Clemson University

ECE 4310: Computer Vision

Lab 3: Letters

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Due: September 29, 2020

**Purpose:**

The purpose of this lab is an extension on the last lab and is to detect the letter ‘e’ throughout a certain given picture of text and to see if thinning and identifying branchpoints and endpoints to calculate the false positive rate and true positive rates is more accurate. Using the original image, it was thinned and tested for endpoints and branchpoints. To detect a certain letter, you can compare it to the number of branchpoints and end points. For example, an ‘e’ has one branchpoint and one endpoint. If the 9x15 template image (from the original image) had 1 endpoint and 1 breakpoint, then it was marked as an ‘e’. Those were then compared to the ground truth file to calculate the roc (false positives vs. true positives).

**Input:**

Text, letter

Description automatically generated

Figure 1: Input Image

Text

Description automatically generated

Figure 2: MSF Image from Lab 2

**Results/Output:**

Below are the results that I received from the output of the program:

Text

Description automatically generated

Figure 3: Original Image at 128 Threshold (Binary) Inverted

Text

Description automatically generated  
Figure 4: Thinned Out image

Text

Description automatically generated

Figure 5: Thinned with the endpoints and branchpoints

Background pattern

Description automatically generated

Figure 6: Endpoints and Branchpoints detected

Table 1: ROC Calculations

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Threshold | TP | FP | FN | TN | TPR | FPR | PPV |
| 0 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 5 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 10 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 15 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 20 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 25 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 30 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 35 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 40 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 45 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 50 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 55 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 60 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 65 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 70 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 75 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 80 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 85 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 90 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 95 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 100 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 105 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 110 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 115 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 120 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 125 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 130 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 135 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 140 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 145 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 150 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 155 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 160 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 165 | 145 | 166 | 6 | 945 | 0.96 | 0.15 | 0.53 |
| 170 | 145 | 165 | 6 | 946 | 0.96 | 0.15 | 0.53 |
| 175 | 145 | 157 | 6 | 954 | 0.96 | 0.14 | 0.52 |
| 180 | 145 | 134 | 6 | 977 | 0.96 | 0.12 | 0.48 |
| 185 | 145 | 99 | 6 | 1012 | 0.96 | 0.09 | 0.41 |
| 190 | 145 | 61 | 6 | 1050 | 0.96 | 0.05 | 0.3 |
| 195 | 145 | 36 | 6 | 1075 | 0.96 | 0.03 | 0.2 |
| 200 | 145 | 20 | 6 | 1091 | 0.96 | 0.02 | 0.12 |
| 205 | 142 | 8 | 9 | 1103 | 0.94 | 0.01 | 0.05 |
| 210 | 138 | 2 | 13 | 1109 | 0.91 | 0 | 0.01 |
| 215 | 129 | 0 | 22 | 1111 | 0.85 | 0 | 0 |
| 220 | 117 | 0 | 34 | 1111 | 0.77 | 0 | 0 |
| 225 | 96 | 0 | 55 | 1111 | 0.64 | 0 | 0 |
| 230 | 73 | 0 | 78 | 1111 | 0.48 | 0 | 0 |
| 235 | 47 | 0 | 104 | 1111 | 0.31 | 0 | 0 |
| 240 | 31 | 0 | 120 | 1111 | 0.21 | 0 | 0 |
| 245 | 16 | 0 | 135 | 1111 | 0.11 | 0 | 0 |
| 250 | 5 | 0 | 146 | 1111 | 0.03 | 0 | 0 |

Figure 5: ROC Curve

**Conclusion:**

The purpose of this lab was to create a program that thins an image, identifies branchpoint and endpoints, and determine the ROC curve. I found the best threshold with the lowest false positive and the highest true positives was 200. After thinning and identifying the amount of branchpoints and endpoints the program found: number of endpoints is 2548 and number of branchpoints is 730. The ROC curve was much different for this lab compared to the pervious lab. For the ROC curve for this lab, the results were much better (less false positives) than that compared to the last lab. Overall, thinning and identifying branchpoints and endpoints shows to be more accurate than using an MSF filter.