ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

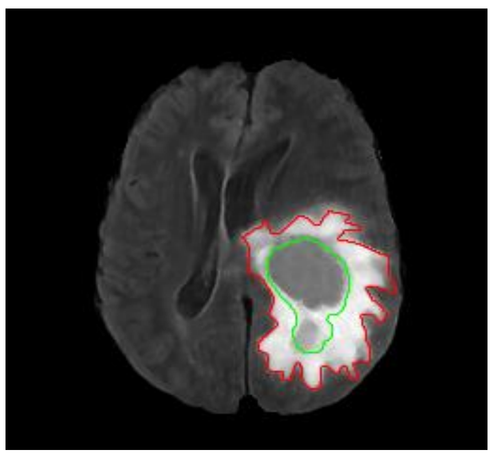
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Course No: EEE4602

Course Title: Signal & Systems lab

Project Name:

Brain tumor segmentation



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Introduction:

Image segmentation:

Image segmentation is a commonly used technique in digital image processing and analysis to partition an image into multiple parts or regions, often based on the characteristics of the pixels in the image. Image segmentation could involve separating foreground from background, or clustering regions of pixels based on similarities in color or shape. For example, a common application of image segmentation in medical imaging is to detect and label pixels in an image or voxels of a 3D volume that represent a tumor in a patient's brain or other organs.

Brain tumor segmentation:

Brain tumor segmentation is a critical task in medical image analysis, particularly in the field of neuroimaging. MRI (Magnetic Resonance Imaging) scans are commonly used in clinical practice for visualizing brain structures and abnormalities, including tumors. However, interpreting these images manually can be time-consuming and subjective, requiring expertise from radiologists or clinicians. The goal of our brain tumor segmentation project is to develop computer algorithms that can automatically identify and delineate tumor regions within MRI scans. This process involves analyzing the intensity, texture, and spatial characteristics of the image to differentiate between tumor tissue and healthy brain tissue. By accurately segmenting tumor regions, clinicians can obtain quantitative measurements of tumor size, location, and growth rate, which are crucial for diagnosis, treatment planning, and monitoring of patients with brain tumors.

Methodology:

We mainly perform three segmentation techniques-

- Threshold-based segmentation
- Edge-based segmentation
- Clustering-based segmentation

Adjust:

At first, we take a MRI of brain and adjust the saturation. imadjustn(V) maps the values in the *N*-D volumetric intensity image V to new values in J. imadjustn increases the contrast of the output volumetric image J. By default, imadjustn saturates the bottom 1% and the top 1% of all pixel values.

Threshold-based segmentation:

Threshold-based segmentation is one of the simplest and most commonly used techniques. It involves setting a threshold value to separate pixels into different regions based on their intensity or color values. This technique is effective when the objects of interest have distinct intensities or colors compared to the background. In this case, we can set a threshold value. The pixel values falling below or above that threshold can be classified accordingly as an object or the If we have multiple objects along with the background, we must define multiple thresholds. These thresholds are collectively known as the local threshold.

We will take the mean of the pixel values and use that as a threshold. If the pixel value is more than our threshold, we can say that it belongs to an object. If the pixel value is less than the threshold, it will be treated as the background.

imbinarize(I,T) creates a binary image from image I using the threshold value T. T can be a global image threshold, specified as a scalar luminance value, or a locally adaptive threshold, specified as a matrix of luminance values.

Edge-based segmentation:

Edge-based segmentation techniques focus on detecting and utilizing the edges in an image to define object boundaries. Edges represent significant changes in pixel intensities and can be detected using edge detection algorithms such as Sobel, Canny, and Laplacian of Gaussian. We implemented LoG and Canny algorithm.

We can make use of this discontinuity to detect edges and hence define a boundary of the object. Here's the step-by-step process of how this works:

- Take the weight matrix
- Put it on top of the image
- Perform element-wise multiplication and get the output
- Move the weight matrix as per the stride chosen
- Convolve until all the pixels of the input are used

'log'-Finds edges by looking for zero-crossings after filtering I with a Laplacian of Gaussian (LoG) filter.

'Canny'-Finds edges by looking for local maxima of the gradient of I. The edge function calculates the gradient using the derivative of a Gaussian filter. This method uses two thresholds to detect strong and weak edges, including weak edges in the output if they are connected to strong edges. By using two thresholds, the Canny method is less likely than the other methods to be fooled by noise, and more likely to detect true weak edges.

