Deeb Armaly

ECE 4310

Lab3

Fall 2022

In this lab thinning and branchpoint and end endpoint detection techniques were used to recognize letters in an image of text.

**Fig: D**

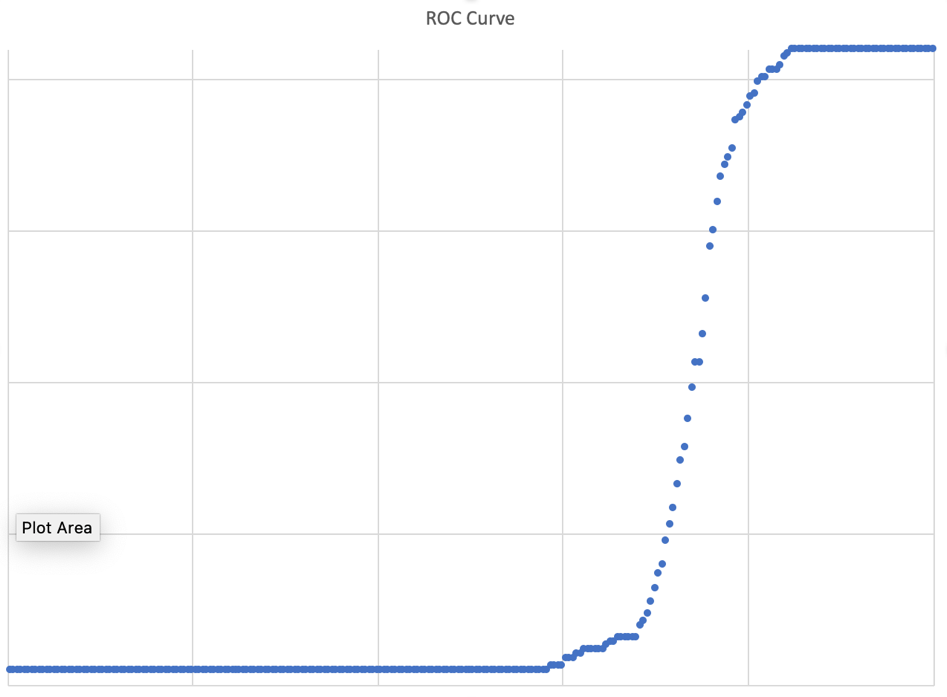
**Fig: C**

**Fig: A**

**Fig: B**



Figure A shows the pixel image extracted from the original image. Figure B shows the binary extracted image (step iv). Figure C shows the image after thinning (step v) and Figure D shows the detection of branchpoints and endpoints (step vi) where the branch points are shown as lighter grey and endpoints as darker grey. Here is an output confirming the branchpoints and endpoints were equal to 1 for this letter.



To the right is the ROC curve generated given the output of the program:

For this lab, I chose the optimal threshold value to be 203. Below are the TP and FP values at this threshold

Below is the output of all values for the different thresholds.

Threshold = 0 TP = 102 FP = 154 FN = 49 TN = 957 TPR = 0.675 FPR = 0.139

Threshold = 1 TP = 102 FP = 154 FN = 49 TN = 957 TPR = 0.675 FPR = 0.139

Threshold = 2 TP = 102 FP = 154 FN = 49 TN = 957 TPR = 0.675 FPR = 0.139

Threshold = 3 TP = 102 FP = 154 FN = 49 TN = 957 TPR = 0.675 FPR = 0.139

Threshold = 4 TP = 102 FP = 154 FN = 49 TN = 957 TPR = 0.675 FPR = 0.139

Threshold = 5 TP = 102 FP = 154 FN = 49 TN = 957 TPR = 0.675 FPR = 0.139

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Threshold = 151 TP = 102 FP = 151 FN = 49 TN = 960 TPR = 0.675 FPR = 0.136

Threshold = 152 TP = 102 FP = 151 FN = 49 TN = 960 TPR = 0.675 FPR = 0.136

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Threshold = 155 TP = 102 FP = 149 FN = 49 TN = 962 TPR = 0.675 FPR = 0.134

