

ECE 6310 – Introduction to Computer Vision – LAB 2 REPORT

Optical Character Recognition

TASKS

- Read input files
- Calculate the matched-spatial-filter (MSF) image using convolution
- Normalize the MSF image to 8-bits using the normalization formula
- Detect 'e' at various thresholds after converting MSF image into a binary image
- Calculate TP, FP, TN, FN, TPR and FPR
- Generate a ROC curve

Input Image

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.

Template

200	204	199	200	203	203	202	202	200
199	199	196	199	198	198	199	199	202
197	196	195	198	200	197	199	199	198
195	196	196	199	197	198	196	196	193
194	195	193	155	133	150	187	196	196
195	192	109	69	105	88	78	184	194
193	145	74	177	189	186	100	105	191
191	72	139	191	192	188	168	46	183
186	43	89	110	114	114	107	37	176
191	43	126	133	133	137	129	132	187
191	52	167	188	192	195	195	195	191
189	94	108	189	193	192	191	192	192
193	173	49	141	175	177	108	125	195
199	197	163	90	70	75	109	180	191
194	197	193	192	185	188	195	196	195

NORMALIZED MSF IMAGE

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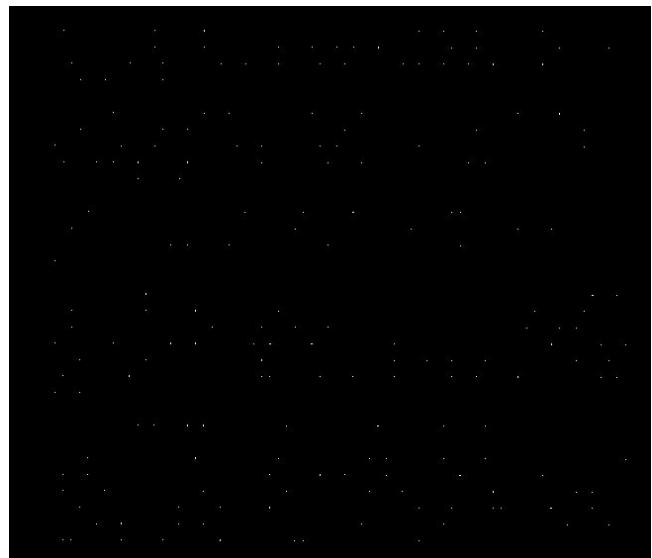
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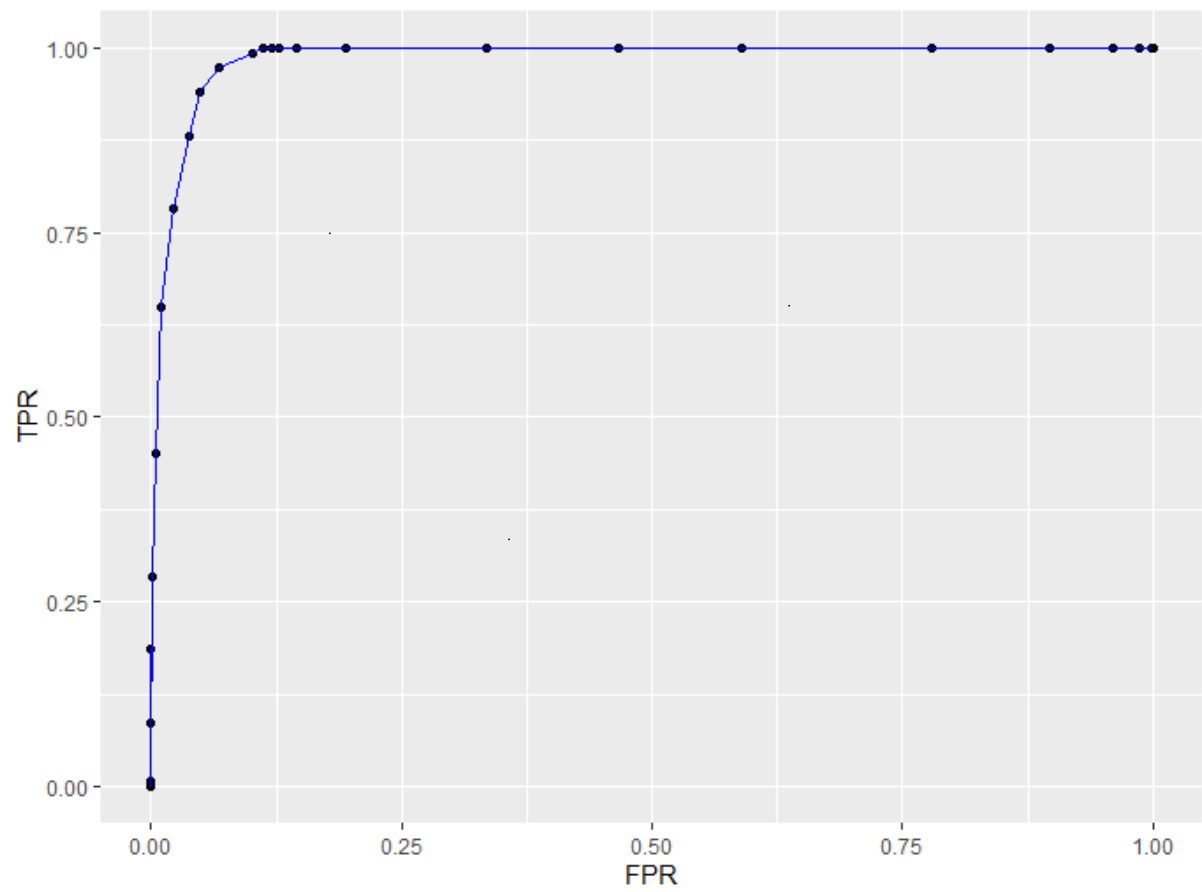
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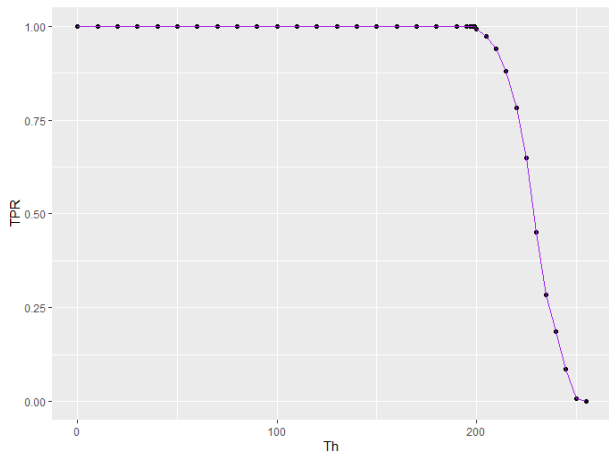
Binary Image



