**LAB 2 REPORT – Aaron Bruner**

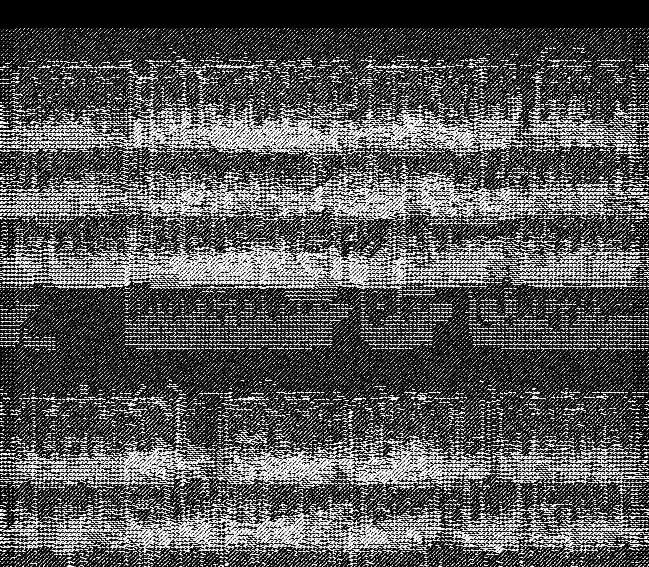
The purpose of this lab was to detect the location of characters in an image. The lab instructions laid out 4 steps for us to follow. The first step was to read the input image, template image, and ground truth files.

./lab2  
Step 1:  
Performing matched filter on images [parenthood.ppm] and [parenthood\_e\_template.ppm] using ground truth [parenthood\_gt.txt]  
 \* Reading in source image... [SUCCESS]  
 \* Reading in template image... [SUCCESS]  
 \* Opening ground truth file... [SUCCESS]  
 \* Found 1261 number of rows in the ground truth file  
 \* Allocating space for ground truth file... [SUCCESS]  
 \* Scanning in values from ground truth file... [Read in 1261 rows]

The above text is the first step output from the terminal when we execute out code. As we can see, the files parenthood.ppm, parenthood\_e\_template.ppm and parenthood\_gt.txt are used since command line arguments were not provided. We have the option of specifying which files we want to use by using the following command: ./lab2 (sourceFile.ppm) (templateFile.ppm) (groundTruth.txt). We can see that 1261 rows were read in from the ground truth and all files were successfully opened and read in.

Step 2 asked us to calculate the matched-spatial filter (MSF) image. Below is the output from the terminal and the MSF image.

Step 2:  
Calculate the mean of the template image...  
 \* Mean pixel value in the template image = 165  
 \* Generating the zero mean template image  
 \* Allocating space for template MSF image... [SUCCESS]  
 \* Allocating space for MSF image... [SUCCESS]  
 \* Convolving source and zero-mean centered image... [SUCCESS]



Step 3 asked us to normalize the MSF image to 8-bits. Below is the output from the terminal and the normalized image.

Step 3:  
Finding the minimum pixel and maximum pixel of the MSF...  
 \* Calculating the minimum and maximum pixel in MSF image... [SUCCESS]  
 \* Minimum determined to be: -128215  
 \* Maximum determined to be: 309645  
 \* Normalizing the MSF image to 8-bit...  
 \* Creating space for normalized image... [SUCCESS]

Text

Description automatically generated

The pixel values with values closer to 255 are more likely to be e.

Step 4 has us thresholding the above image for ranging values of T. The ideal value of T was determined to be 200 which yields the highest number of e’s with the lowest number of FP.

Step 4:  
Creating a binary image using the threshold...  
 \* Allocating space for result image [SUCCESS]  
 \* Loop over the MSF image with threshold values from 0 to 255 incrementing by 10...  
 \* Generating the ideal OCR image using threshold value [200]... [SUCCESS]  
 \* Sending result image to idealImage.ppm... [SUCCESS]

The full output of TP and FP values for T values ranging from 0 to 255 are on the next page along with the ideal output image at 200.