BW = edge(I,method) detects edges in image I using the edge-detection algorithm specified by method.

Clustering-based Segmentation

Clustering-based segmentation techniques aim to group similar pixels or regions together based on their features. Common clustering algorithms used for image segmentation include K-means and Mean Shift. K-means Clustering One of the most commonly used clustering algorithms is k-means. Here, the k represents the number of clusters (not to be confused with k-nearest neighbor). Let’s understand how k-means works:

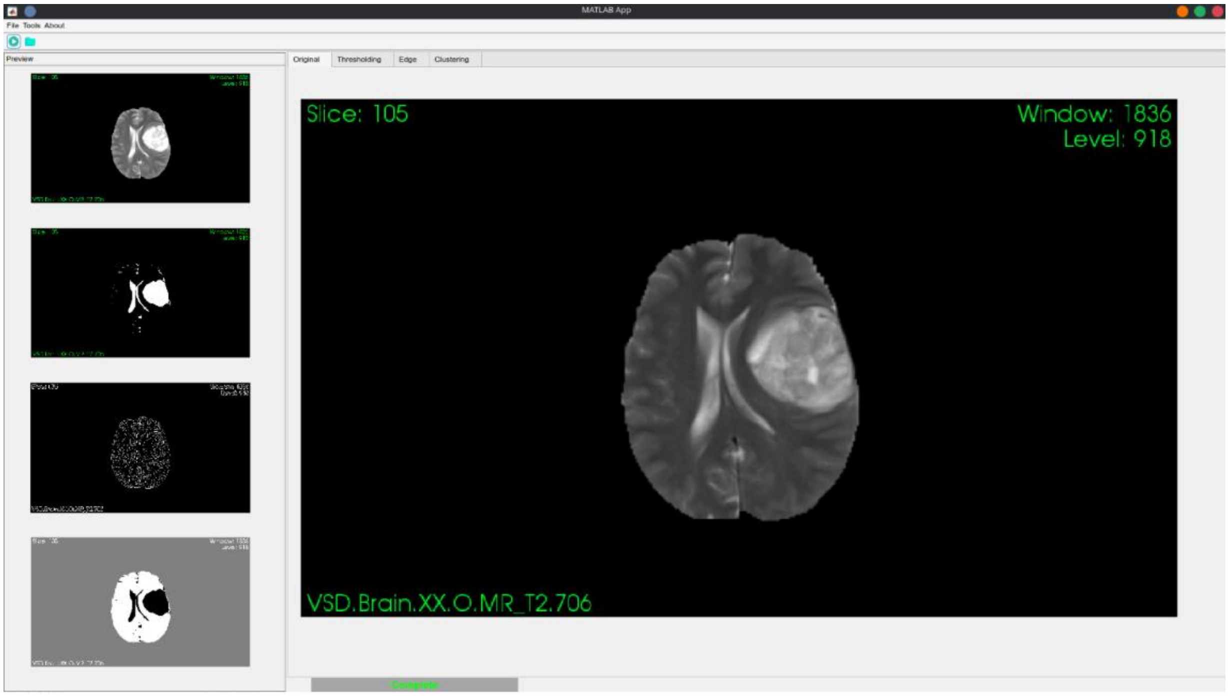
1. First, randomly select k initial clusters
2. Randomly assign each data point to any one of the k clusters
3. Calculate the centers of these clusters
4. Calculate the distance of all the points from the center of each cluster
5. Depending on this distance, the points are reassigned to the nearest cluster
6. Calculate the center of the newly formed clusters.

Finally, repeat steps (4), (5) and (6) until either the center of the clusters does not change or we reach the set number of iterations.