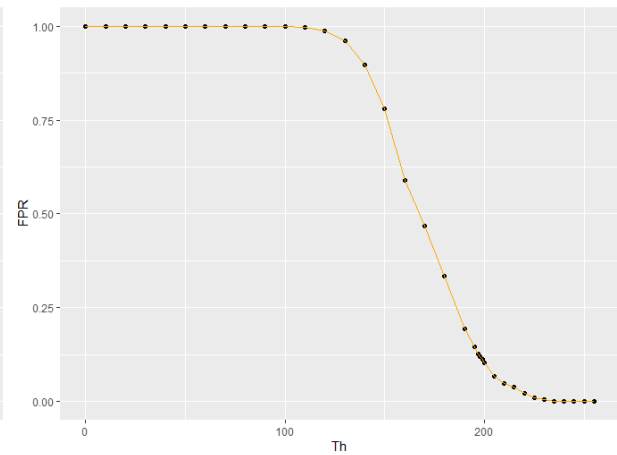
ROC CURVE

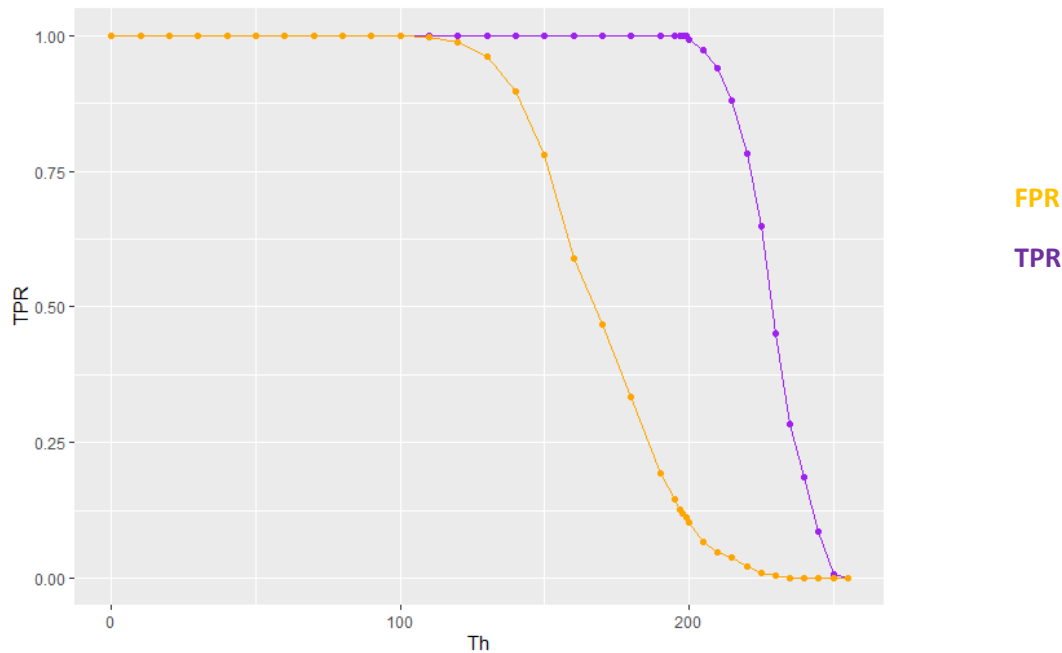


TPR vs. Threshold



FPR vs. Threshold



Superimposing the two plots:**DISCUSSION AND ANALYSIS****Choosing the optimal threshold value**

The goal in this lab is to select an optimal threshold value where the TPR and FPR values would be at an appropriate balance. For this particular application, it is most appropriate to choose a threshold value where TPR is almost 1.0 and FPR is almost 0.0.

As seen in the graph above, FPR is zero at approximately $T = 220$, and then it levels off. TPR maintains at 1.0 until about $T = 200$. Then, it plummets down to $TPR = 0.0$.