Background pattern

Description automatically generated

Threshold [ 0] : TP = 151 | FP = 1111

Threshold [ 1] : TP = 151 | FP = 1111

Threshold [ 2] : TP = 151 | FP = 1111

Threshold [ 3] : TP = 151 | FP = 1111

Threshold [ 4] : TP = 151 | FP = 1111

Threshold [ 5] : TP = 151 | FP = 1111

Threshold [ 6] : TP = 151 | FP = 1111

Threshold [ 7] : TP = 151 | FP = 1111

Threshold [ 8] : TP = 151 | FP = 1111

Threshold [ 9] : TP = 151 | FP = 1111

Threshold [ 10] : TP = 151 | FP = 1111

Threshold [ 11] : TP = 151 | FP = 1111

Threshold [ 12] : TP = 151 | FP = 1111

Threshold [ 13] : TP = 151 | FP = 1111

Threshold [ 14] : TP = 151 | FP = 1111

Threshold [ 15] : TP = 151 | FP = 1111

Threshold [ 16] : TP = 151 | FP = 1111

Threshold [ 17] : TP = 151 | FP = 1111

Threshold [ 18] : TP = 151 | FP = 1111

Threshold [ 19] : TP = 151 | FP = 1111

Threshold [ 20] : TP = 151 | FP = 1111

Threshold [ 21] : TP = 151 | FP = 1111

Threshold [ 22] : TP = 151 | FP = 1111

Threshold [ 23] : TP = 151 | FP = 1111

Threshold [ 24] : TP = 151 | FP = 1111

Threshold [ 25] : TP = 151 | FP = 1111

Threshold [ 26] : TP = 151 | FP = 1111

Threshold [ 27] : TP = 151 | FP = 1111

Threshold [ 28] : TP = 151 | FP = 1111

Threshold [ 29] : TP = 151 | FP = 1111

Threshold [ 30] : TP = 151 | FP = 1111

Threshold [ 31] : TP = 151 | FP = 1111

Threshold [ 32] : TP = 151 | FP = 1111

Threshold [ 33] : TP = 151 | FP = 1111

Threshold [ 34] : TP = 151 | FP = 1111

Threshold [ 35] : TP = 151 | FP = 1111

Threshold [ 36] : TP = 151 | FP = 1111

Threshold [ 37] : TP = 151 | FP = 1111

Threshold [ 38] : TP = 151 | FP = 1111

Threshold [ 39] : TP = 151 | FP = 1111

Threshold [ 40] : TP = 151 | FP = 1111

Threshold [ 41] : TP = 151 | FP = 1111

Threshold [ 42] : TP = 151 | FP = 1111

Threshold [ 43] : TP = 151 | FP = 1111

Threshold [ 44] : TP = 151 | FP = 1111

Threshold [ 45] : TP = 151 | FP = 1111

Threshold [ 46] : TP = 151 | FP = 1111

Threshold [ 47] : TP = 151 | FP = 1111

Threshold [ 48] : TP = 151 | FP = 1111

Threshold [ 49] : TP = 151 | FP = 1111

Threshold [ 50] : TP = 151 | FP = 1111

Threshold [ 51] : TP = 151 | FP = 1111

Threshold [ 52] : TP = 151 | FP = 1111

Threshold [ 53] : TP = 151 | FP = 1111

Threshold [ 54] : TP = 151 | FP = 1111

Threshold [ 55] : TP = 151 | FP = 1111

Threshold [ 56] : TP = 151 | FP = 1111

Threshold [ 57] : TP = 151 | FP = 1111

Threshold [ 58] : TP = 151 | FP = 1111

Threshold [ 59] : TP = 151 | FP = 1111

Threshold [ 60] : TP = 151 | FP = 1111

Threshold [ 61] : TP = 151 | FP = 1111

Threshold [ 62] : TP = 151 | FP = 1111

Threshold [ 63] : TP = 151 | FP = 1111

Threshold [ 64] : TP = 151 | FP = 1111

Threshold [ 65] : TP = 151 | FP = 1111

Threshold [ 66] : TP = 151 | FP = 1111

Threshold [ 67] : TP = 151 | FP = 1111

Threshold [ 68] : TP = 151 | FP = 1111

Threshold [ 69] : TP = 151 | FP = 1111

Threshold [ 70] : TP = 151 | FP = 1111

Threshold [ 71] : TP = 151 | FP = 1111

Threshold [ 72] : TP = 151 | FP = 1111

Threshold [ 73] : TP = 151 | FP = 1111

Threshold [ 74] : TP = 151 | FP = 1111

Threshold [ 75] : TP = 151 | FP = 1111

Threshold [ 76] : TP = 151 | FP = 1111

Threshold [ 77] : TP = 151 | FP = 1111

Threshold [ 78] : TP = 151 | FP = 1111

Threshold [ 79] : TP = 151 | FP = 1111

Threshold [ 80] : TP = 151 | FP = 1111

Threshold [ 81] : TP = 151 | FP = 1111

