1 Methods

1.1 Computing Feature Vectors

1.2 Feature Normalization

2 Visualizations

2.1 Successful Segmentations

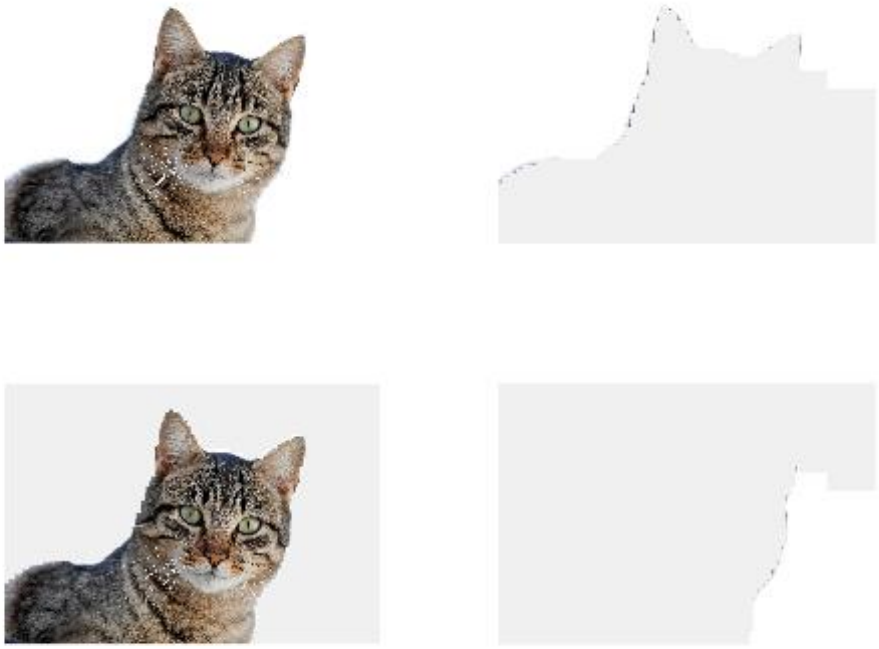

Figure 1: `cat_march.jpg`, using HAC with $k = 3$, position + color features, feature normalization, and a resize factor of 0.025.

Figure 2: `Cat_Bed.jpg`, using k-means clustering with $k = 4$, position + color features, and feature normalization.

Figure 3: `black_kitten_star.jpg`, using k-means clustering with $k = 3$, color features, and no feature normalization.

2.2 Unsuccessful Segmentations

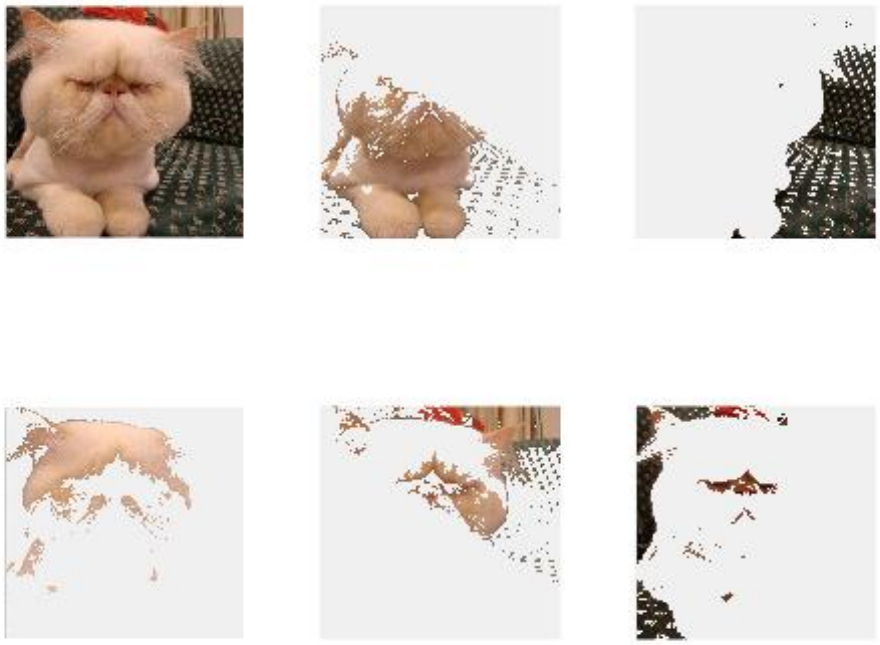

Figure 4: `cat_grumpy.jpg`, using k-means clustering with $k = 5$, position + color features, and no feature normalization.

