**Objective**
- Bring hand-held mmWave imaging which gives human perceptible 2D shapes, 3D orientation for objects, even in out of line-of-sight.

**Challenge 1 – Imaging Issues**
- Samples from manual scanning do not fall under uniform, ideal grid points.
- There is localized sparsity due to non-uniform scanning.

**Challenge 2 – Specularity of Object**
- Specular reflectivity due to improper orientation of object w.r.t scan plane.
- Specularity only allows for a partial human imperceptible shape reconstruction.

**Reconstruction using Machine Learning**
- Recovering human perceptible 2D shapes using cGAN.
  - Conditional Generative Adversarial Networks (cGAN) uses Generator and Discriminator with Custom Loss Function to train Generator.
  - Post Training, Generator takes 3D mmWave heatmap and generates 2D shape.
- 3D Features with Quantifier.
  - Quantifier uses 2D shape to compute Depth and Orientation.
  - Orientation includes Rotation, Azimuth, and Elevation angles.

**Motion Error Correction & Sparse Sample Recovery**
- **Motion Error Correction**
  - The back-scattered samples are deviated away from the linear grid. A phase correction factor:  
    \[ \Phi = \exp(jk2(d_u - d_s)) \]
  - is multiplied to the deviated samples to estimate the equivalent samples on the closest point in the linear grid.
- **Sparse Sample Recovery**
  - The localized sparsity in measurements does not allow all samples to be estimated from motion error correction. A Compressed Sensing (CS) algorithm is exploited to estimate the missing samples.

**Preliminary Results and Conclusion**
- **2D Shape Reconstruction**
  - Rough silhouette from motion error correction and sparse recovery.
  - 3D mmWave test samples were fed to Generator, to get 2D shapes.
  - More than 90% similarity score to ground-truth shapes.

**Conclusion and Future Works**
- ZigZagCam brings imaging functionality to mmWave enabled mobile devices.
- Machine Learning allows precise reconstruction of 2D shape and 3D features.