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)
Reading and displaying MATLAB images

- Data stored in mat files (ref and current)
  ```matlab
  load('rotation_data.mat')
  imshow(ref);
  imshow(cur);
  ```

- Data stored in ‘tif’ files
  ```matlab
  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

\[
\text{cur(subimage)} = \text{cur(vlo:vhi,hlo:hh)};
\]
Image correlation

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

```matlab
% Code snippet for finding the center of a sub image

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

Coords of center of subimage in refimage
Finding displacements

Crop a small piece

Find the piece in the def image with normxcorr2

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

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

Point(s) in deformed image

Point(s) in ref image

Full images
Matlab can differentiate data on a regular grid

\[ [\text{uxx}, \text{uxy}] = \text{gradient} (\text{hdisp}, \text{hspacing}, \text{vspacing}); \]
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.