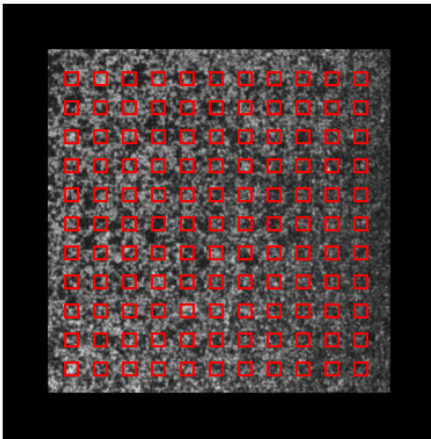


Project 1: Analyzing deformation with DIC

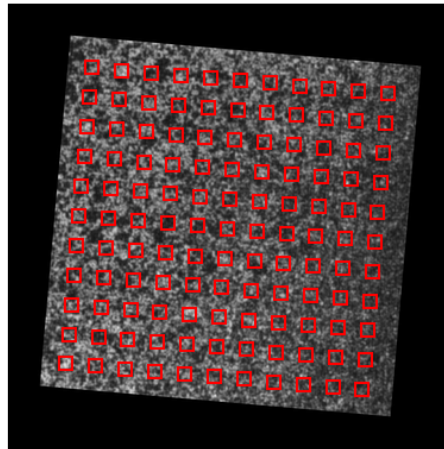
Goal: write a MATLAB code that will:

1. Read two images (samples can be downloaded from the web)
2. Use MATLAB image processing toolbox to calculate displacements at points in the image
3. Calculate deformation measures (you can choose what you would like to plot – strains, rotations, displacements, principal strains, etc)

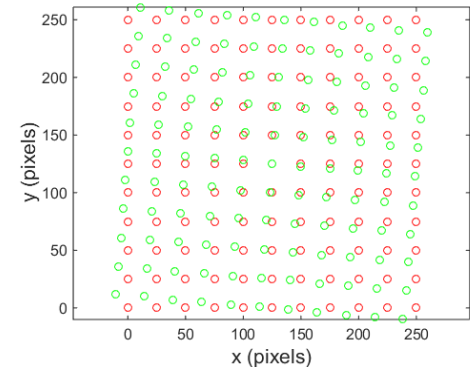
Sub-regions in reference image



Sub-regions in deformed image



Grid displacement



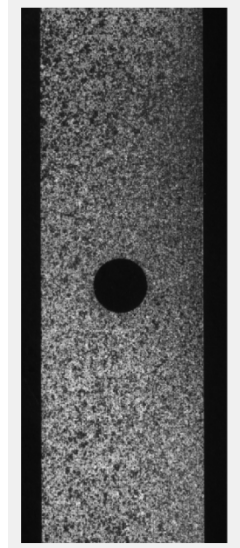
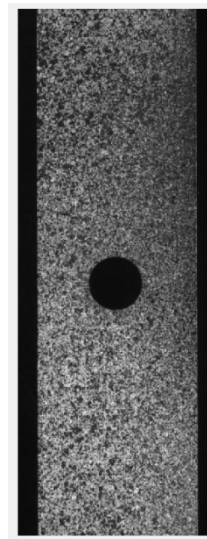
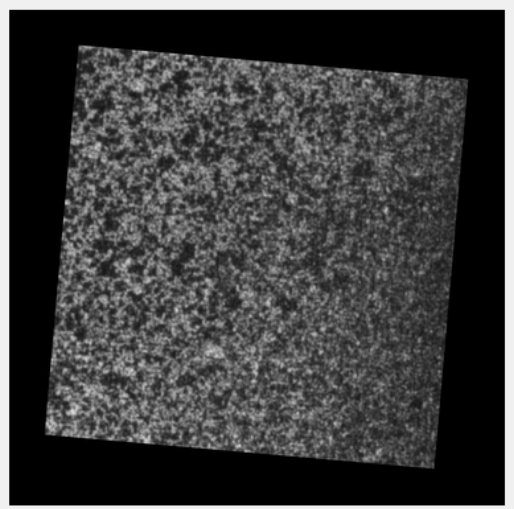
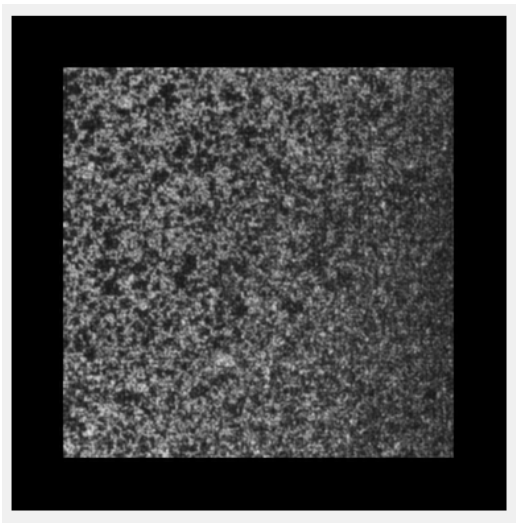
Reading and displaying MATLAB images

