IBM MACHINE LEARNING: CLUSTERINGPROJECT

Image Segmentation using Clustering of Arial Image of Aircrafts

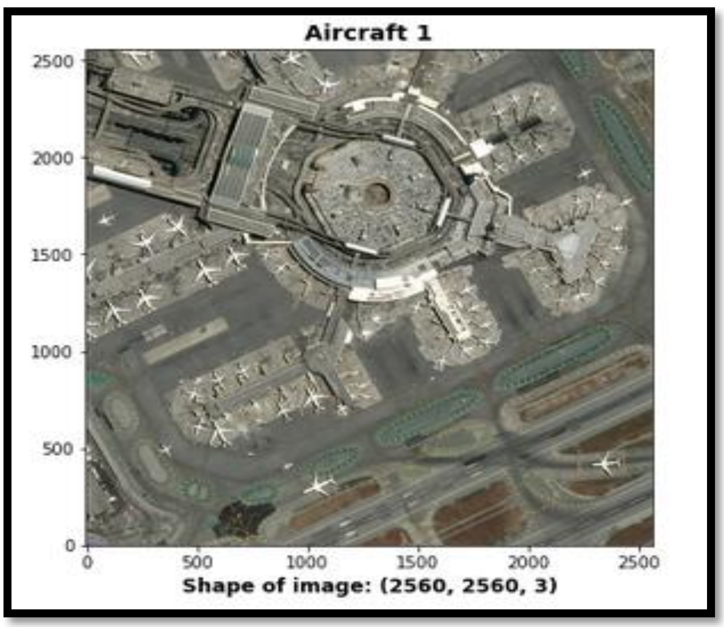
1. Objective

Arial images of airports can give tremendous information about the activities that are happening in that airport. Information like number of aircraft, size and type of aircraft can be obtained. In order to automate this process, these images will have to be fed into a computer algorithm. A computer cannot understand an image directly. So, it has to be processed. One of the processing techniques used in computer vision is Image segmentation.

In this project, we are going to segment Arial images of airports using unsupervised machine learning algorithms like clustering. We will use three different clustering techniques to segment the images.

2. Data

The data of images is given by Airbus Aircrafts Detection Sample Dataset. It contains 109 high resolution images of airports taken by Airbus satellites like Pléiades, SPOT, Vision-1 and DMC. Each image is stored as a JPEG file of size 2560 x 2560 pixels (i.e. 1280 meters on ground). The locations are various airports worldwide. Some airports appear multiple time at different acquisition dates. Some images also include fog or cloud for diversity.



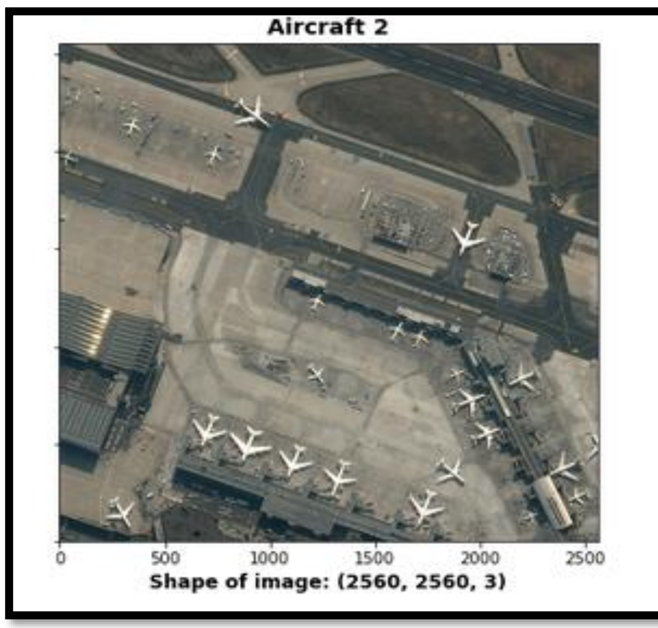


Figure 1. Sample Images of the dataset.

3. Data Preprocessing

3.1 Resizing Image

The images in the dataset are high resolution images with more than 2500 pixel in one dimension. So, we will make the image to a lower resolution of 250 x 250 x 3. This will make the algorithms run faster.

Figure 2. Resized Image of shape 250 x 250 x 3.

