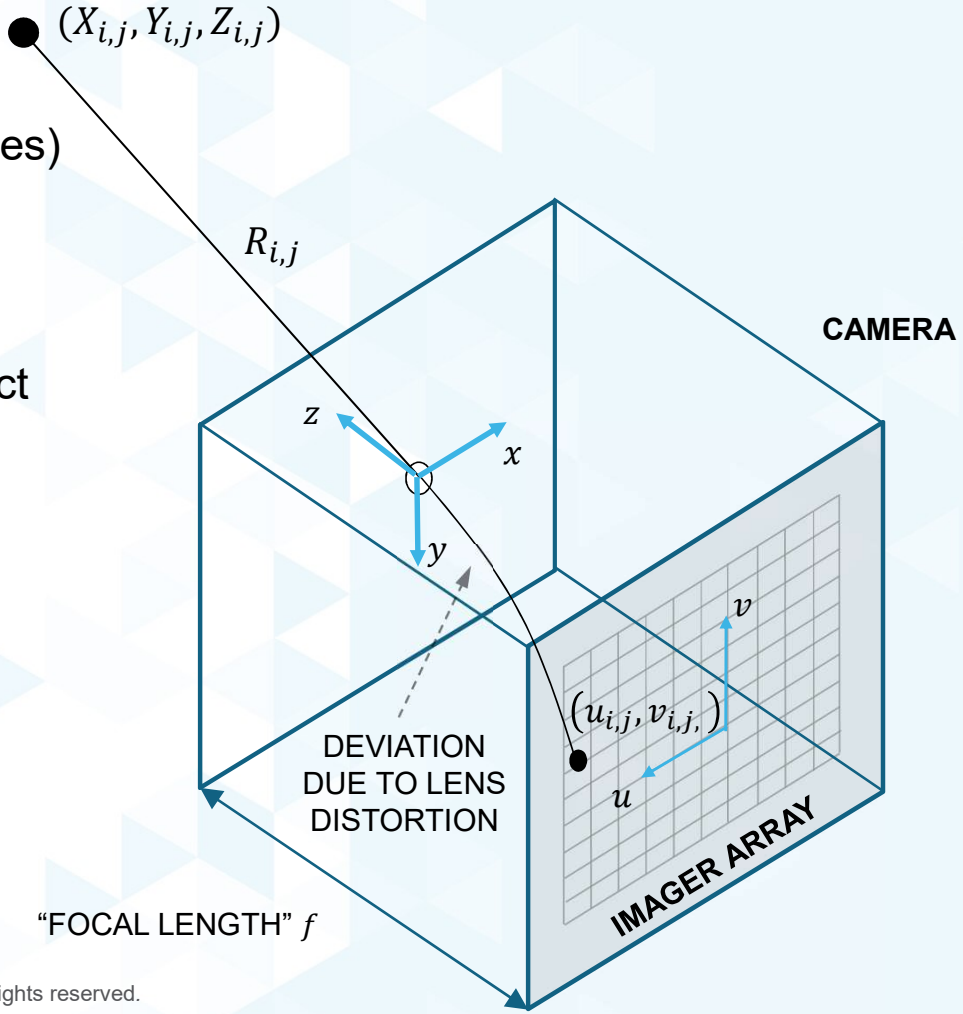
ADI ToF Depth Characterization

AHEAD OF WHAT'S POSSIBLE™

Definitions

- $(u_{i,j}, v_{i,j})$ – position of pixel (i,j) (image coordinates)
- $(X_{i,j}, Y_{i,j}, Z_{i,j})$ – position of object point mapping to pixel (i,j) (world coordinates)
- $R_{i,j} = \sqrt{X_{i,j}^2 + Y_{i,j}^2 + Z_{i,j}^2}$ – "**radial distance**" of object point mapping to pixel (i,j)

- "**Depth map**" – image containing all $Z_{i,j}$
- "**Radial distance map**" – image containing all $R_{i,j}$
- "**Point Cloud**" – list of all $(X_{i,j}, Y_{i,j}, Z_{i,j})$



Metrics

- **Depth temporal mean**
  Average of measured $Z_{i,j}$ (noted $\hat{Z}_{i,j}$) over N frames (n is frame index)

$$\bar{Z}_{i,j} = \frac{1}{N}\sum_{n=0}^{N-1} \hat{Z}_{i,j}[n]$$

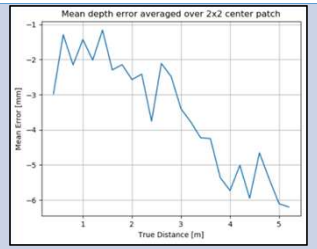
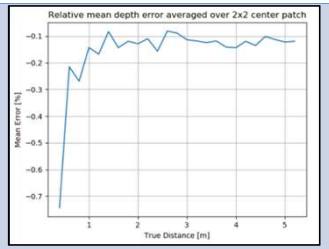
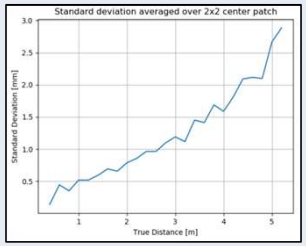
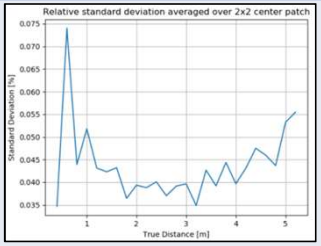
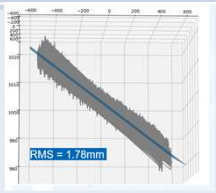
- **Depth temporal standard deviation ("depth noise")**
  Standard deviation of $\hat{Z}_{i,j}$ over N frames