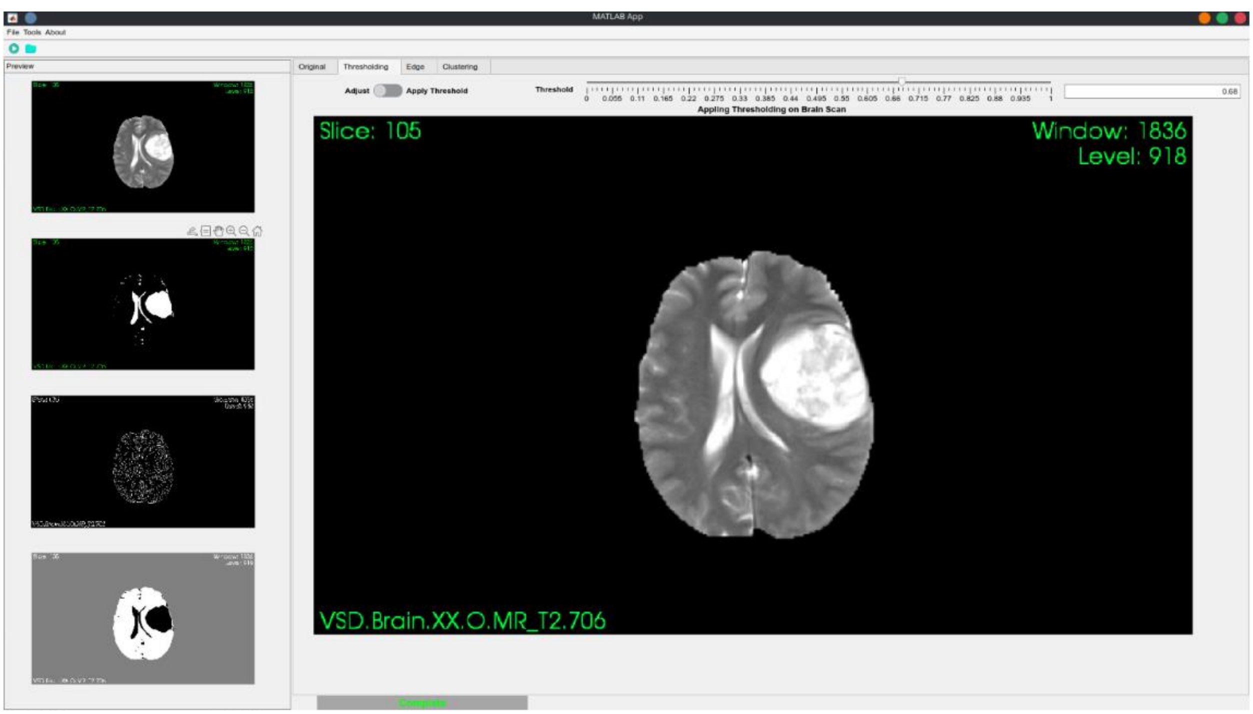
Result & Illustration:

We implemented our project on MATLAB designer app.

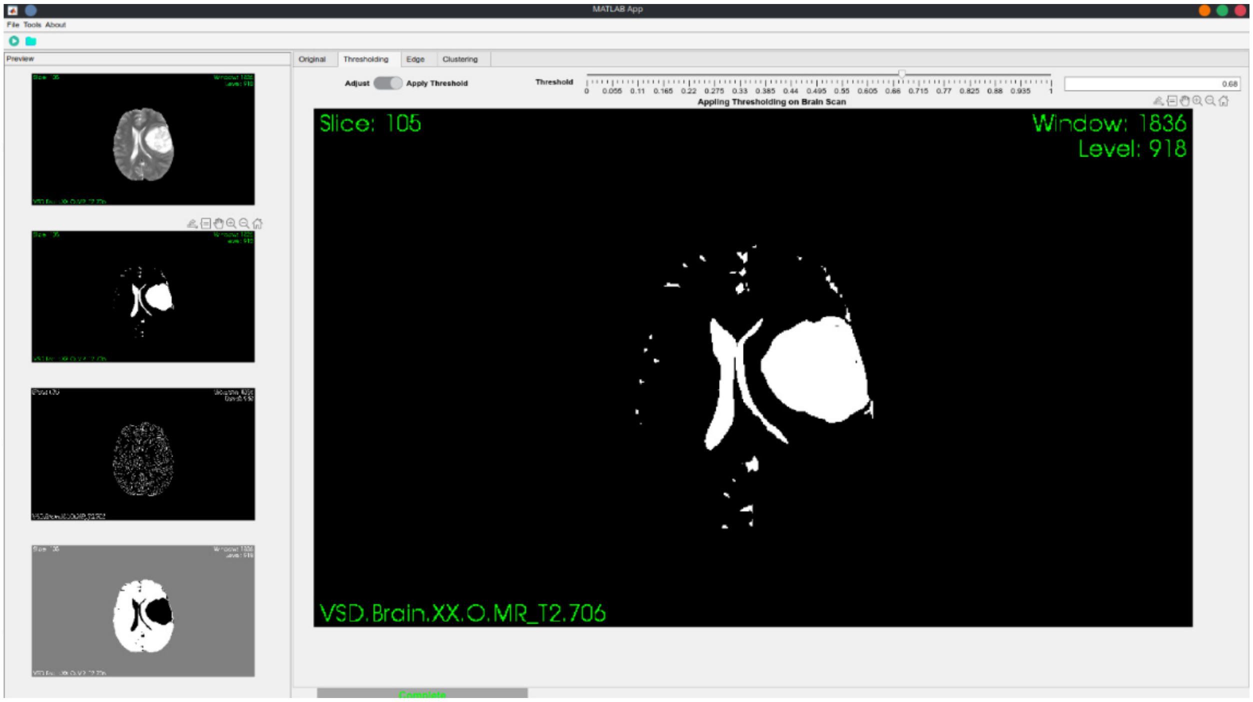
Image before segmentation:



After adjusting:

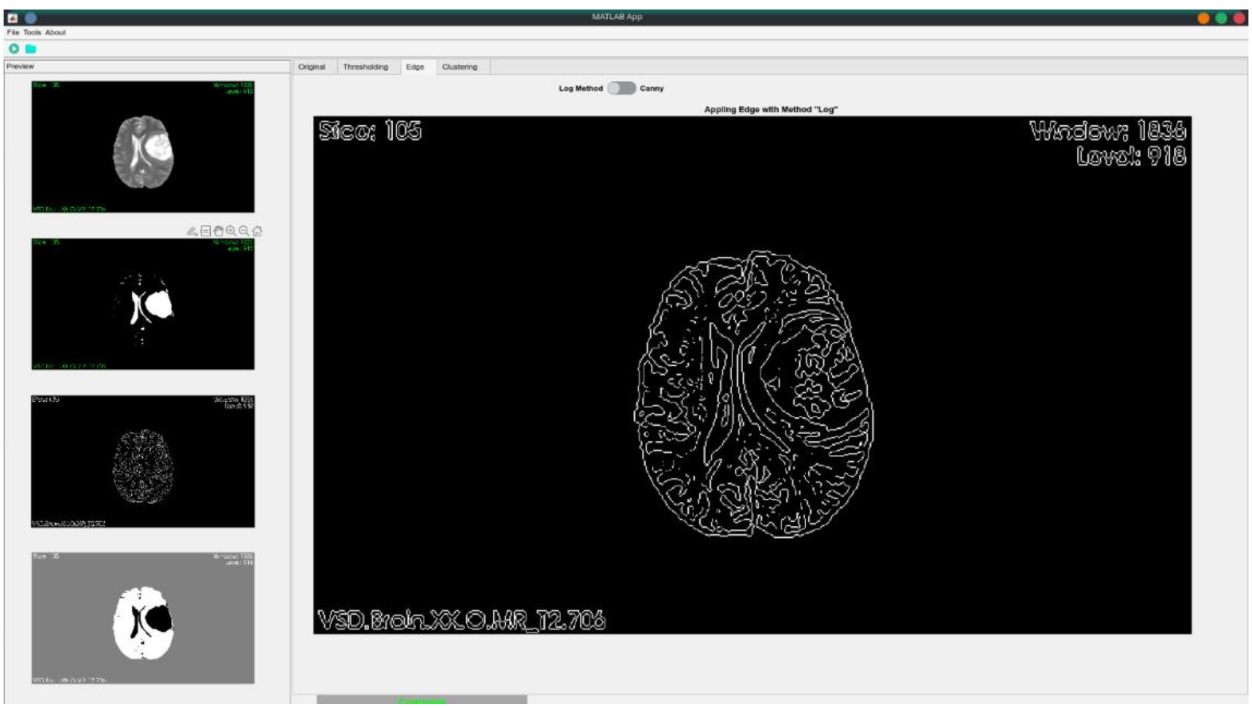


After threshold segmentation:

