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CMPSC-497
Lab 1b - Detecting Defective Cookies
Materials: Matlab, Cookies Camera (Phone)

Discussion

In this Lab, I tweaked and extended `processImage()` function from my Lab 1a to optimize it for the task of distinguishing Intact cookies from broken ones. The function will output a processed image, with the defective cookies having a large black 'X' through their center. Each Cookie will also have its roundness metric displayed next to it.

Code

The code is quite similar to that of Lab 1a, but there are a few adjustments. Below is the full function followed by the adjustments:

```
% Importing cookie images

im_1 = imread('/home/aaron/Pictures/cookies_2.jpg');

processCookies(im_1, .85, .2)

% importing function from previous lab
function [total_objects, round_objects] = processCookies(im,
roundness_threshold, graypoint)
    % display original image
   imtool(im);

    % converting to grayscale
    im_gray = rgb2gray(im);


    % binarizing the image (passing -1 lets us have the default
```

```
algorithm choose the gray point)
    if graypoint == -1
        graypoint = graythresh(im_gray);
    end

    im_bin_threshold = imbinarize(im_gray, graypoint); % removes
objects

    % removing noise/grains
    im_bin_denoise = bwareaopen(im_bin_threshold, 1000); % lots of
tweaking

    % filling in any holes in the image
    se = strel('disk', 20); % lots of tweaking
    im_bin_closed = imclose(im_bin_denoise, se);
    im_bin_filled = imfill(im_bin_closed, 'holes');


    % Boundary and Label Matrices
    [B, L] = bwboundaries(im_bin_filled, 'noholes')
    imshow(label2rgb(L, @jet, [.5 .5 .5])) % Displaying the distinct
objects



     % getting true and circular areas
     stats = regionprops(L, 'Area', 'Centroid');

     % counting round objects (those that are above threshold value)
     objects_exceed_threshold = 0;

      % appending more data to the graph
    hold on


    % drawing boundaries
    for k = 1 : length(B)
            boundary = B{k}
            plot(boundary(:,2), boundary(:,1), 'w', 'LineWidth', 2)

        delta_sq = diff(boundary).^2;
```

```
        perimeter = sum(sqrt(sum(delta_sq,2)));

        area1 = perimeter^2/(4*pi);
        area2 = stats(k).Area;

        area_true = stats(k).Area;
        metric = area2/area1

        metric_string = sprintf("%2.2f",metric);

        % plot a circle about the centroid
        if metric < roundness_threshold
                centroid = stats(k).Centroid;
            objects_exceed_threshold = objects_exceed_threshold + 1;
                plot(centroid(1), centroid(2), 'KX', 'MarkerSize',
50);
        end



        % plot the roundness or ciruclarity metric near the object
        text(boundary(1,2)-100, boundary(1,1)+120, metric_string,
'color', 'y','FontSize', 14, 'FontWeight', 'bold');
    end

     hold off

    sprintf("Total Cookies: %.f", length(B))
    sprintf("Total DEFECTIVE Cookies: %.f",
objects_exceed_threshold)
    sprintf("Total INTACT Cookies: %.f", (length(B) -
objects_exceed_threshold))

end
```

Roundness Value

it was interesting to note that a seemingly round cookie was actually not as round as expected (no intact cookies had a metric higher than 91%)

```
processCookies(im_1, .80, .2); % roundness value of 85%
```

Gray Point

this also helped with the contrast and therefore the roundness calculations (although only slightly - in the range of ~5% increase for intact cookies)

```
processCookies(im_1, .80, .2); % graypoint of .2
```

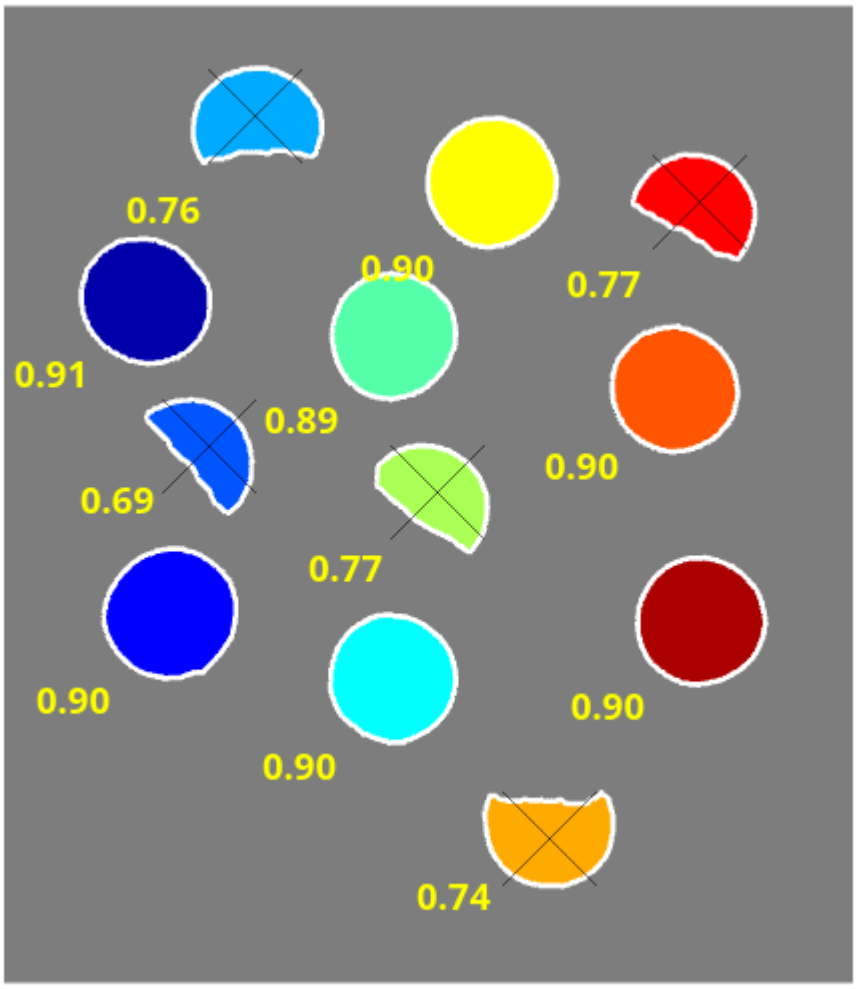
Disk approximation

Adjusting this value to 20 allowed for slightly better roundness values for all intact cookies

```
se = strel("disk", 20);
```

Results


Image Tool 1 - im
Pixel info: (X, Y) Pixel Value



ans = "Total Cookies: 12"

ans = "Total DEFECTIVE Cookies: 5"

ans = "Total INTACT Cookies: 7"

Analysis & Conclusion

There were a few interesting things to note from this lab. First, using my previous experience working with LAB 1a, I selected the Ritz Cracker Bites as their light color would contrast well against the black background. These cookies were stacked and although I did not expect it to be such a factor, the fact that the cookies were stacked crackers with a filling combined with the fact that there was a slight angle to the shot reduced their level of roundness. This explains the reduction in roundness overall of the intact cookies (10%) which

was higher than expected. This however did not impede the algorithms ability to distinguish between intact and defective cookies.