



# ECE 6310: INTRODUCTION TO COMPUTER VISION

Lab 3

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## 1. Introduction

In the previous Lab we were asked to detect a letter from the entire parenthood.ppm with the help of a template image of the letter e which we used to scan over every pixel and compare the surroundings pixels with the template and if the pixels match it can be detected as the letter we are looking for. For this lab we must apply thinning and detection of endpoints and branchpoints to the copy of the template to determine the letter e based on the number of endpoints and branchpoints.

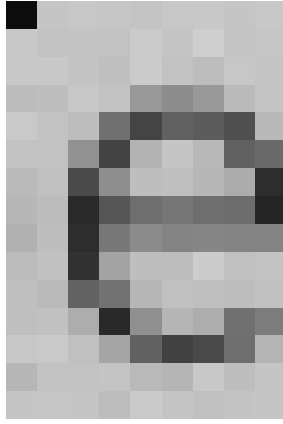
## 2. Implementation

The Matched Spatial Filter output from the previous lab was used and the ground truth table was also the same. A threshold range of 50 – 255 was applied on the MSF image. The reason for choosing the range from 50 rather than 0 is because below a certain threshold there are no changes noticed so randomly, I chose 50. After the thresholding, the image, 9x15 area is checked for each pixel coordinates in ground truth if there was a single pixel that is on or equal to 255, it meant e is found. Next, that particular 9x15 area would be copied and send for thinning. Example of copied image is shown in figure 1.

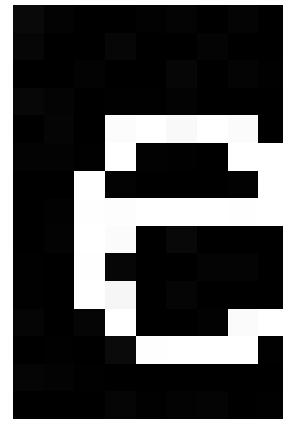
In the thinning function every pixel is threshold to 128 i.e. any pixel having a value lesser than 128 is set to 255 and any pixel having value over 128 is set 0. Later every pixel is checked if it greater than 0 or in other words is not black then that pixel is considered. And every pixel around it is checked and number of neighbors & edge to non-edge is counted. And later it is checked for some conditions if they satisfy those conditions that pixel is erased until there are no pixels satisfying those conditions and cannot be erased. The example of the output of the thinning function is in figure 2

After that we check for the endpoints and branchpoints. After checking surrounding pixels if the pixel has one edge to non-edge transition it is called an endpoint and if it has more than 2 edge to non-edge transition it is called a branchpoint. And in total if we have a one endpoint and one branchpoint it will be detected as letter 'e'.

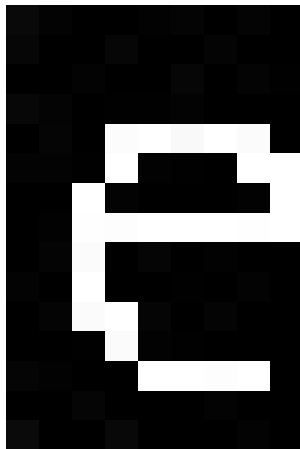
Once the above function returns letter 'e' as found it will be cross checked with the ground truth and the no of True positive, False positive, True negative and False negative are calculated.



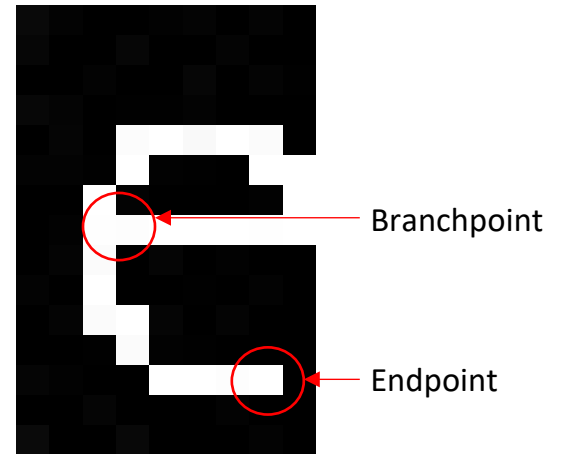
*Figure 1 Copied Image*



*Figure 2 Threshold Image at 128*



*Figure 3 Thinned Image*



*Figure 4 Output Image after detection of branchpoint & endpoint*

Total of the TP, TN, FP and FN were exported to a csv file for storing and using these values the ROC curve was calculated and the best threshold value was calculated with the help of the distance to the corner where it was 1 for TP and 0 for FP rate.

$$TPR = \frac{TP}{(TP + FN)}$$

$$FPR = \frac{FP}{(FP + TN)}$$

$$Sensitivity = TPR$$

$$Specifity = 1 - FPR$$

### 3. Results:

The ROC curve is in the figure 3 and this ROC curve is very different from the curve from the previous lab. The curve never reaches the values of  $TPR = 1$  but that does not mean that the results are not good.