- Data stored in mat files (ref and current)

```
load('rotation_data.mat')  
imshow(ref);  
imshow(cur);
```

- Data stored in 'tif' files

```
filedirectory = 'Hole_Plate_Images';  
filename = 'ohtcfrp_';  
ref = read(Tiff(strcat(filedirectory, '/', filename, '00', '.tif')));  
ref = double(ref)/256.;  
cur = read(Tiff(strcat(filedirectory, '/', filename, '11', '.tif')));  
cur = double(cur)/256.;
```



Images

Matlab images

Stored as a 2D matrix eg `cur(row,col)`

Can crop a small sub-image using

```
cursubimage = cur(vlo:vhi,hlo:hhi);
```

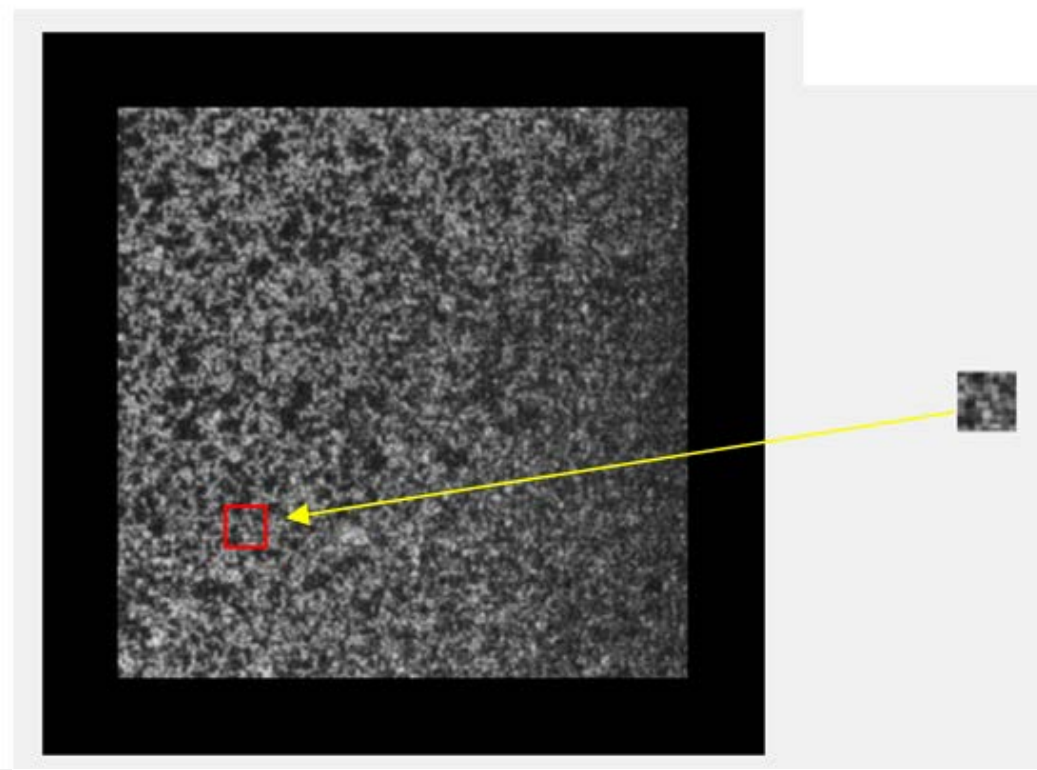
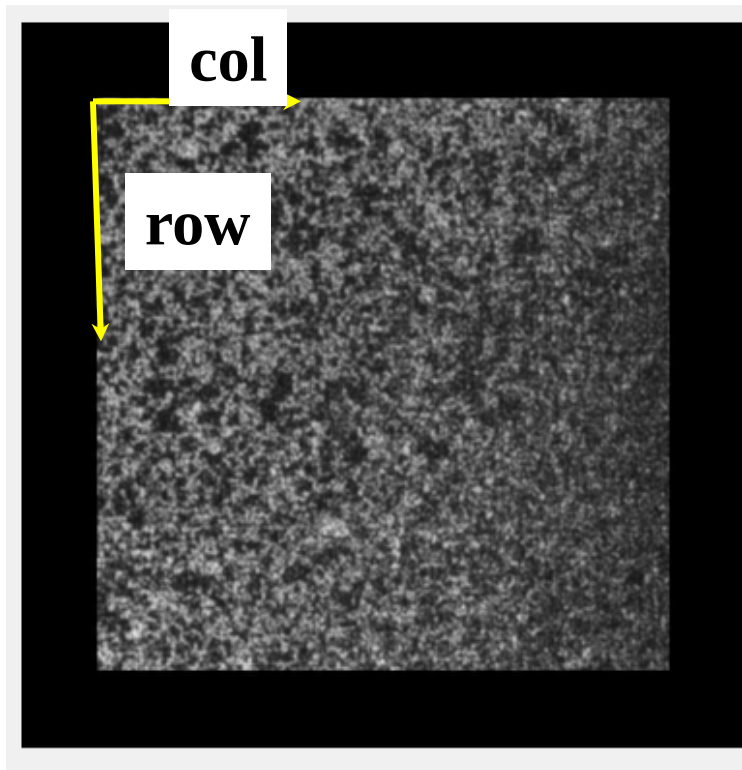
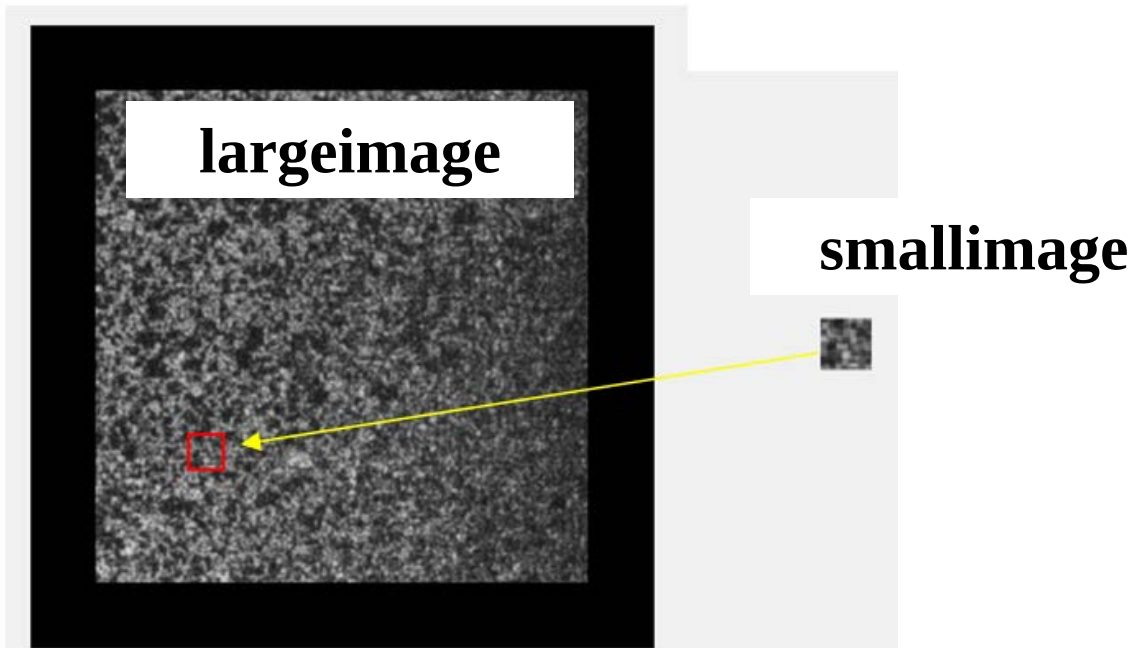


Image correlation

- Search for the center of a sub image in a reference image

```
c = normxcorr2(smallimage, largeimage);  
[vpeak, hpeak] = find(c==max(c(:)));
```

