Multimedia Fundamentals Project
Counting characters in an image

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1. Introduction
The aim of this project is to recognize A, B and C letters in an image using their different number of holes. Holes are the encapsulated areas within a connected component, for example the letter A has one hole and B has two while C has none. Counting the holes in an object in the image, one can determine which character the object represents. This is the technique used in this project.

Input files are gray scale images containing only uppercase letters A, B, C. Letters can be in any size or any rotation but can not be overlapped. Since we use distinct number of holes to detect the characters, any other character other than depicted will be recognized as one of those or none. If the image contains the letter F, it will be counted as C since it has no holes in it.

2. Operations
In order to ease the detection process, the image read from a file first converted into binary. There is only two levels in a binary image, thus to convert a gray scale image to binary, some threshold value must be determined. Matlab provides `graytrash` function which uses Otsu's method. Otsu's method as an algorithm is;

1. Compute histogram and probabilities of each intensity level
2. Set up initial $\omega i(0)$ and $\mu i(0)$
3. Step through all possible thresholds $t = 1 ...$ maximum intensity
   a. Update ωi and μi
   b. Compute $\sigma_b^2(t)$
4. Desired threshold corresponds to the maximum $\sigma_b^2(t)$

Once the threshold value is found, the pixel values under this value are made zero (black) and others are made 1 (white) which will give us a binary image. Matlab function `im2bw` can used to achive this.

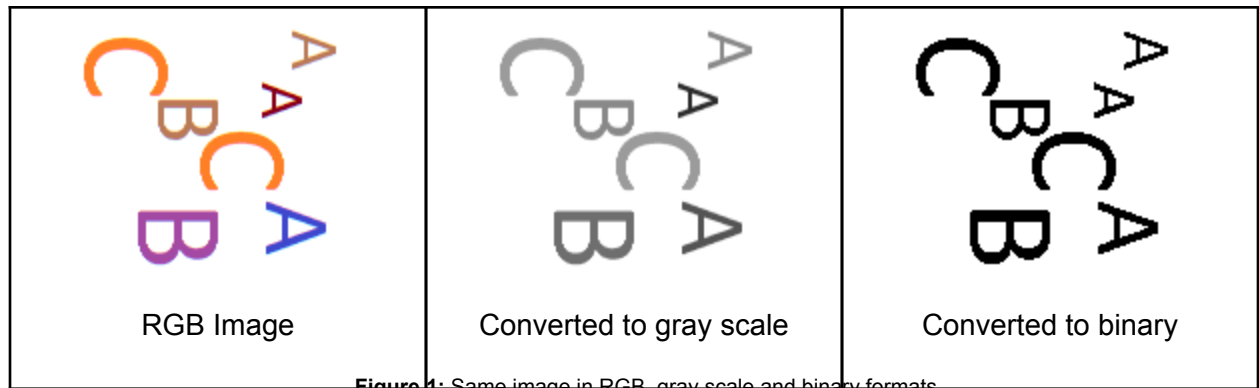| RGB Image | Converted to gray scale | Converted to binary |

Figure 1: Same image in RGB, gray scale and binary formats

After achieving the binary image, our task is to find connected components (a.k.a. blobs or objects). Matlab provides several functions to extract objects from the image. One of these is `bwlabel` which finds connected components in the image. Figure 2 shows the image with components labeled with different colors.


Figure 2: Labeled components

I used `bwconncomp` function for this purpose. This function outputs all objects in the image which then can be passed as a parameter to `regionprops` function. `regionprops` gives several statistical information about an object or an image such as area or eccentricity. It also gives the Euler number of an object which means number of objects minus number of holes (-1 for B e.g.). Since we want the hole count and know that there is only one object in a connected component, we can use this function to recognize the character.