3.2 Data Preparation

In order to pass the image into clustering algorithm, we have to prepare the data in the correct sequence. An image contains 3 channels i.e. RGB channels, with 250 x 250 integer values ranging from 0 to 255 for each channel. Thus, we have a total of 250 x 250 x 3 integer values.

We need to format the data into a two-dimensional matrix, these values have to be grouped in such a way that one row has three columns where each column has the corresponding RGB values corresponding to a point in the image. Thus, our final dataset matrix dimension is 62500 x 3.

```
print('Shape of Flattened Image:', img_flat.shape)
```

```
Shape of Flattened Image: (62500, 3)
```

Figure 3. Final data dimension.

4. Methodology

We will be using three different clustering algorithms for clustering. In particular we will use the following algorithms:

1. K-Means Clustering
2. DBSCAN Clustering
3. Gaussian Mixture Models

4.1 K-Means Clustering:

We apply k-means clustering algorithm on the pre-processed image. In order to get the k value properly, we use the elbow method to find the optimal k-value to segment the image. After running the algorithm, we got the optimal k-value as 3 with an inertia of 43517829.24.

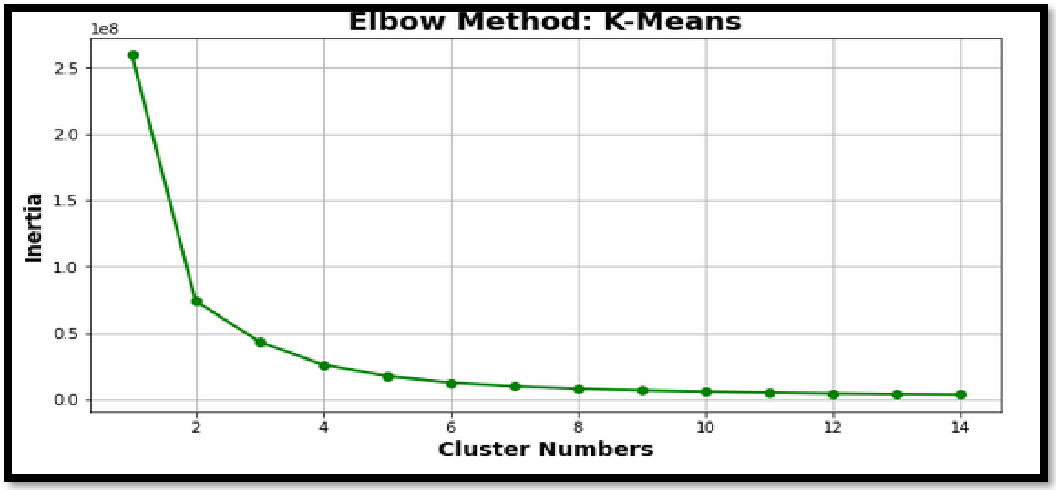


Figure 4. Elbow Method.

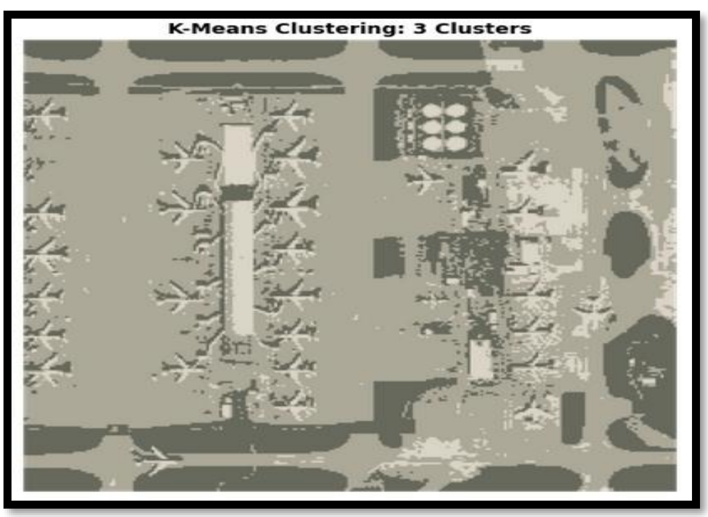


Figure 5. Segmented Image with k-value of 3.