$$\sigma_{Z_{i,j}} = \sqrt{\frac{1}{N-1}\sum_{n=0}^{N-1}\left(\hat{Z}_{i,j}[n] - \bar{Z}_{i,j}\right)^2}$$

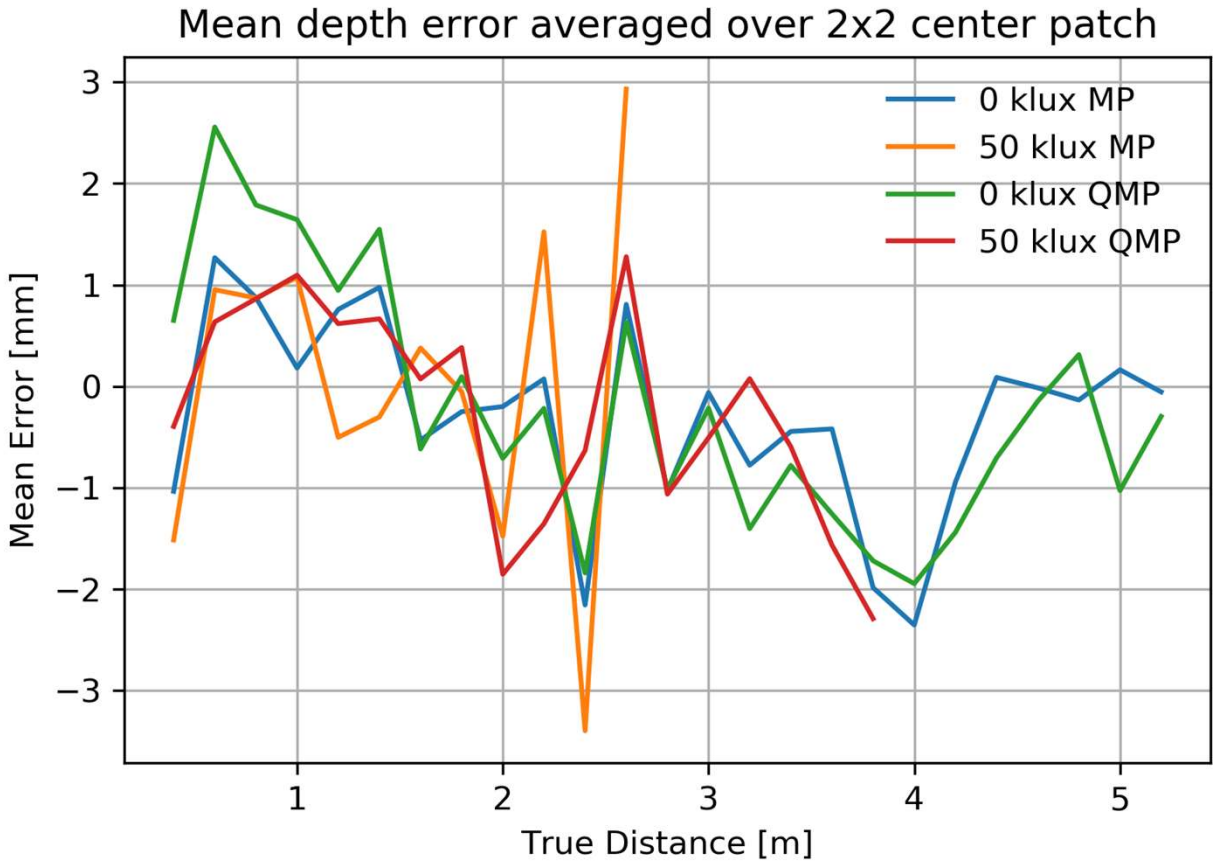
- **Mean depth error (accuracy)**
  Average of difference between true depth and measured depth

$$\epsilon_{i,j} = \bar{Z}_{i,j} - Z_{i,j}$$

Characterizations Performed at ADI

Parameter	Across	Conditions	Graph Example
Accuracy Error between true distance and average measured distance	Distance	- 100 frames - ambient light: 0 to ~10W/m^2 (940nm) - different reflectivity targets	 
Depth noise Standard deviation per pixel over time	Distance	- 100 frames - ambient light: 0 to ~10W/m^2 (940nm) - different reflectivity targets	 
Point Cloud quality	True distance	XYZ data Processing at the set distances	
Point Cloud flatness (RANSAC Plane Fitting Method)	XYZ Pixels	20 Frames, one distance, one reflectivity	

Depth accuracy (100-frame **temporal** average error)



Depth accuracy (100-frame **temporal** standard deviation)