Coords of center of subimage in refimage



Finding displacements

Ref image

Crop a small piece

Find the piece
in the def image
with `normxcorr2`

Def image

Optional – speed up code by cropping a sub-image expected to contain the reference region from deformed image before correlation

```
%% Improve the displacement resolution using cpcorr  
adjustedpoints = cpcorr(defpoints, refpoints, cur, ref);
```

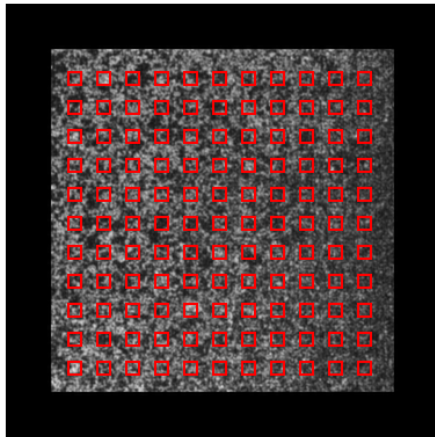
Point(s) in deformed image

Point(s) in ref image

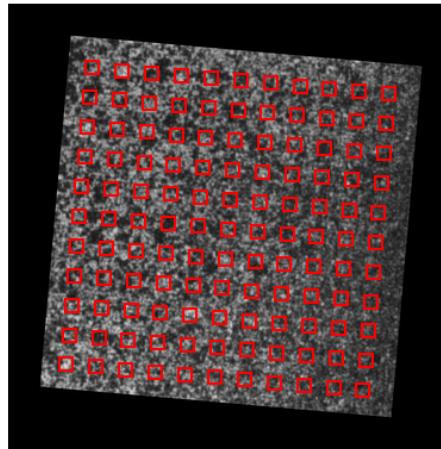
Full images

Displacement grid

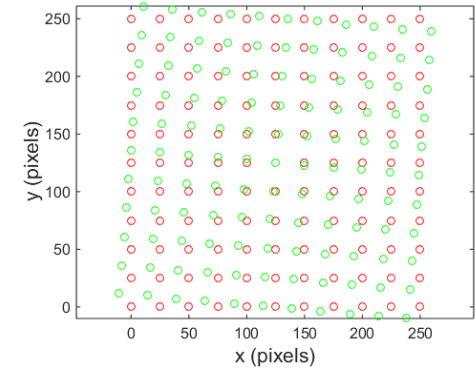
Sub-regions in reference image



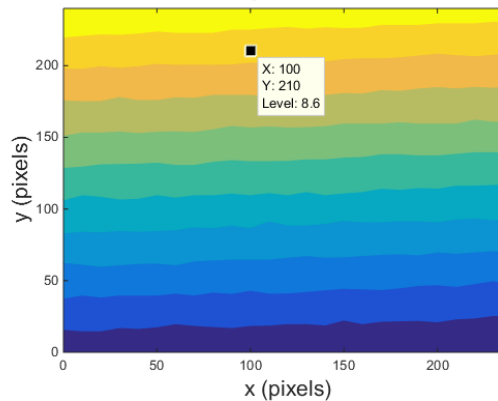
Sub-regions in deformed image



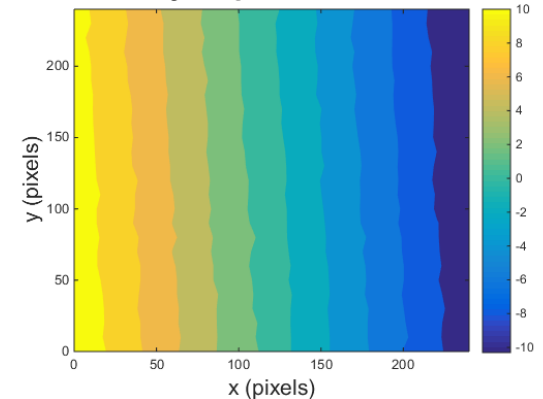
Grid displacement



x displacement



y displacement



Matlab can differentiate data on a regular grid

```
[uxx, uxy] = gradient(hdisp, hspacing, vspacing);
```

More advanced code (for experienced programmers)

Handle displacements on an unstructured grid

- Calculate displacements at randomly placed points
- Discard points outside solid of interest (check for black)
- Triangulate mesh
- (Smooth displacements – eg Laplace smoothing)
- Use FE interpolation functions to compute gradients.

