Getting Started with 3D Time-of-Flight Sensing

Session 3

Understanding the system trade-offs

What's In the Video Series

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Depth Sensing Quality

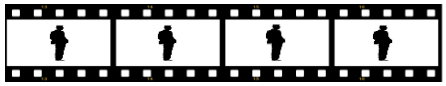
$$\sigma = \frac{c}{4\sqrt{2}\pi f} \cdot \frac{\sqrt{B + A}}{c_d A}$$

σ	Depth variance	↓
A	Amplitude	↑
B	Offset	↓
c	Speed of Light	
f	Modulation Frequency	↑
c_d	Modulation Contrast	↑

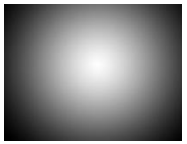
Directions of increasing accuracy

Payne et. al, “Multiple Frequency Range Imaging to Remove Measurement Ambiguity”

Amplitude Tradeoffs



Frame Rate



FOV

Medium

Optics

Vm

Distance

$I = 1/d^2$

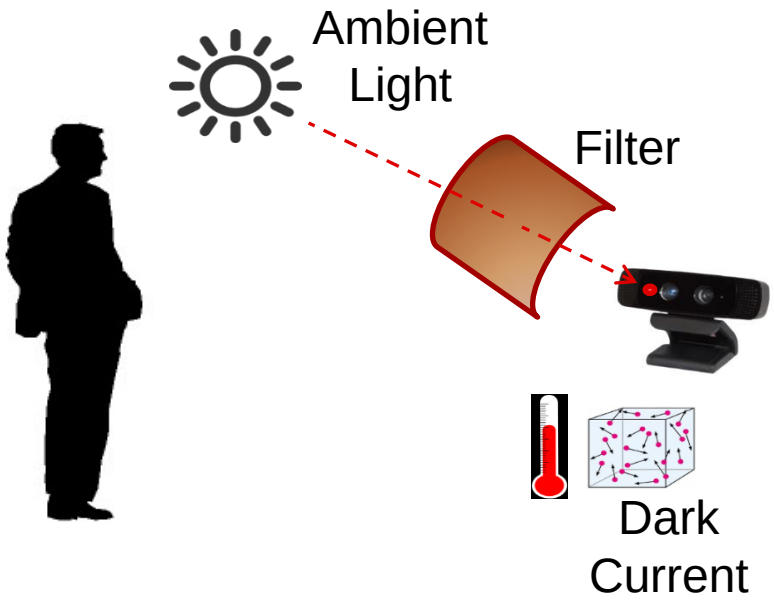
Reflectivity

Power

σ	Depth variance	
A	**Amplitude**	
B	Offset	
c	Speed of Light	
f	Modulation Frequency	
c_d	Modulation Contrast	

Directions of increasing accuracy

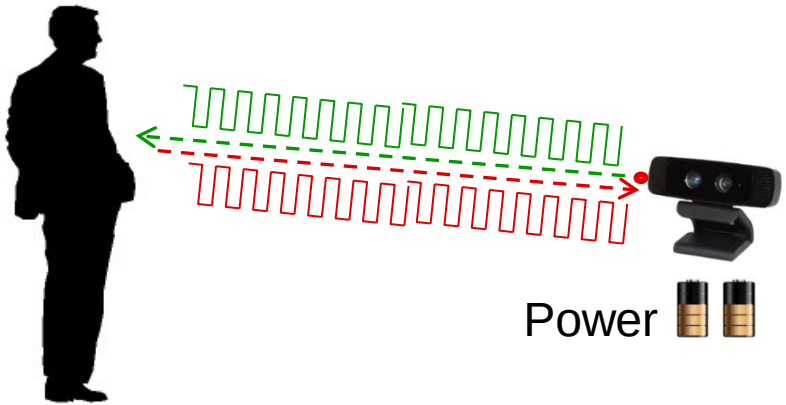
Offset Tradeoffs



σ	Depth variance	
A	Amplitude	
B	**Offset**	
c	Speed of Light	
f	Modulation Frequency	
c_d	Modulatio Contrast	