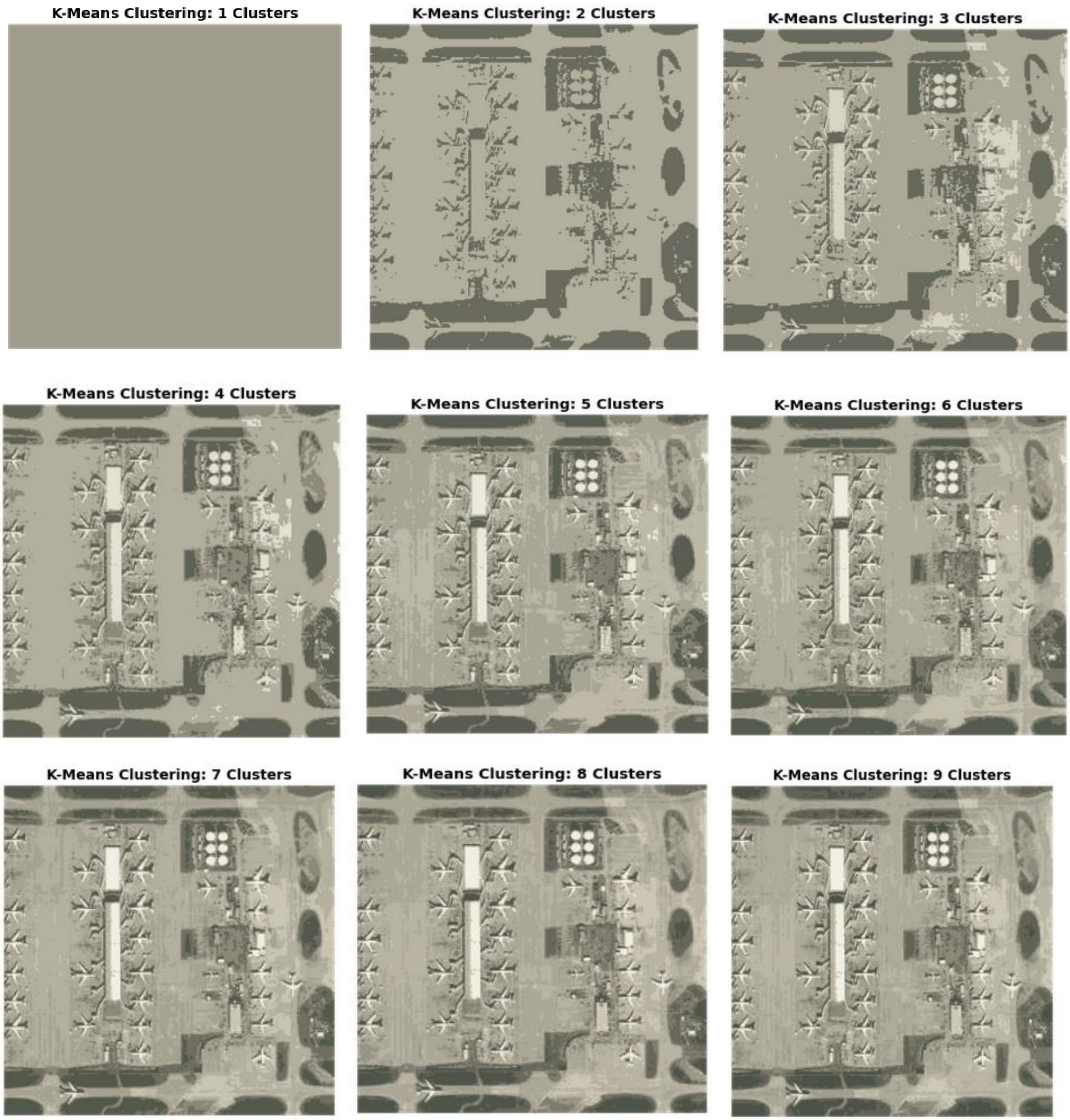


Figure 6. Segmentation images with different k-values.

4.2 DBSCAN Clustering:

The second method we use is the DBSCAN Clustering algorithm. In this method we need to find the correct maximum distance between two samples for one to be considered as in the neighborhood of the other and he number of samples (or total weight) in a neighborhood for a point to be considered as a core point. These parameters are hyperparameters and are to found after number of iterations. After various values of epsilon and number of samples, it was found to be 3.05 and 75. The metric to find the distance was set as Euclidian.