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Threshold = 161 TP = 102 FP = 148 FN = 49 TN = 963 TPR = 0.675 FPR = 0.133

Threshold = 162 TP = 102 FP = 147 FN = 49 TN = 964 TPR = 0.675 FPR = 0.132

Threshold = 163 TP = 102 FP = 147 FN = 49 TN = 964 TPR = 0.675 FPR = 0.132

Threshold = 164 TP = 102 FP = 146 FN = 49 TN = 965 TPR = 0.675 FPR = 0.131

Threshold = 165 TP = 102 FP = 146 FN = 49 TN = 965 TPR = 0.675 FPR = 0.131

Threshold = 166 TP = 102 FP = 146 FN = 49 TN = 965 TPR = 0.675 FPR = 0.131

Threshold = 167 TP = 102 FP = 146 FN = 49 TN = 965 TPR = 0.675 FPR = 0.131

Threshold = 168 TP = 102 FP = 146 FN = 49 TN = 965 TPR = 0.675 FPR = 0.131

Threshold = 169 TP = 102 FP = 146 FN = 49 TN = 965 TPR = 0.675 FPR = 0.131

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Threshold = 171 TP = 102 FP = 142 FN = 49 TN = 969 TPR = 0.675 FPR = 0.128

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Threshold = 173 TP = 102 FP = 137 FN = 49 TN = 974 TPR = 0.675 FPR = 0.123