Threshold [ 82] : TP = 151 | FP = 1111

Threshold [ 83] : TP = 151 | FP = 1111

Threshold [ 84] : TP = 151 | FP = 1111

Threshold [ 85] : TP = 151 | FP = 1111

Threshold [ 86] : TP = 151 | FP = 1111

Threshold [ 87] : TP = 151 | FP = 1111

Threshold [ 88] : TP = 151 | FP = 1111

Threshold [ 89] : TP = 151 | FP = 1111

Threshold [ 90] : TP = 151 | FP = 1111

Threshold [ 91] : TP = 151 | FP = 1111

Threshold [ 92] : TP = 151 | FP = 1111

Threshold [ 93] : TP = 151 | FP = 1111

Threshold [ 94] : TP = 151 | FP = 1111

Threshold [ 95] : TP = 151 | FP = 1111

Threshold [ 96] : TP = 151 | FP = 1111

Threshold [ 97] : TP = 151 | FP = 1111

Threshold [ 98] : TP = 151 | FP = 1111

Threshold [ 99] : TP = 151 | FP = 1111

Threshold [100] : TP = 151| FP = 1111

Threshold [101] : TP = 151| FP = 1111

Threshold [102] : TP = 151| FP = 1111

Threshold [103] : TP = 151| FP = 1111

Threshold [104] : TP = 151| FP = 1111

Threshold [105] : TP = 151| FP = 1111

Threshold [106] : TP = 151| FP = 1111

Threshold [107] : TP = 151| FP = 1111

Threshold [108] : TP = 151| FP = 1110

Threshold [109] : TP = 151| FP = 1110

Threshold [110] : TP = 151| FP = 1110

Threshold [111] : TP = 151| FP = 1110

Threshold [112] : TP = 151| FP = 1109

Threshold [113] : TP = 151| FP = 1109

Threshold [114] : TP = 151| FP = 1108

Threshold [115] : TP = 151| FP = 1107

Threshold [116] : TP = 151| FP = 1106

Threshold [117] : TP = 151| FP = 1105

Threshold [118] : TP = 151| FP = 1105

Threshold [119] : TP = 151| FP = 1102

Threshold [120] : TP = 151| FP = 1101

Threshold [121] : TP = 151| FP = 1097

Threshold [122] : TP = 151| FP = 1097

Threshold [123] : TP = 151| FP = 1096

Threshold [124] : TP = 151| FP = 1096

Threshold [125] : TP = 151| FP = 1094

Threshold [126] : TP = 151| FP = 1091

Threshold [127] : TP = 151| FP = 1088

Threshold [128] : TP = 151| FP = 1084

Threshold [129] : TP = 151| FP = 1079

Threshold [130] : TP = 151| FP = 1073

Threshold [131] : TP = 151| FP = 1068

Threshold [132] : TP = 151| FP = 1066

Threshold [133] : TP = 151| FP = 1058

Threshold [134] : TP = 151| FP = 1053

Threshold [135] : TP = 151| FP = 1047

Threshold [136] : TP = 151| FP = 1041

Threshold [137] : TP = 151| FP = 1035

Threshold [138] : TP = 151| FP = 1026

Threshold [139] : TP = 151| FP = 1016

Threshold [140] : TP = 151| FP = 1010

Threshold [141] : TP = 151| FP = 1003

Threshold [142] : TP = 151| FP = 994

Threshold [143] : TP = 151| FP = 984

Threshold [144] : TP = 151| FP = 971

Threshold [145] : TP = 151| FP = 957

Threshold [146] : TP = 151| FP = 947

Threshold [147] : TP = 151| FP = 929

Threshold [148] : TP = 151| FP = 921

Threshold [149] : TP = 151| FP = 908

Threshold [150] : TP = 151| FP = 889

Threshold [151] : TP = 151| FP = 873

Threshold [152] : TP = 151| FP = 849

Threshold [153] : TP = 151| FP = 830

Threshold [154] : TP = 151| FP = 809

Threshold [155] : TP = 151| FP = 791

Threshold [156] : TP = 151| FP = 767

Threshold [157] : TP = 151| FP = 746

Threshold [158] : TP = 151| FP = 726

Threshold [159] : TP = 151| FP = 699

Threshold [160] : TP = 151| FP = 675

Threshold [161] : TP = 151| FP = 656

Threshold [162] : TP = 151| FP = 643

Threshold [163] : TP = 151| FP = 624

Threshold [164] : TP = 151| FP = 612

Threshold [165] : TP = 151| FP = 597

Threshold [166] : TP = 151| FP = 580

