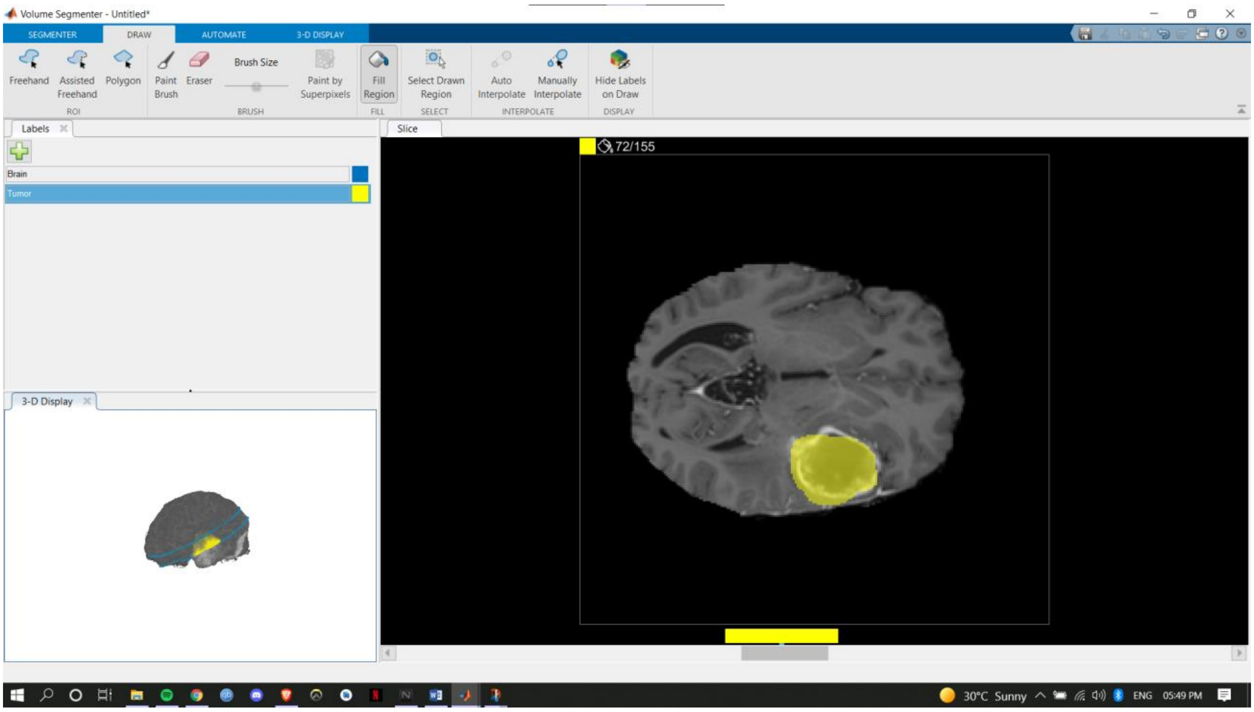
7.2.5) Before Manual Interpolation of First and Second ROI:



7.2.6) After Manual Interpolation of First and Second ROI:



7.2.7) Slice between Manually Interpolated ROI's:



8. **Any other information:**

8.1) REFERENCES:

[1] S. K. Dewangan, "Importance & Applications of Digital Image Processing," International Journal of Computer Science & Engineering Technology (IJCSET), vol. 7, no. 7, pp. 316-320, 2016.

[2] D. Zhang, F. Wang, R. Burgos, and D. Boroyevich, "Common mode circulating current control of interleaved three-phase two-level voltage-source converters with discontinuous space-vector modulation," 2009 IEEE Energy Conversion Congress and Exposition, 2009, pp. 2801-2807, doi: 10.1109/ECCE.2009.5316313.

[3] R. S. Kavita, R. Bala, and S. Siwach, "Review paper on overview of image processing and image segmentation, " International journal of Research in Computer applications and Robotics, vol. 1, no. 7, 2013.

[4] H. Zhang, Z. Zhang, and Z. Pei, "Design and Implementation of Image Processing System Based on MATLAB," in International Conference on Logistics Engineering, Management and Computer Science (LEMCS 2015), 2015, pp. 1356-1359, doi: 10.2991/lemcs-15.2015.270.

[5] Image processing system using MATLAB-based analytics research paper
Gerald K. Ijemaru1, Augustine O. Nwajana2, Emmanuel U. Oleka3, Richard I. Otuka4, Isibor K. Ihianle5, Solomon H. Ebenuwa6, Emenike Raymond Obi7

[6] https://en.wikipedia.org/wiki/Discrete_cosine_transform

[7] https://sci-hub.se/10.1109/2945.468390

Dean-CLET **Dean -TIIC**