Hand Segmentation Report

**Implementation Discussion**

For the implementation of k-means, I used the NumPy, Matplotlib, and OpenCV Python libraries. The OpenCV library offered a “black box” for k-means clustering of images, which is what was used for the iterative k-means. The initial centroids were chosen randomly via the “cv2.KMEANS\_RANDOM\_CENTERS” flag. In order to find the pixel assignments, I implemented the “pxAssign()” function, which takes the (x,y) coordinates of a pixel and returns the frequency of assignment for that pixel in the various clusters. Additionally, I completed the graduate assignment of supervised classification via a Support Vector Machine. For the SVM implementation, I used the “scikit-learn” Python library. To collect the samples from the training images, the “sample()” function selects the top-left corner and the bottom-right corner of the sample box. This region is then used to train the classifier.

**Results Discussion**

A picture containing handwear

Description automatically generatedChart

Description automatically generated with low confidenceTo best optimize k-means, I ensured a black, smooth image background with controlled lighting. This allowed for a k=2 selection which greatly simplifies the classification process. Although k=2 allows for a complete separation of the background/hand, there is some detail lost compared to larger k values. Below are the before and after images produced from one iteration of the k=2 classification.

As previously stated, k=2 did an adequate job of segmenting the hand region from the background, even with a loss of some details such as wrinkles and skin spots. To preserve these details, one can implement k-means with a k larger value, and the multiple skin regions can be combined into a single group for the same “hand/background” representation. Regarding the SVM classifier, the same original image was segmented much less robustly than with k-means. This is likely due to a lack of a full training set which would better train the classifier for the slight variations in skin color. Below is the image generated by the SVM which sampled the background and hand regions of the image. As displayed in the image, the SVM was able to segment some portions of the background (red) from the hand (green). To better improve these results, more training data is needed for Chart

Description automatically generatedthe slight variances in color in the background and hand regions. For this particular image, a 50x50px sample box was used for the background and a 55x25px box was sampled for the hand region. However, it seems like the lower background regions varied slightly in color from the upper background regions. This variance is likely due to an inconsistency in lighting from the original image. In order to get equal results as the k-means classifier, one needs the ensure that the samples provided cover the slight differences in color values due to inconsistent lighting. Both of these methods will be shown in their entirety in the execution/demo video.

**Demo Outline**

1. Enter desired k value
2. K-means runs 100x
3. Choose px to lookup frequency of assignment
4. START SVM
5. Enter in background/hand sample regions
6. Segmented image is generated