Figure 5: `cat-jumping-running-grass.jpg`, using k-means clustering with $k = 3$, color features, and feature normalization.

Figure 6: `kitten16.jpg`, using HAC with $k = 3$, color features, feature normalization, and a resize factor of 0.25.

2.3 Questions

1. What effect do each of the segmentation parameters (feature transform, feature normalization, number of clusters, clustering method, resize) have on the quality of the final segmentation?

2. How do each of these parameters affect the speed of computing a segmentation?

3. How do the properties of an image affect the difficulty of computing a good segmentation for that image?

2.4 Composite Images

Using the script titled `GrabCat.m`, we were able to produce composite images by transferring segments from one image to another background image. This allowed us to create the two composite images shown below.

Figure 7: Input: `black_kitten_star.jpg, desert.jpg`, using k-means clustering with $k = 3$, color features, and feature normalization.

Figure 8: Input: `black_kitten.jpg, beach.jpg`, using HAC with $k = 5$, color features, feature normalization, and a resize factor of 0.2.

3 Evaluation

Feature Transform	Feature Normalization	Clustering Method	Number of Clusters	Resize (Max Pixels)	Mean Accuracy
Color	Yes	K-Means	3	50000	.8341
Color	Yes	K-Means	5	50000	.8736
Color	Yes	K-Means	7	50000	.8795
Color	Yes	K-Means	15	50000	.9087
Color	Yes	K-Means	30	50000	.9228
Color	No	K-Means	5	50000	.8680
Color/Position	Yes	K-Means	5	50000	.8765
Color/Position	No	K-Means	5	50000	.8802
Color/Edges	Yes	K-Means	5	50000	.7991
Color/Edges	No	K-Means	5	50000	.8670
Color/Gradients	Yes	K-Means	5	50000	.7905
Color/Gradients	No	K-Means	5	50000	.8775
Color/Position/Edges	Yes	K-Means	5	50000	.7951
Color/Position/Edges	No	K-Means	5	50000	.8800
Color/Position/Edges/Gradients	Yes	K-Means	5	50000	.7924
Color/Position/Edges/Gradients	No	K-Means	5	50000	.8866
Color	Yes	HAC	5	1000	.8623
Color	Yes	HAC	3	1000	.8340
Color	Yes	HAC	7	1000	.8691
Color	Yes	HAC	15	1000	.8906
Color	Yes	HAC	15	1000	.9123
Color	No	HAC	5	1000	.8585
Color/Position	Yes	HAC	5	1000	.8531
Color/Position	No	HAC	5	1000	.8585
Color/Edges	Yes	HAC	5	1000	.9288
Color/Edges	No	HAC	5	1000	.8585
Color/Gradients	Yes	HAC	5	1000	.9108
Color/Gradients	No	HAC	5	1000	.8578
Color/Position/Edges	Yes	HAC	5	1000	.9256
Color/Position/Edges	No	HAC	5	1000	.8585
Color/Position/Edges/Gradients	Yes	HAC	5	1000	.9052
Color/Position/Edges/Gradients	No	HAC	5	1000	.8550
Color	Yes	K-Means	5	1000	.8610
Color	Yes	K-Means	5	10000	.8649
Color	Yes	K-Means	5	100000	.8666
Color	Yes	HAC	5	2000	.8638
Color	Yes	HAC	5	4000	.8702

3.1 Questions

1. Based on your quantitative experiments, how do each of the segmentation parameters affect the quality of the final foreground-background segmentation?

2. Are some images simply more difficult to segment correctly than others? If so, what are the qualities of these images that cause the segmentation algorithms to perform poorly?

3. Also feel free to point out or discuss any other interesting observations that you made.