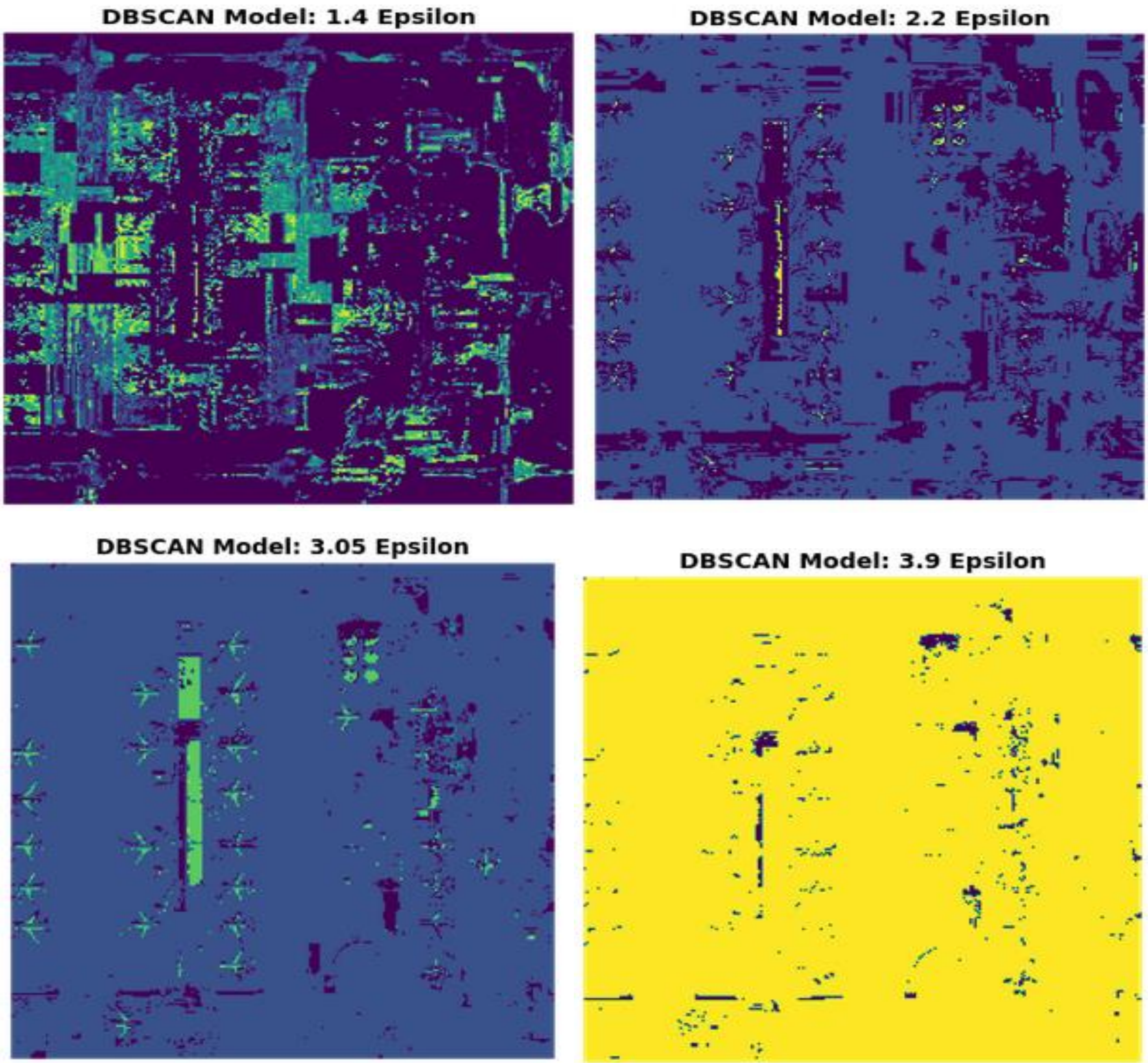


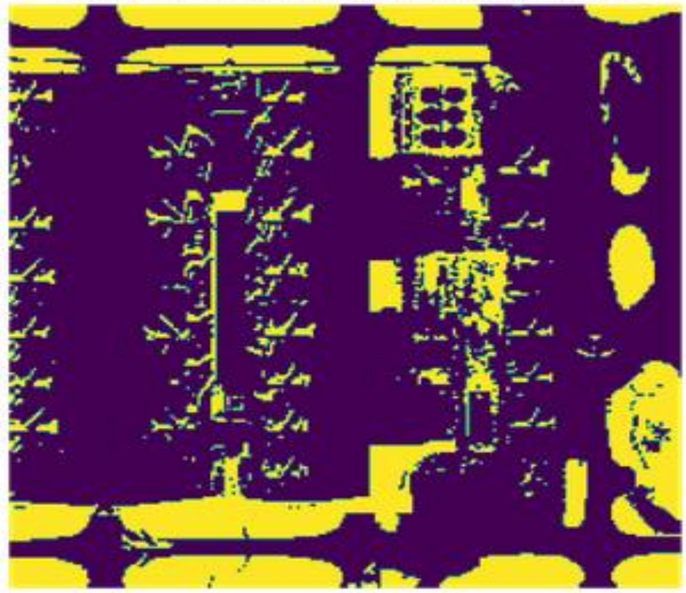
Figure 7. Segmentation images with different epsilon values. The best image is with the epsilon value of 3.5 and 75 samples.

4.3 Gaussian Mixture Model:

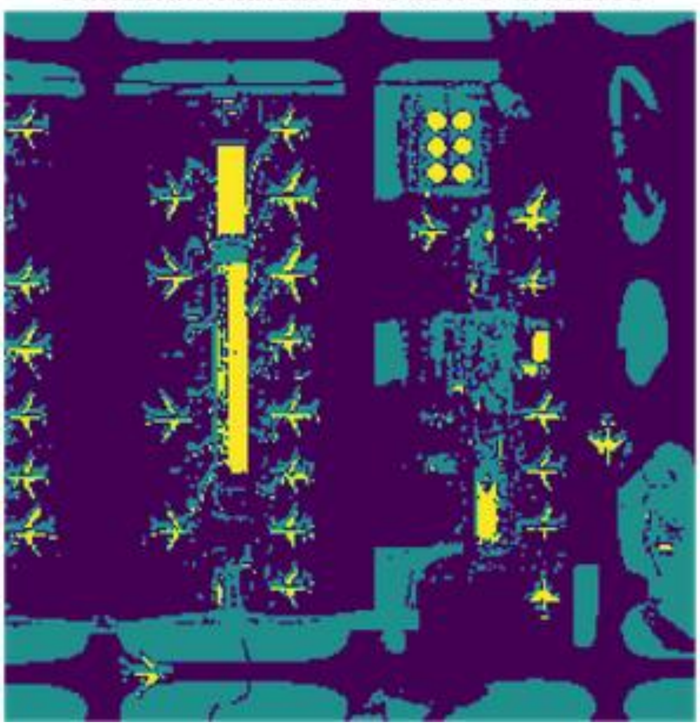
The GMM can be used to cluster images. It is very similar to k-means where we need the number of clustering points. It also needs us to specify the covariance type. Here it is set as tied. The best number of cluster points was obtained to be 3 and 4.