Threshold = 174 TP = 102 FP = 134 FN = 49 TN = 977 TPR = 0.675 FPR = 0.121

Threshold = 175 TP = 102 FP = 130 FN = 49 TN = 981 TPR = 0.675 FPR = 0.117

Threshold = 176 TP = 102 FP = 128 FN = 49 TN = 983 TPR = 0.675 FPR = 0.115

Threshold = 177 TP = 102 FP = 122 FN = 49 TN = 989 TPR = 0.675 FPR = 0.110

Threshold = 178 TP = 102 FP = 118 FN = 49 TN = 993 TPR = 0.675 FPR = 0.106

Threshold = 179 TP = 102 FP = 114 FN = 49 TN = 997 TPR = 0.675 FPR = 0.103

Threshold = 180 TP = 102 FP = 108 FN = 49 TN = 1003 TPR = 0.675 FPR = 0.097

Threshold = 181 TP = 102 FP = 102 FN = 49 TN = 1009 TPR = 0.675 FPR = 0.092

Threshold = 182 TP = 102 FP = 99 FN = 49 TN = 1012 TPR = 0.675 FPR = 0.089

Threshold = 183 TP = 102 FP = 92 FN = 49 TN = 1019 TPR = 0.675 FPR = 0.083

Threshold = 184 TP = 102 FP = 84 FN = 49 TN = 1027 TPR = 0.675 FPR = 0.076

Threshold = 185 TP = 102 FP = 78 FN = 49 TN = 1033 TPR = 0.675 FPR = 0.070

Threshold = 186 TP = 102 FP = 78 FN = 49 TN = 1033 TPR = 0.675 FPR = 0.070

Threshold = 187 TP = 102 FP = 71 FN = 49 TN = 1040 TPR = 0.675 FPR = 0.064

Threshold = 188 TP = 102 FP = 62 FN = 49 TN = 1049 TPR = 0.675 FPR = 0.056

Threshold = 189 TP = 102 FP = 49 FN = 49 TN = 1062 TPR = 0.675 FPR = 0.044

Threshold = 190 TP = 102 FP = 45 FN = 49 TN = 1066 TPR = 0.675 FPR = 0.041

Threshold = 191 TP = 102 FP = 38 FN = 49 TN = 1073 TPR = 0.675 FPR = 0.034

Threshold = 192 TP = 102 FP = 32 FN = 49 TN = 1079 TPR = 0.675 FPR = 0.029

Threshold = 193 TP = 102 FP = 29 FN = 49 TN = 1082 TPR = 0.675 FPR = 0.026

Threshold = 194 TP = 102 FP = 27 FN = 49 TN = 1084 TPR = 0.675 FPR = 0.024

Threshold = 195 TP = 102 FP = 25 FN = 49 TN = 1086 TPR = 0.675 FPR = 0.023

Threshold = 196 TP = 102 FP = 18 FN = 49 TN = 1093 TPR = 0.675 FPR = 0.016

Threshold = 197 TP = 102 FP = 17 FN = 49 TN = 1094 TPR = 0.675 FPR = 0.015

Threshold = 198 TP = 102 FP = 16 FN = 49 TN = 1095 TPR = 0.675 FPR = 0.014

Threshold = 199 TP = 102 FP = 14 FN = 49 TN = 1097 TPR = 0.675 FPR = 0.013

Threshold = 200 TP = 101 FP = 12 FN = 50 TN = 1099 TPR = 0.669 FPR = 0.011

Threshold = 201 TP = 101 FP = 11 FN = 50 TN = 1100 TPR = 0.669 FPR = 0.010

Threshold = 202 TP = 101 FP = 8 FN = 50 TN = 1103 TPR = 0.669 FPR = 0.007

Threshold = 203 TP = 100 FP = 7 FN = 51 TN = 1104 TPR = 0.662 FPR = 0.006

Threshold = 204 TP = 99 FP = 7 FN = 52 TN = 1104 TPR = 0.656 FPR = 0.006

Threshold = 205 TP = 98 FP = 5 FN = 53 TN = 1106 TPR = 0.649 FPR = 0.005

Threshold = 206 TP = 98 FP = 5 FN = 53 TN = 1106 TPR = 0.649 FPR = 0.005

Threshold = 207 TP = 97 FP = 5 FN = 54 TN = 1106 TPR = 0.642 FPR = 0.005

Threshold = 208 TP = 96 FP = 4 FN = 55 TN = 1107 TPR = 0.636 FPR = 0.004

Threshold = 209 TP = 95 FP = 2 FN = 56 TN = 1109 TPR = 0.629 FPR = 0.002

Threshold = 210 TP = 95 FP = 1 FN = 56 TN = 1110 TPR = 0.629 FPR = 0.001

Threshold = 211 TP = 95 FP = 0 FN = 56 TN = 1111 TPR = 0.629 FPR = 0.000

Threshold = 212 TP = 94 FP = 0 FN = 57 TN = 1111 TPR = 0.623 FPR = 0.000

Threshold = 213 TP = 93 FP = 0 FN = 58 TN = 1111 TPR = 0.616 FPR = 0.000

Threshold = 214 TP = 90 FP = 0 FN = 61 TN = 1111 TPR = 0.596 FPR = 0.000

Threshold = 215 TP = 90 FP = 0 FN = 61 TN = 1111 TPR = 0.596 FPR = 0.000