3. Usage

After executing the m-file, user is asked to choose an image file. Only gray scale images in PNG, BMP or JPG format are allowed. After computations, a message box with the number of characters is shown.

```
file');
```
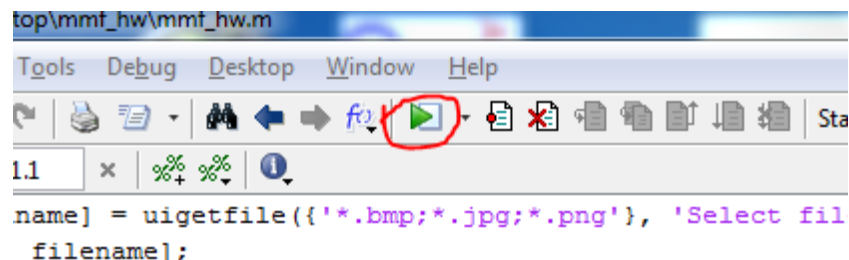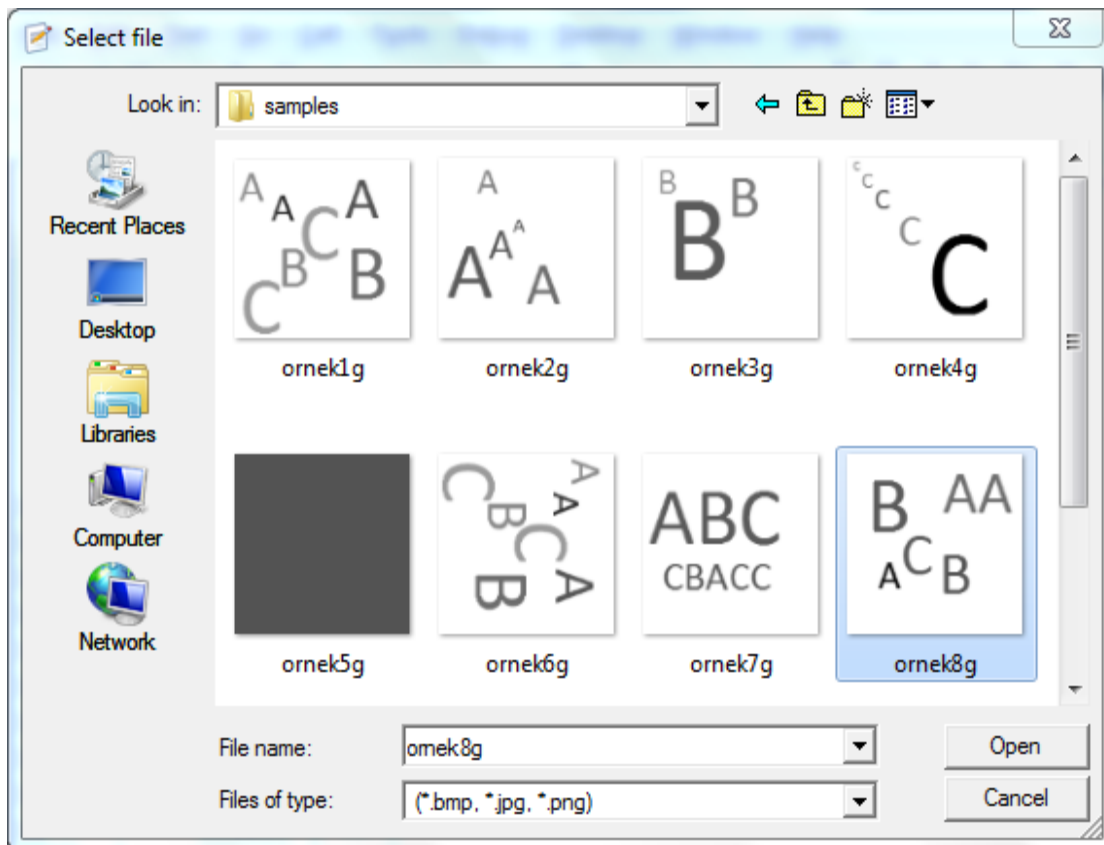
```
20 -          ccount = ccount + 1;
21 -      elseif i == -1
22 -          bcount = bcount + 1;
```

Results

There is 3 As, 2 Bs and 1 Cs

OK