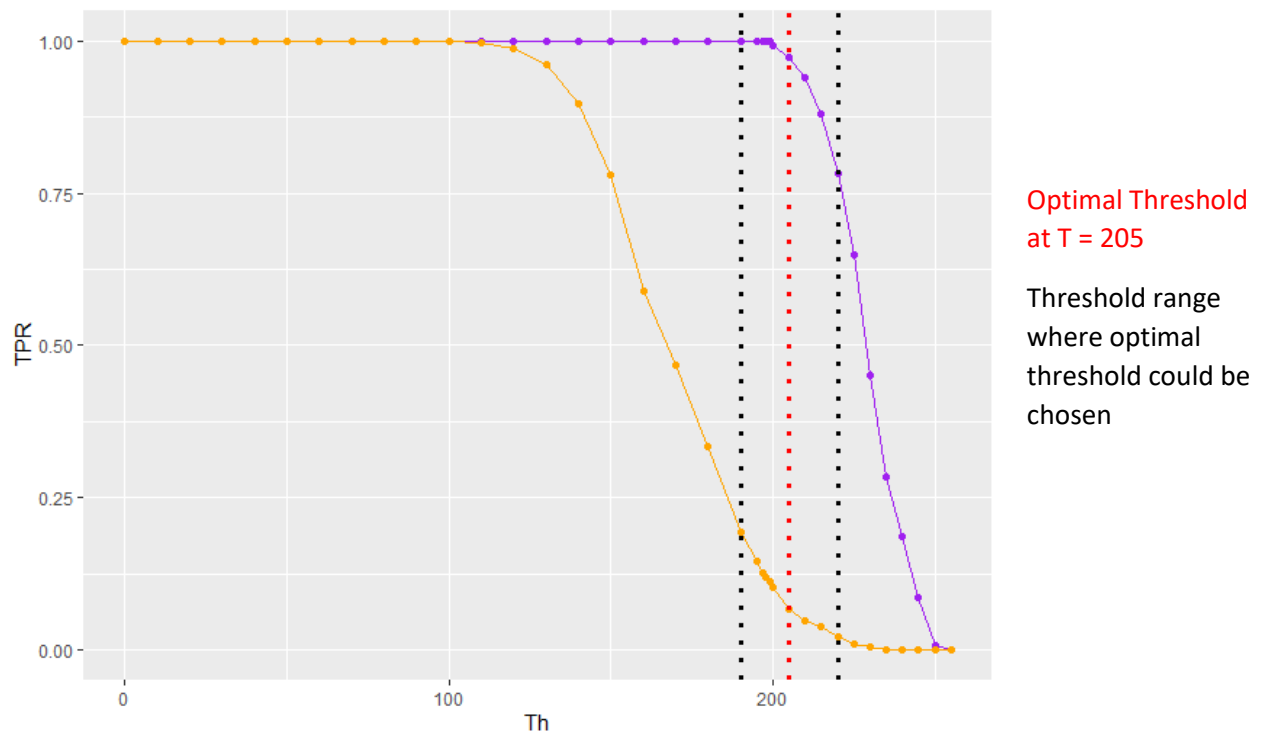
At $T=220$, TPR is almost at 0.75. So, choosing T where $FPR \approx 0$ is not optimal. In order to maintain a high TPR, FPR must be compromised, and vice versa.

At $FPR = 0.067$ and $TPR = 0.974$, the optimal threshold is $T = 205$.

The following table summarizes the ROC curve

THRESHOLD	BEHAVIOR
$T = 0$	$FPR = 1$, $TPR = 1$, all characters are detected
$T = 110$	FPR starts to decrease, TPR stays at 1.0
$T = 199$	Highest T where $TPR = 1.0$, $FPR = 0.112$
$T = 200$	TPR starts to decrease, $FPR = 0.102$
$T = 205$	Largest difference between TPR and FPR; optimal threshold
$T = 215$	TPR starts to decrease drastically, FPR is near zero
$T = 240$	TPR and FPR are near zero