Gaussian Mixture Model: 1 Clusters

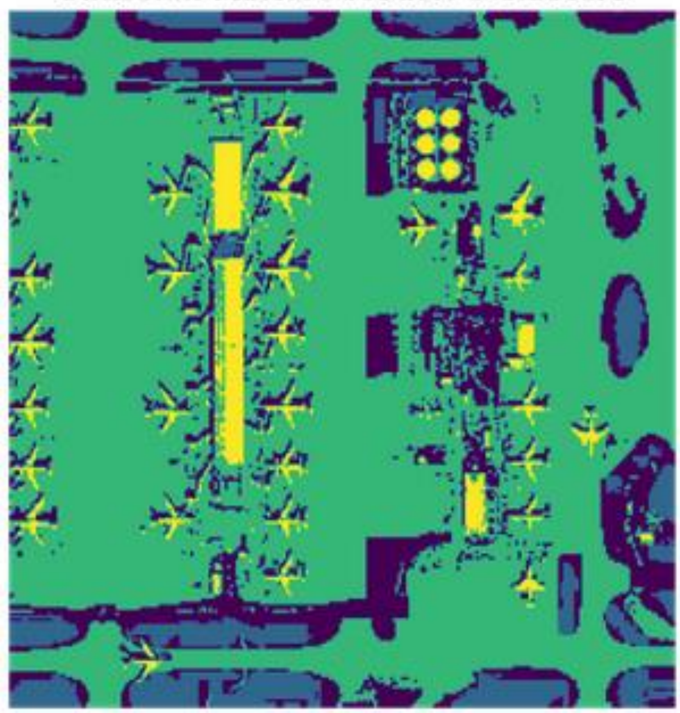
Gaussian Mixture Model: 2 Clusters



Gaussian Mixture Model: 3 Clusters



Gaussian Mixture Model: 4 Clusters



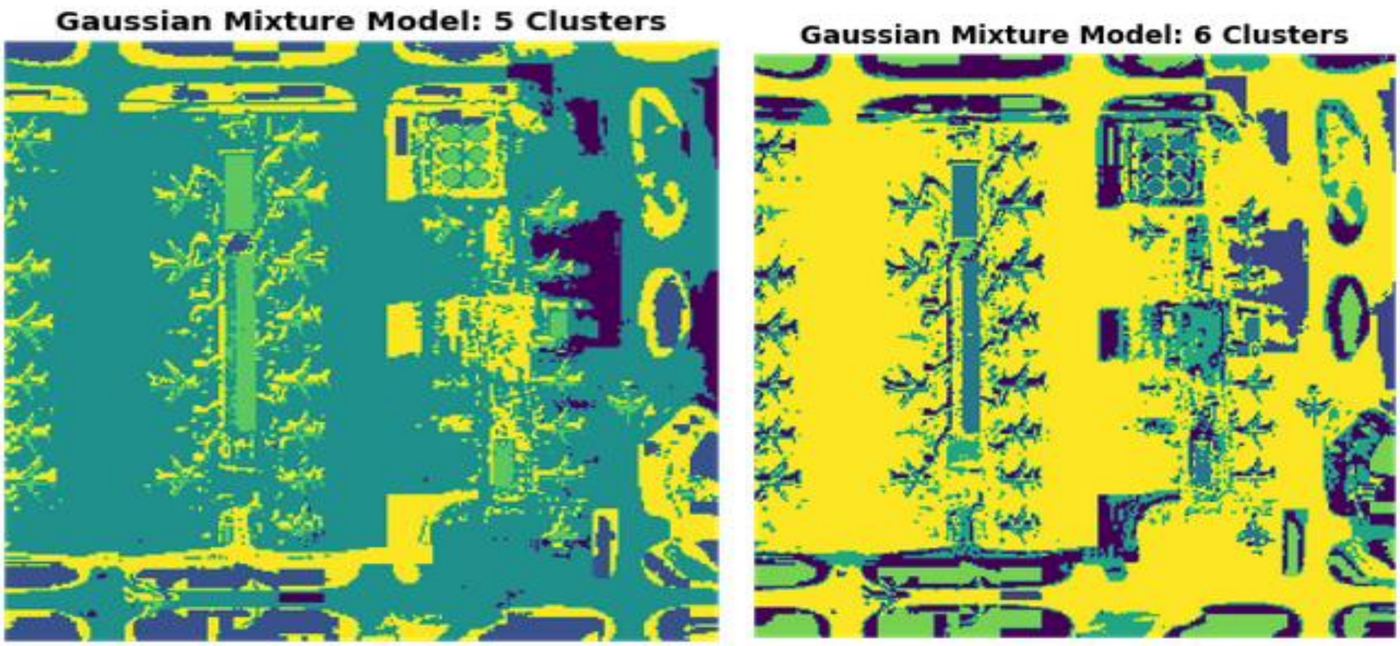


Figure 8. Segmentation images of GMM with various cluster numbers. The best image is either 3 or 4.

5. Conclusion

The best model wihch segmented the images was k-means which can be seen in the quality of the image result. The second model which performed good was GMM model and the last was DBSCAN Model.

Though segmentation with clustering is a very crude way to segment an image, in this project, we showed it can be done and the segmented images were accepctable. In future, a better way to segment an image would be with the possible use of Convolution Neural Networks with a U-Net Network.

6. References:

1. Data: https://www.kaggle.com/airbusgeo/airbus-aircrafts-sample-dataset

2. Airbus Arial Aircraft Detection sample Dataset.