Threshold = 216 TP = 88 FP = 0 FN = 63 TN = 1111 TPR = 0.583 FPR = 0.000

Threshold = 217 TP = 86 FP = 0 FN = 65 TN = 1111 TPR = 0.570 FPR = 0.000

Threshold = 218 TP = 82 FP = 0 FN = 69 TN = 1111 TPR = 0.543 FPR = 0.000

Threshold = 219 TP = 82 FP = 0 FN = 69 TN = 1111 TPR = 0.543 FPR = 0.000

Threshold = 220 TP = 80 FP = 0 FN = 71 TN = 1111 TPR = 0.530 FPR = 0.000

Threshold = 221 TP = 79 FP = 0 FN = 72 TN = 1111 TPR = 0.523 FPR = 0.000

Threshold = 222 TP = 75 FP = 0 FN = 76 TN = 1111 TPR = 0.497 FPR = 0.000

Threshold = 223 TP = 72 FP = 0 FN = 79 TN = 1111 TPR = 0.477 FPR = 0.000

Threshold = 224 TP = 70 FP = 0 FN = 81 TN = 1111 TPR = 0.464 FPR = 0.000

Threshold = 225 TP = 69 FP = 0 FN = 82 TN = 1111 TPR = 0.457 FPR = 0.000

Threshold = 226 TP = 64 FP = 0 FN = 87 TN = 1111 TPR = 0.424 FPR = 0.000

Threshold = 227 TP = 61 FP = 0 FN = 90 TN = 1111 TPR = 0.404 FPR = 0.000

Threshold = 228 TP = 55 FP = 0 FN = 96 TN = 1111 TPR = 0.364 FPR = 0.000

Threshold = 229 TP = 52 FP = 0 FN = 99 TN = 1111 TPR = 0.344 FPR = 0.000

Threshold = 230 TP = 48 FP = 0 FN = 103 TN = 1111 TPR = 0.318 FPR = 0.000

Threshold = 231 TP = 45 FP = 0 FN = 106 TN = 1111 TPR = 0.298 FPR = 0.000

Threshold = 232 TP = 43 FP = 0 FN = 108 TN = 1111 TPR = 0.285 FPR = 0.000

Threshold = 233 TP = 39 FP = 0 FN = 112 TN = 1111 TPR = 0.258 FPR = 0.000

Threshold = 234 TP = 34 FP = 0 FN = 117 TN = 1111 TPR = 0.225 FPR = 0.000

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Threshold = 237 TP = 28 FP = 0 FN = 123 TN = 1111 TPR = 0.185 FPR = 0.000

Threshold = 238 TP = 24 FP = 0 FN = 127 TN = 1111 TPR = 0.159 FPR = 0.000

Threshold = 239 TP = 23 FP = 0 FN = 128 TN = 1111 TPR = 0.152 FPR = 0.000

Threshold = 240 TP = 21 FP = 0 FN = 130 TN = 1111 TPR = 0.139 FPR = 0.000

Threshold = 241 TP = 18 FP = 0 FN = 133 TN = 1111 TPR = 0.119 FPR = 0.000

Threshold = 242 TP = 17 FP = 0 FN = 134 TN = 1111 TPR = 0.113 FPR = 0.000

Threshold = 243 TP = 16 FP = 0 FN = 135 TN = 1111 TPR = 0.106 FPR = 0.000

Threshold = 244 TP = 13 FP = 0 FN = 138 TN = 1111 TPR = 0.086 FPR = 0.000

Threshold = 245 TP = 10 FP = 0 FN = 141 TN = 1111 TPR = 0.066 FPR = 0.000

Threshold = 246 TP = 9 FP = 0 FN = 142 TN = 1111 TPR = 0.060 FPR = 0.000

Threshold = 247 TP = 6 FP = 0 FN = 145 TN = 1111 TPR = 0.040 FPR = 0.000

Threshold = 248 TP = 5 FP = 0 FN = 146 TN = 1111 TPR = 0.033 FPR = 0.000

Threshold = 249 TP = 4 FP = 0 FN = 147 TN = 1111 TPR = 0.026 FPR = 0.000

Threshold = 250 TP = 0 FP = 0 FN = 151 TN = 1111 TPR = 0.000 FPR = 0.000

Threshold = 251 TP = 0 FP = 0 FN = 151 TN = 1111 TPR = 0.000 FPR = 0.000

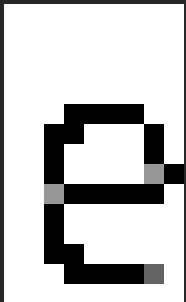
Threshold = 252 TP = 0 FP = 0 FN = 151 TN = 1111 TPR = 0.000 FPR = 0.000

Threshold = 253 TP = 0 FP = 0 FN = 151 TN = 1111 TPR = 0.000 FPR = 0.000

Threshold = 254 TP = 0 FP = 0 FN = 151 TN = 1111 TPR = 0.000 FPR = 0.000

Threshold = 255 TP = 0 FP = 0 FN = 151 TN = 1111 TPR = 0.000 FPR = 0.000

The reason for having numerous false negatives was due to the ignoring of the edge pixels which I was told to do by John Lawler. Below is an example of a false negative e.



As can be seen the reason it detected 2 branch points was because the edge cases were ignored as instructed to do.