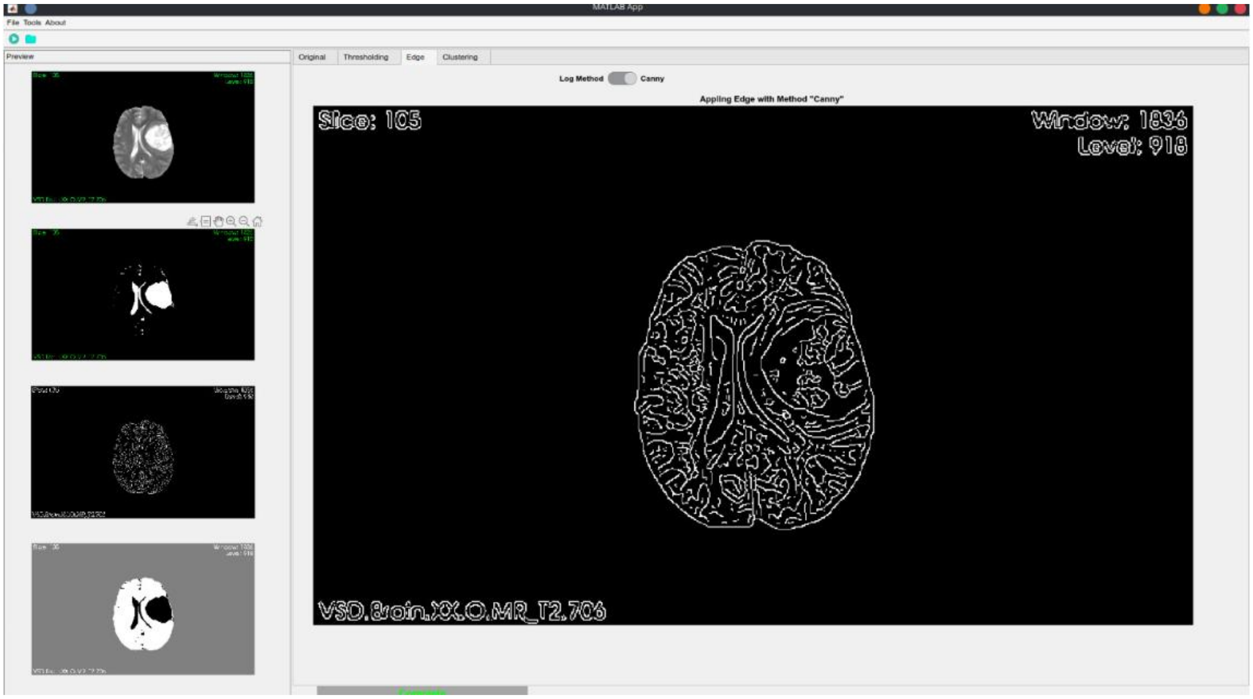


After edge-based segmentation:

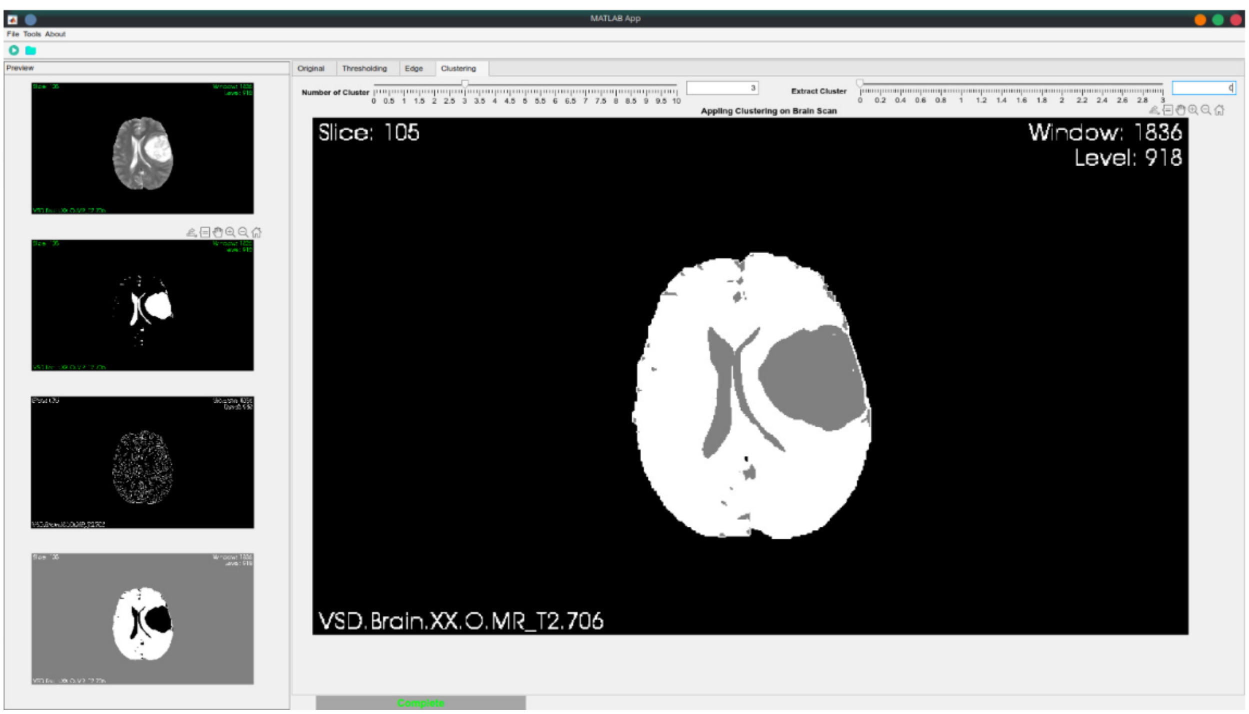
Log:



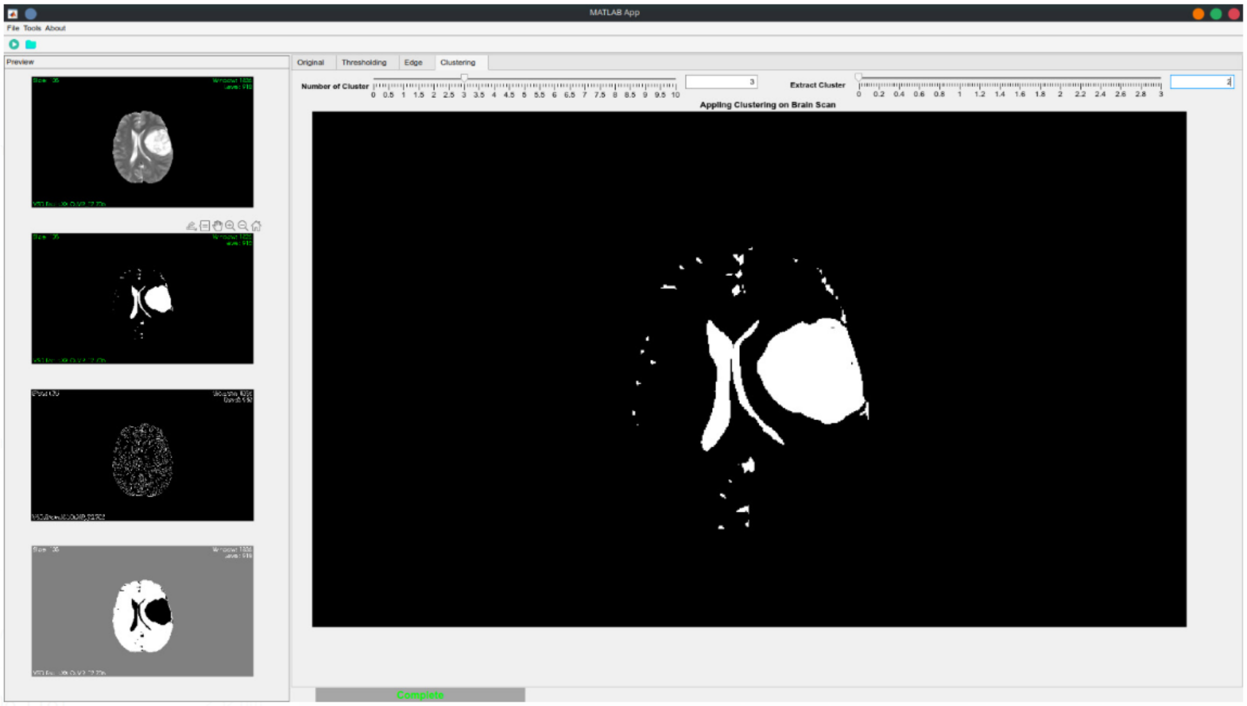
Canny:



After cluster-based segmentation:



Extract Cluster:



Limitations:

- Variations in lighting conditions, and textures affected our clustering algorithm.
- Appropriate for high-grade tumors, can't segmentize on low grade tumors.
- Oversegmentation divided the image into excessive regions.

Future implications:

- To contribute to the field of Radiology we should improvise the process of project.
- ML can also be used to improve accuracy.
- Can provide an automated report of the segmentation in medical terms.