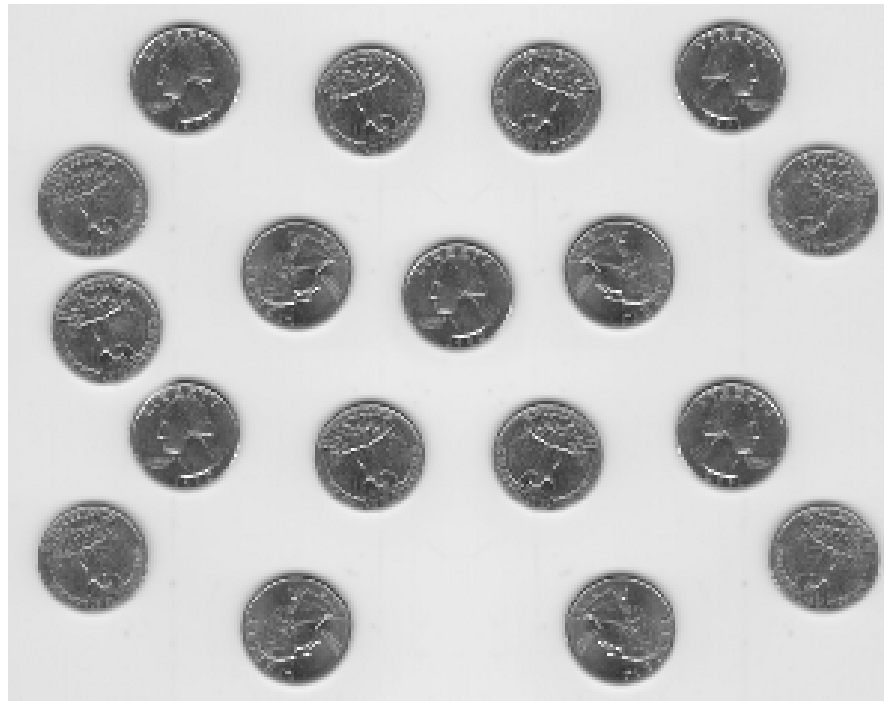# Template matching

Outline

- Use template matching to count the number of coins in the image 'coins.png'

Template matching

- In Matlab, given an image img and a template B, values of convolution, correlation and normalized cross correlation coefficients can be computed as follows:

  - Convolution: **conv2**(img, B, 'same');
  - Correlation: **conv2**(img, rot90(B,2), 'same');
  - Norm. cross. corr. coeff: **normxcorr2**(B,img);

- These operators slide the template B over the image img, computing at each step the corresponding value
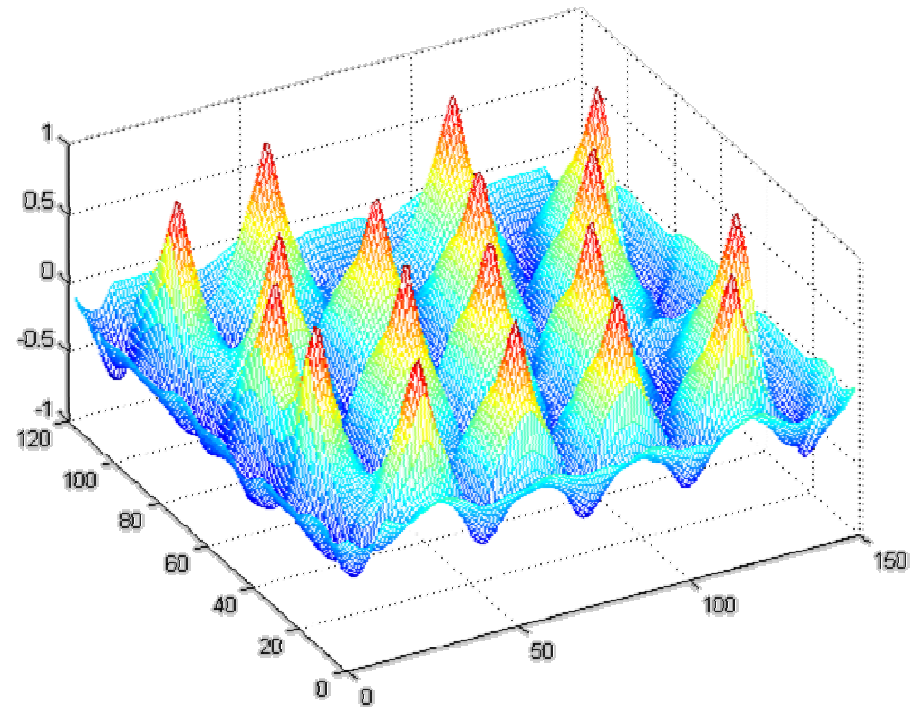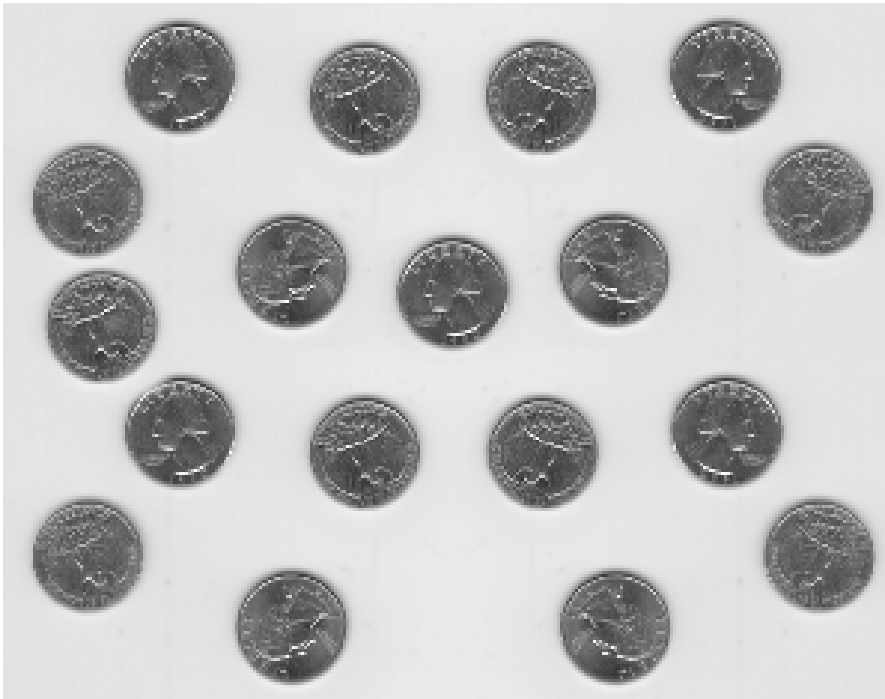
Template matching