Optimal Threshold – Graphical Representation

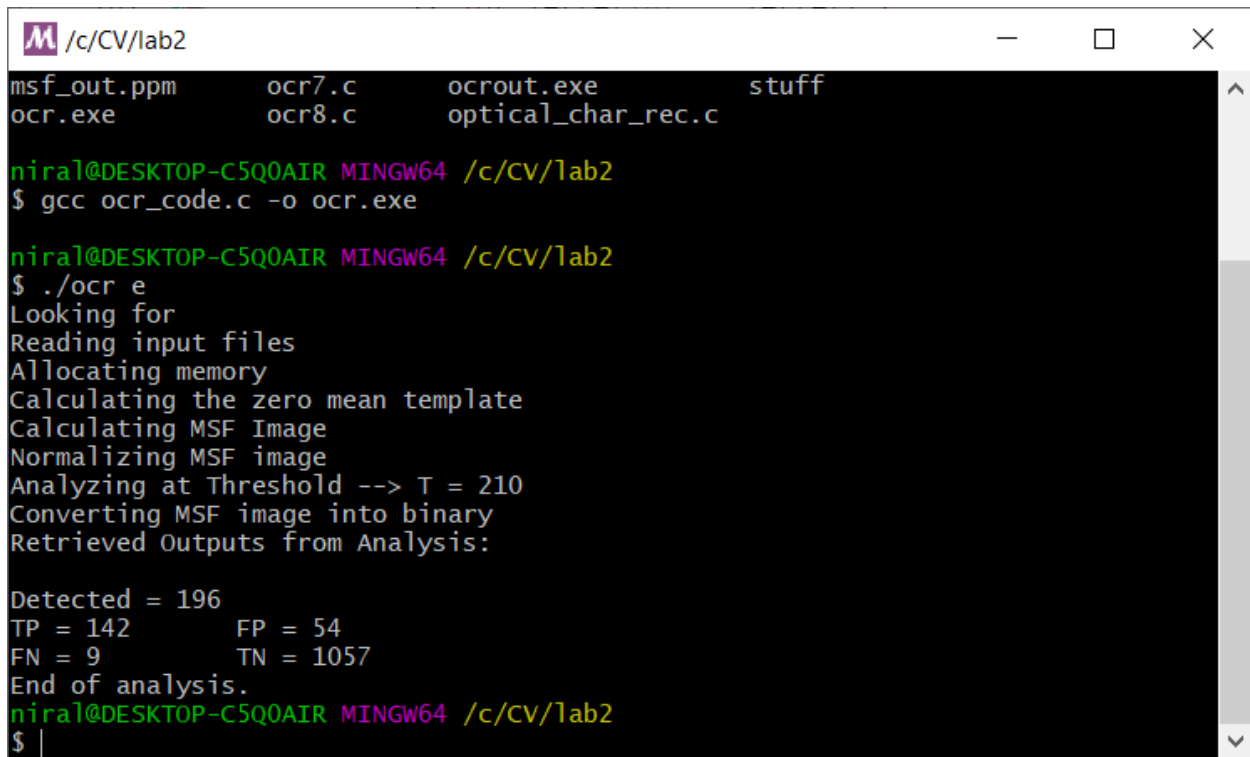


If a threshold must be chosen where the FPR is lower and TPR is still fairly high, then another option would be at $T = 210$ where $TPR = 0.940$ and $FPR = 0.048$.

Difficulties Encountered and Rectifications

1. Failure to display negative values when calculating the zero mean template resulted in the incorrect maximum and minimum values in the MSF image. This led to an incorrect normalized MSF image output. This error was caused by the declaration of zero mean template array as an "unsigned char." The error was removed when the array's data type was changed to "char."
2. The zero mean template was indexed incorrectly and resulted in incorrect outputs. The indexes were negative and produced garbage values. This was rectified by adding constant values to the index to produce correct indexes.
3. A common error that was encountered was the segmentation fault, which was fixed when memory was correctly allocated to input and output images using calloc.

Sample Output from Code



```
M /c/CV/lab2
msf_out.ppm      ocr7.c      ocrout.exe      stuff
ocr.exe          ocr8.c      optical_char_rec.c

niral@DESKTOP-C5Q0AIR MINGW64 /c/CV/lab2
$ gcc ocr_code.c -o ocr.exe

niral@DESKTOP-C5Q0AIR MINGW64 /c/CV/lab2
$ ./ocr e
Looking for
Reading input files
Allocating memory
Calculating the zero mean template
Calculating MSF Image
Normalizing MSF image
Analyzing at Threshold --> T = 210
Converting MSF image into binary
Retrieved Outputs from Analysis:

Detected = 196
TP = 142      FP = 54
FN = 9        TN = 1057
End of analysis.
niral@DESKTOP-C5Q0AIR MINGW64 /c/CV/lab2
$ |
```