Threshold [167] : TP = 151| FP = 565

Threshold [168] : TP = 151| FP = 554

Threshold [169] : TP = 151| FP = 544

Threshold [170] : TP = 151| FP = 535

Threshold [171] : TP = 151| FP = 519

Threshold [172] : TP = 151| FP = 509

Threshold [173] : TP = 151| FP = 492

Threshold [174] : TP = 151| FP = 477

Threshold [175] : TP = 151| FP = 468

Threshold [176] : TP = 151| FP = 450

Threshold [177] : TP = 151| FP = 440

Threshold [178] : TP = 151| FP = 421

Threshold [179] : TP = 151| FP = 400

Threshold [180] : TP = 151| FP = 386

Threshold [181] : TP = 151| FP = 372

Threshold [182] : TP = 151| FP = 349

Threshold [183] : TP = 151| FP = 339

Threshold [184] : TP = 151| FP = 319

Threshold [185] : TP = 151| FP = 308

Threshold [186] : TP = 151| FP = 292

Threshold [187] : TP = 151| FP = 283

Threshold [188] : TP = 151| FP = 272

Threshold [189] : TP = 151| FP = 253

Threshold [190] : TP = 151| FP = 231

Threshold [191] : TP = 151| FP = 215

Threshold [192] : TP = 151| FP = 200

Threshold [193] : TP = 151| FP = 187

Threshold [194] : TP = 151| FP = 180

Threshold [195] : TP = 151| FP = 169

Threshold [196] : TP = 151| FP = 162

Threshold [197] : TP = 151| FP = 148

Threshold [198] : TP = 151| FP = 141

Threshold [199] : TP = 151| FP = 133

Threshold [200] : TP = 151| FP = 124

Threshold [201] : TP = 150| FP = 113

Threshold [202] : TP = 150| FP = 108

Threshold [203] : TP = 150| FP = 101

Threshold [204] : TP = 149| FP = 90

Threshold [205] : TP = 148| FP = 82

Threshold [206] : TP = 147| FP = 75

Threshold [207] : TP = 146| FP = 69

Threshold [208] : TP = 145| FP = 65

Threshold [209] : TP = 144| FP = 64

Threshold [210] : TP = 143| FP = 59

Threshold [211] : TP = 142| FP = 54

Threshold [212] : TP = 142| FP = 52

Threshold [213] : TP = 140| FP = 48

Threshold [214] : TP = 139| FP = 45

Threshold [215] : TP = 133| FP = 43

Threshold [216] : TP = 133| FP = 42

Threshold [217] : TP = 130| FP = 40

Threshold [218] : TP = 128| FP = 37

Threshold [219] : TP = 122| FP = 34

Threshold [220] : TP = 121| FP = 30

Threshold [221] : TP = 118| FP = 25

Threshold [222] : TP = 115| FP = 20

Threshold [223] : TP = 111| FP = 17

Threshold [224] : TP = 104| FP = 16

Threshold [225] : TP = 99 | FP = 14

Threshold [226] : TP = 98 | FP = 10

Threshold [227] : TP = 93 | FP = 7

Threshold [228] : TP = 89 | FP = 7

Threshold [229] : TP = 81 | FP = 5

Threshold [230] : TP = 75 | FP = 5

Threshold [231] : TP = 68 | FP = 4

Threshold [232] : TP = 63 | FP = 4

Threshold [233] : TP = 60 | FP = 2

Threshold [234] : TP = 53 | FP = 2

Threshold [235] : TP = 48 | FP = 1

Threshold [236] : TP = 43 | FP = 1

Threshold [237] : TP = 41 | FP = 0

Threshold [238] : TP = 39 | FP = 0

Threshold [239] : TP = 35 | FP = 0

Threshold [240] : TP = 31 | FP = 0

Threshold [241] : TP = 28 | FP = 0

Threshold [242] : TP = 24 | FP = 0

Threshold [243] : TP = 23 | FP = 0

Threshold [244] : TP = 20 | FP = 0

Threshold [245] : TP = 16 | FP = 0

Threshold [246] : TP = 13 | FP = 0

Threshold [247] : TP = 11 | FP = 0

Threshold [248] : TP = 8 | FP = 0

Threshold [249] : TP = 6 | FP = 0

Threshold [250] : TP = 5 | FP = 0

Threshold [251] : TP = 1 | FP = 0

Threshold [252] : TP = 1 | FP = 0

Threshold [253] : TP = 1 | FP = 0

Threshold [254] : TP = 1 | FP = 0

Threshold [255] : TP = 1 | FP = 0