By this method, the number of true positive have decreased a bit but there are very less false positive which is more crucial. After thresholding for different values and analyzing the values in csv file it was determined that for **threshold = 202** we get **TP = 146** and **FP = 17**. The distance from the point (0,1) to this threshold value is **0.036478**. The figure 3 shows the ROC curve and the orange point is the threshold point of 199 with the lowest distance from the point (0,1). The figure 4 shows the original image and figure 5 shows the MSF image from the previous lab.

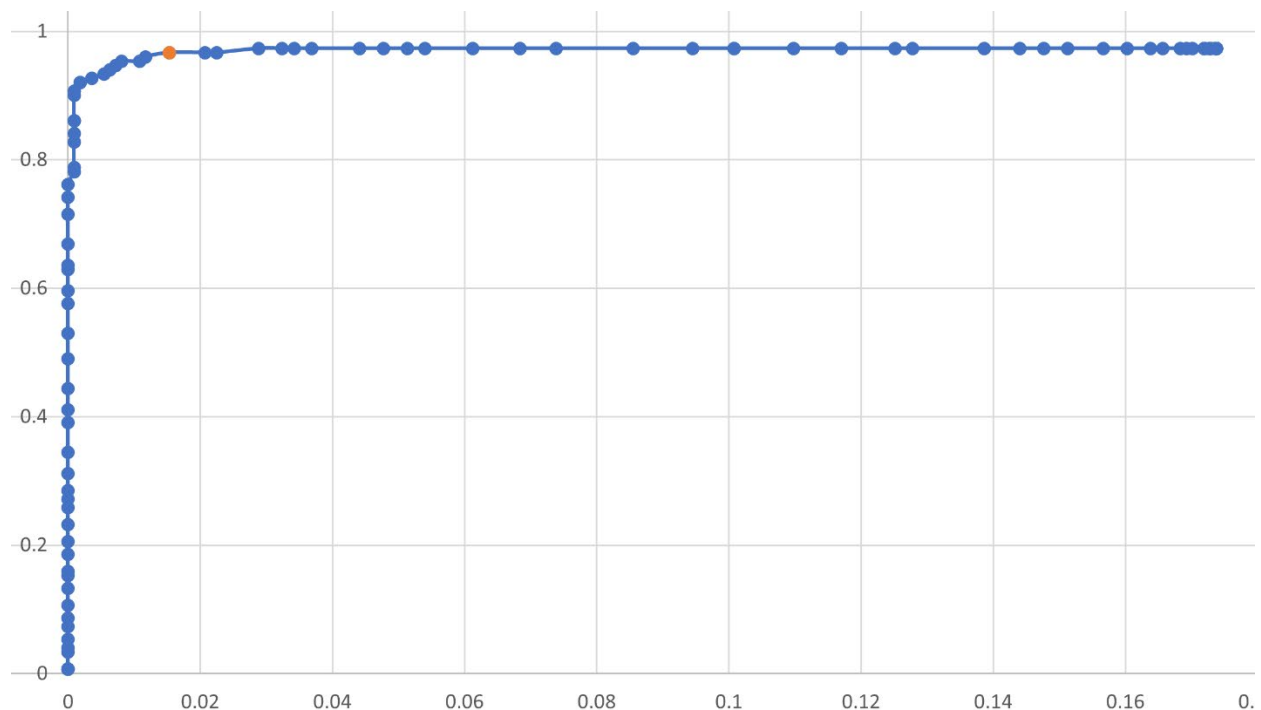


Figure 3 ROC curve

Preparation for parenthood is not just a matter of reading books and decorating the nursery. Here are some tests for expectant parents to take to prepare themselves for the real-life experience of being a mother or father.

4. Can you stand the mess children make? To find out, smear peanut butter onto the sofa and jam onto the curtains. Hide a fish finger behind the stereo and leave it there all summer. Stick your fingers in the flowerbeds then rub them on the clean walls. Cover the stains with crayons. How does that look?

5. Dressing small children is not as easy as it seems. First buy an octopus and a string bag. Attempt to put the octopus into the string bag so that none of the arms hang out. Time allowed for this - all morning.

7. Forget the Miata and buy a Mini Van. And don't think you can leave it out in the driveway spotless and shining. Family cars don't look like that. Buy a chocolate ice cream bar and put it in the glove compartment. Leave it there. Get a quarter. Stick it in the cassette player. Take a family-size packet of chocolate cookies. Mash them down the back seats. Run a garden rake along both sides of the car. There!.. Perfect!

9. Always repeat everything you say at least five times.

11. Hollow out a melon. Make a small hole in the side. Suspend it from the ceiling and swing it from side to side. Now get a bowl of soggy Froot Loops and attempt to spoon it into the swaying melon by pretending to be an airplane. Continue until half of the Froot Loops are gone. Tip the rest into your lap, making sure that a lot of it falls on the floor. You are now ready to feed a 12-month old baby.

Figure 4 Original Image



Figure 5 MSF Image