- The following Matlab code can be used to compute the normalized cross correlation coefficient between image img and a template:
  - img_out = **normxcorr2**(template, img);
- The template can be one of the coins in the image:
  - img = imread('coins.png');
  - template = **imcrop**(img);

press the mouse button and drag to define the crop rectangle. Adjust the rectangle bounds and then double-click inside the rectangle.
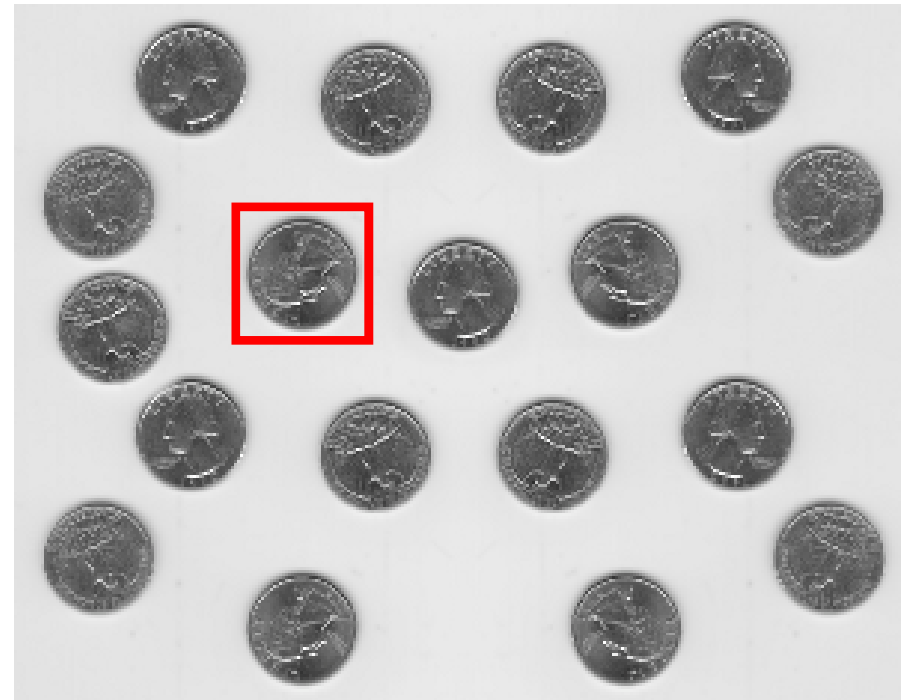
Template matching

```
>> figure; imshow(img);
>> figure; imshow(template);
>> figure; mesh(img_out); colormap('jet');
```

Template matching

- Finally, detect maxima points and count them
  - Trace:
    - Define a function (e.g. isMax) that processes a 2D array and returns 1 if the central element of the array is a maximum (and its value is greater than a threshold) 0 otherwise
    - Process values of the correlation coefficient (img_out) using nlfilter and isMax and put results into img_max
    - Count the number of elements of img_max that are equal to 1:
      - sum(img_max(:)==1)

Template matching

- img_max = nlfilter(img_out, [5 5], @isMax);
- sum(img_max(:)==1);

```
function out = isMax(inputData)

central = uint8( (size(inputData)+1)/2 );

if (inputData(central(1), central(2))<0.8)
    out=0;
elseif ( inputData(central(1), central(2)) == max(inputData(:)) )
    out=1;
else
    out=0;
end
```