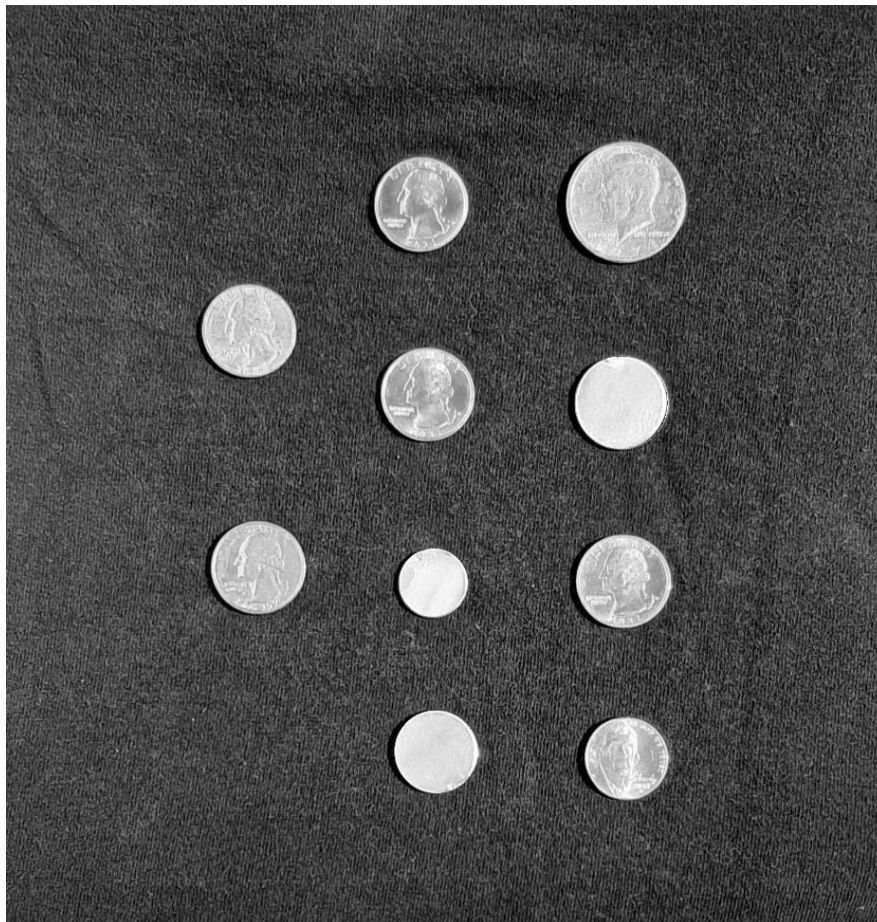


## VALID COIN COUNTING PROJECT

### Image Processing - MATLAB

Given an image of US coins, one must count the number of valid coins in the image and then later estimate the total amount of money present in the image by assigning a value to the coins based on their sizes.



As one can see, the picture contains 3 blanks and 7 valid coins.

The steps involved and the processes on how this task is performed are discussed below.

## STEP 1:

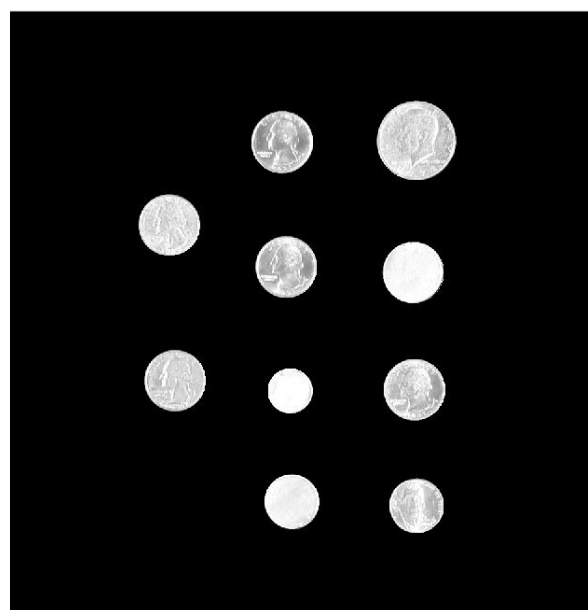
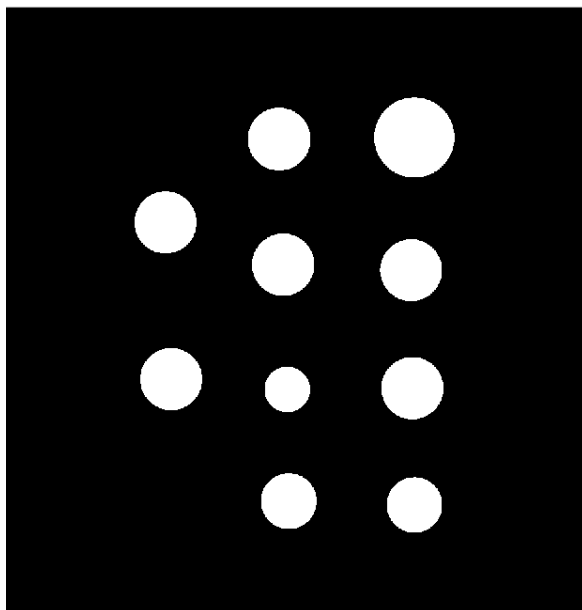
The first step is to segment the foreground and background.

```
CoinImage = imread("CoinImage.png")
[CoinMask, maskedCoinImage] = segmentImage(CoinImage);
imshow(CoinMask)
imshow(maskedCoinImage)

function [BW,maskedImage] = segmentImage(X)
% Find circles
[centers, radii, ~] = imfindcircles(X,[25
75], 'ObjectPolarity', 'bright', 'Sensitivity', 0.85);
BW = false(size(X,1),size(X,2));
[Xgrid,Ygrid] = meshgrid(1:size(BW,2),1:size(BW,1));
for n = 1:10
    BW = BW | (hypot(Xgrid-centers(n,1),Ygrid-centers(n,2)) <= radii(n));
end
% Create masked image.
maskedImage = X;
maskedImage(~BW) = 0;
end
```

