Digital Image Correlation

**Principle of DIC**
- DIC measurement is based on tracking a group of pixels (called subsets) in the deformed and reference image through temporal matching and correlation functions.
- Install digital image is divided into smaller regions called subsets.
- Subset shape functions are imposed to the reference subset to account for the deformed shape of the subset in the deformed image.
- The deformed position of the subset may not be at the integer location. Therefore, interpolation functions are used to obtain the gray intensity value at non-integer location.
- Correlation function (C) is defined to match the similarity between the subset in the undeformed and deformed image.
- The unknown parameters $\Delta x, \Delta y$ are determined by minimizing the correlation function using Newton-Raphson method.

**Parameters affecting DIC measurement**

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**3D DIC**
- Steps involved in obtaining 3D displacement data using 3D DIC are:
  - The process starts with camera parameter calibration to identify the relative position and orientation of cameras in the stereo rig.
  - Two or more cameras are positioned to view same object area and images are captured simultaneously by all cameras.
  - 2D image correlation is performed to identify matching regions in different views.
  - Mapping function generally projective to account for perspective distortion.
  - Thereby, 3D displacement vector $(\mathbf{u}, \mathbf{v}, \mathbf{w})$ is obtained for all points.

**DIC Terminologies**
- DIC is a subset based image correlation technique. Subset is a collection of group of pixels carrying a unique gray value information for deformation measurement.
- The distance between the subset centers are called step size.

**Experimental setup for DIC**
- DIC does not require laser source. A white light source can be used for illumination during the measurement.
- Developments in HD analog and digital high-speed cameras provide pictures at 104 to 106 fps, which suits dynamic DIC analysis.
- Artificially introduced speckles act as information carriers. Also known as "White light speckle correlation".
- Random texture can be created by spraying B/W paint.

**Applications to solid mechanics problem**

- **Cantilever Beam with an in-plane load**
  - Material: Polyurethane
  - $E = 3300 \text{ N/mm}^2$
  - Plane stress quad elem.
  - CPS4 : 4-node bilinear

**Application to practical problems**

- **Spanner tightening nut**
- **Applications to fracture mechanics problem**
  - **C groove specimen**

**References**