Directions of increasing accuracy

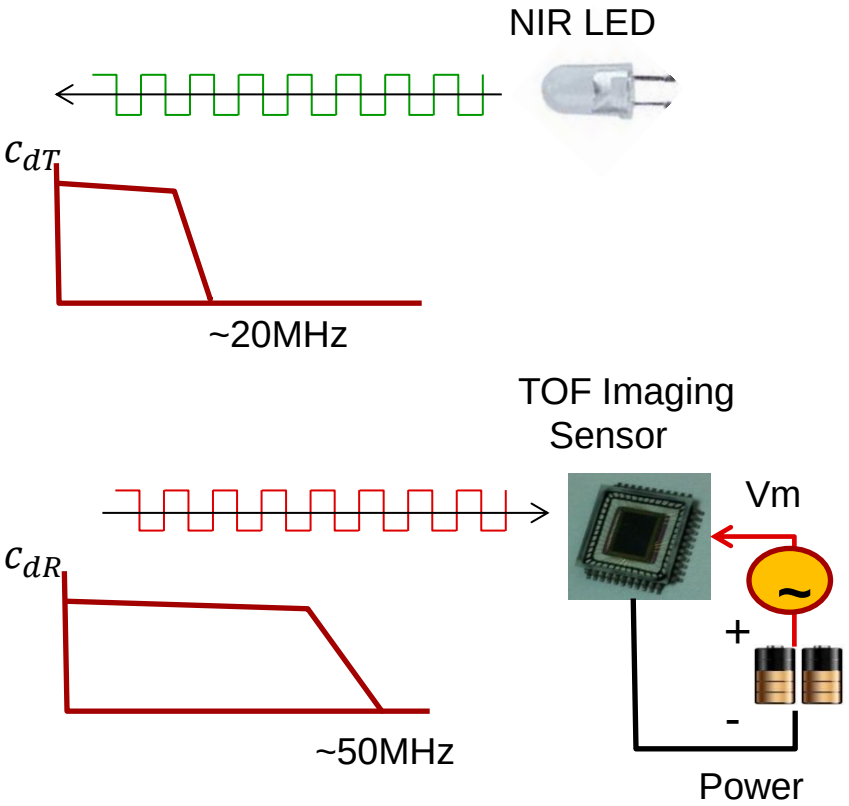
Modulation Frequency Tradeoffs



σ	Depth variance	
A	Amplitude	
B	Offset	
c	Speed of Light	
f	**Modulation Frequency**	
c_d	Modulation Contrast	

Directions of increasing accuracy

Modulation Contrast Tradeoffs



σ	Depth variance	↓
A	Amplitude	↑
B	Offset	↓
c	Speed of Light	
f	Modulation Frequency	↑
c_d	Modulation Contrast	↑

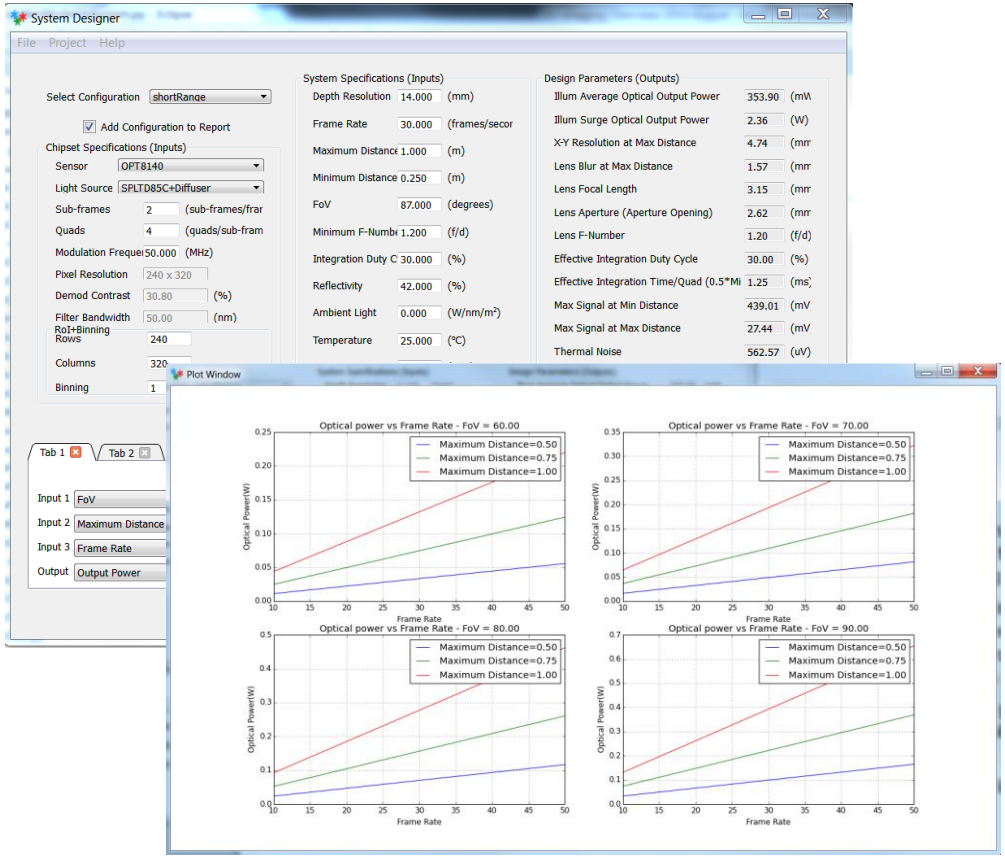
Directions of increasing accuracy

Depth Sensing Quality (more detail)

$$\delta D = \frac{c}{2 \times f_m} \times \sqrt{\frac{\frac{1}{q} \times (P_A + P_{BGL}) \times A_{pix} \times t_{int} + n_{system}^2}{QE \times k_{opt} \times C_{mod}^2 \times \frac{1}{q^2} \times P_A^2 \times A_{pix}^2 \times t_{int}^2}} \times f(\phi)$$

δD	Depth accuracy
P_A	Back-scattered signal power (reflection)
P_{BGL}	Background signal power (ambient)
A_{pix}	Pixel area
t_{int}	Integration time
C_{mod}	Modulation contrast
k_{opt}	Optical constant
n_{system}	Systematic noise

System designer tool



- Complete system modeling from illumination to sensor to depth processing
- Provides insight into accuracy, illumination power and other tradeoffs; enables exploring what-if scenarios
- Outputs detailed graphs and reports for multiple configurations
- Available as a Windows application
- Download from

http://www.ti.com/product/OPT8241/toolssoftwa

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What's Next?

- Contact your local TI Sales Representatives or Distributors
- E-Mail support@ti.com for any questions.
- Visit http://www.ti.com/3dtof for more information.
- Check out http://e2e.ti.com/support/sensor/optical_sensors/
- Check out http://github.com/3dtof