The foreground elements are separated from the background by using segmenting image using the find circles function, the minimum diameter being 50 pixels and maximum being 150 pixels.

The resulting mask and the masked image are shown below:



## STEP 2:

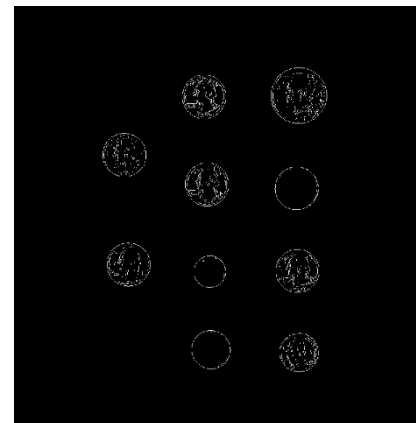
Use this mask and the masked image to determine the valid coins.

This can be done by:

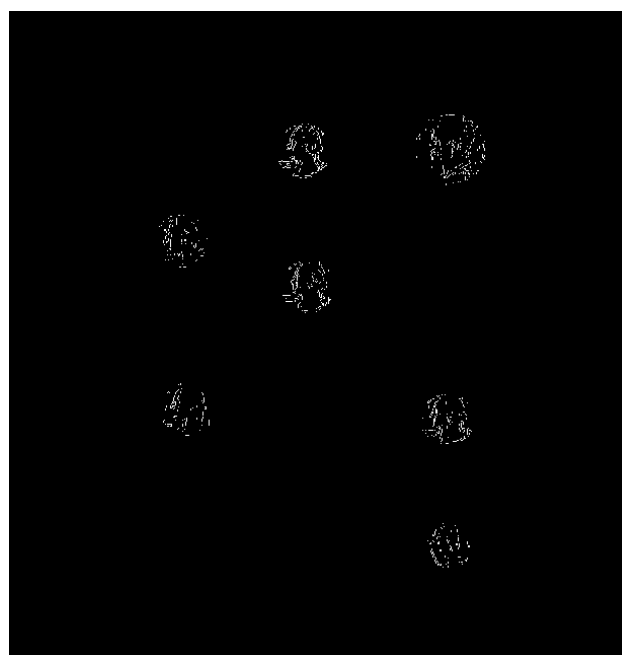
- Finding the edges in the masked image using a Sobel filter.
- Eroding the outer layer of the mask, so that it has true pixels well inside the coin's circumference.
- Logically combining the masked image which now only contains the edges and the eroded mask using '&' operator, such that the resulting image will have only true pixels whenever it encounters a valid coin.

```
maskedCoinImage = im2uint8(edge(maskedCoinImage,"sobel",0.08));  
se = strel("disk",10,0);  
CoinMask = imerode(CoinMask,se);  
faceEdgeMask = maskedCoinImage & CoinMask;  
imshow(faceEdgeMask)
```

The masked image after applying the edge filter.



The face edge mask is as shown below. The valid coins are being identified correctly.



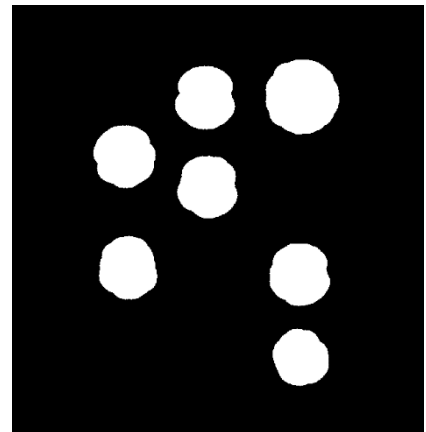
### STEP 3:

The valid coins have been discovered. The next step is to create a valid coin mask by expanding or dilating the pixels such that true pixels at least cover the regions occupied by the valid coins.

