**Project 3 Report**

**Name: Xianhe Zhang**

**Email:** [**zhang.xianh@northeastern.edu**](mailto:zhang.xianh@northeastern.edu)

**Description**

The project builds a system that uses camera to capture the image via cam and conducts a series of operation to identify object on the image. These operations include thresholding the input, introducing morphological processing (dilation & erosion), split image, connect component analysis. Also, the system is able to be trained. You need to press ‘N’, this will store the current identified object’s data/all feature scores into database for the future classification. And as of classification, there are two types of classifiers, scaled Euclidean distance and K-nearest neighbors, to classify new image in different ways. The system also simulates the confusion matrix calculation to evaluate the model performance.

**Source Images**

The following three images are used as required images of each task. They are pumpkin, pen, and book.

A small orange pumpkin on a white surface

Description automatically generatedA pink pen on a white surface

Description automatically generatedA black notebook with yellow label

Description automatically generated

**Threshold**

Threshold value I set is 80, every pixel value bigger than this will be set as 1, otherwise 0. Before thresholding, the original image needs to be blurred and converted into gray scale. The following are binary images after thresholding.

A white circle with black spots

Description automatically generatedA white object on a black background

Description automatically generatedA spiral notebook with a black and white design

Description automatically generated

**Binary Clean (Dilation / Erosion)**

Then we need to do some morphological processing to our binary image trying to remove the noise. Two processing involved here are Dilation and Erosion. Before doing those conversion, we need to grassfire-transform first.

**Dilation**

From what we can observer, the background have some stripes which greatly impact our images.

A black and white image of a planet

Description automatically generatedA black and white sign with a white object on it

Description automatically generatedA black and white photo of a square object

Description automatically generated

**Erosion**

These processing makes the original foreground image smaller because it erodes edges.

**A white circle with a black background

Description automatically generatedA white object on a black background

Description automatically generatedA black and white image of a black and white image

Description automatically generated**

**Connected Component Analysis Image**

These images show connected area, and each area comes with different color. The background is set as black.

**A blue and black rectangular object

Description automatically generatedA blue object on a black background

Description automatically generatedA blue circle with a black background

Description automatically generated**

**How to collect training data**

Typically, as described above, when you want to collect new training data, you simply need to press ‘n’. The system will capture the current image and do all the feature calculation for you and automatically store them in the database. And you need to provide the name for the image. The same object data and scores will be saved into `database/object file`. When classifying new object, our system will loop every categorization file in our database folder to see which categorization have the highest score.

**Confusion Matrix**

**A screenshot of a graph

Description automatically generated**

**DEMO**

The following are the demo of the project. The system has been trained and training data has been save into the database. On the top left, you would be able to see classification result and the current classifier.

KNN – K Nearest Neighbors

SED – Scaled Euclidean Distance

A green marker on a white surface

Description automatically generatedA green pen on a white surface

Description automatically generatedA pink pen on a white surface

Description automatically generatedA pink pen on a white surface

Description automatically generatedA pen on a table

Description automatically generatedA pen on a table

Description automatically generatedA close up of a pumpkin

Description automatically generatedA pumpkin on a table

Description automatically generated

**Key Take-Away**

The takeaway of project 3 is very valuable because compared with the first two projects, this project is more like a complete system. The project can capture the image, do a series of graphics algorithms to calculate feature scores, and enable users to interact to classify new objects. The basic of the object recognition system is very clear but clearly graphics algorithms is way more complicated than I thought to get a very satisfying result.