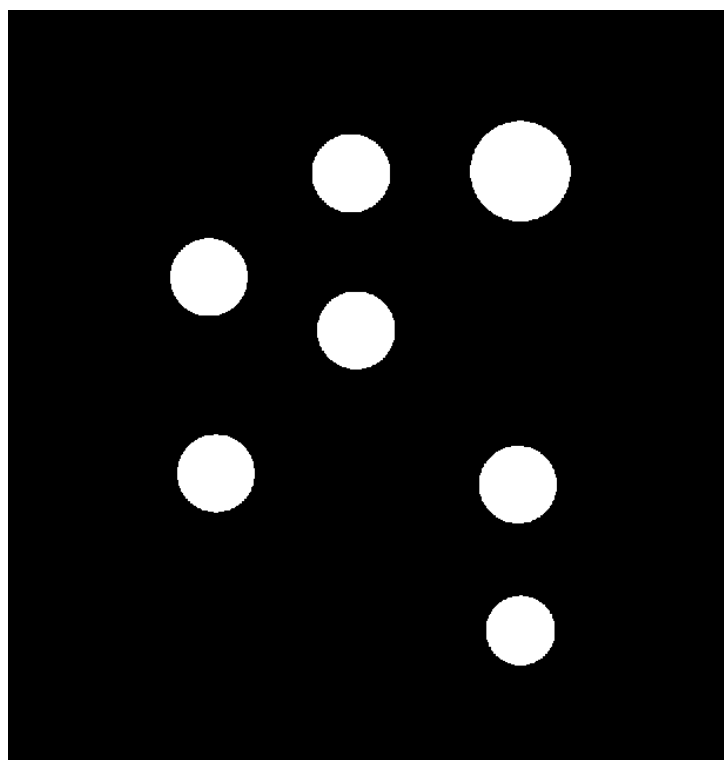
This is done by dilating the true pixels by a disk of dimension 32 pixels and then logically combining it with the original mask.

```
se = strel("disk",32,0);  
faceEdgeMask = imdilate(faceEdgeMask,se);  
validCoinMask = faceEdgeMask & CoinMask  
imshow(validCoinMask)
```

The face edge mask after dilating the pixels.



The valid coin mask after the logical combination is shown below. This mask only extracts the valid coins.



## STEP 4:

Count the amount of money present in the image.

This is done by segregating the coins based on their area and then multiply the number of coins with their value. Image region analyzer is used to get the segment the foreground elements based on area.

```
[bw,coinSizes] = filtertheRegions(validCoinMask);
coinSizes = sortrows(coinSizes,"Area","ascend");
nDimes = nnz(coinSizes.Area<4500)
nNickels = nnz(coinSizes.Area>4500 & coinSizes.Area<7000)
nQuarters = nnz(coinSizes.Area>7000 & coinSizes.Area<10000)
nFiftyCents = nnz(coinSizes.Area>10000 & coinSizes.Area<20000)
USD = nDimes*0.1 + nNickels*0.05 + nQuarters*0.25+nFiftyCents*0.5
```

```
function [BW_out,properties] = filtertheRegions(BW_in)
BW_out = BW_in;

properties = struct2table(regionprops(BW_out, {'Area'}));
end
```

The values of area where true pixels are present:

**6171 ,7732, 7738, 7739, 7775, 7890, 12872.**

Meaning, the image contained **0** dimes, **1** nickel, **5** quarters and **1** fifty-cent coin.

**The total value of the image is USD \$ 1.8**

## MATLAB CODE:

```
CoinImage = imread("CoinImage.png")
[CoinMask, maskedCoinImage] = segmentImage(CoinImage);
maskedCoinImage = im2uint8(edge(maskedCoinImage,"sobel",0.08));
se = strel("disk",10,0);
CoinMask = imerode(CoinMask,se);
faceEdgeMask = maskedCoinImage & CoinMask;
se = strel("disk",32,0);
faceEdgeMask = imdilate(faceEdgeMask,se);
validCoinMask = faceEdgeMask & CoinMask
[bw,coinSizes] = filtertheRegions(validCoinMask);
coinSizes = sortrows(coinSizes,"Area","ascend");
nDimes = nnz(coinSizes.Area<4500)
nNickels = nnz(coinSizes.Area>4500 & coinSizes.Area<7000)
nQuarters = nnz(coinSizes.Area>7000 & coinSizes.Area<10000)
nFiftyCents = nnz(coinSizes.Area>10000 & coinSizes.Area<20000)
USD = nDimes*0.1 + nNickels*0.05 + nQuarters*0.25+nFiftyCents*0.5
```

```
function [BW,maskedImage] = segmentImage(X)
% Find circles
[centers,radii,~] = imfindcircles(X,[25
75], 'ObjectPolarity', 'bright', 'Sensitivity',0.85);
BW = false(size(X,1),size(X,2));
[Xgrid,Ygrid] = meshgrid(1:size(BW,2),1:size(BW,1));
for n = 1:10
    BW = BW | (hypot(Xgrid-centers(n,1),Ygrid-centers(n,2)) <= radii(n));
end
% Create masked image.
maskedImage = X;
maskedImage(~BW) = 0;
end
```

```
function [BW_out,properties] = filtertheRegions(BW_in)
BW_out = BW_in;

properties = struct2table(regionprops(BW_out, {'Area'}));
end
```