ADVANCED MATERIAL HANDLING WITH

New Sony DepthSense™ ToF Technology

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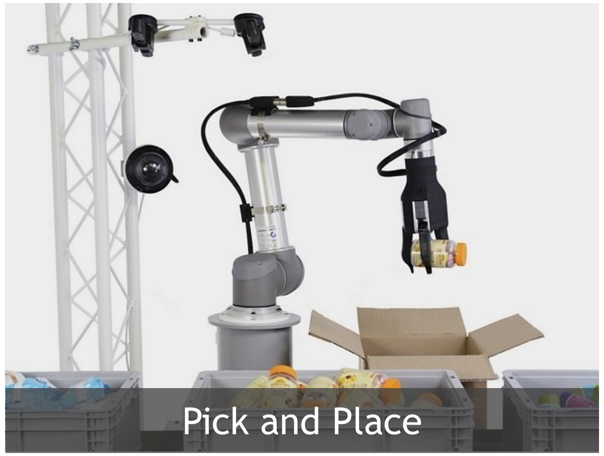
Product Marketing
November 7, 2018

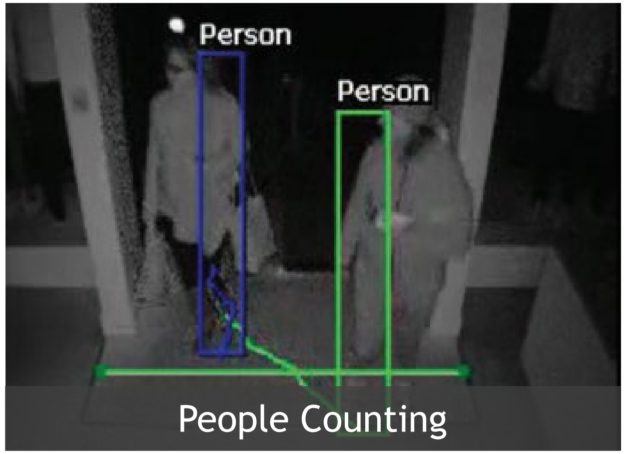
LUCID VISION LABS

3D SENSING APPLICATIONS


Pick and Place


Drones


Collision Detection

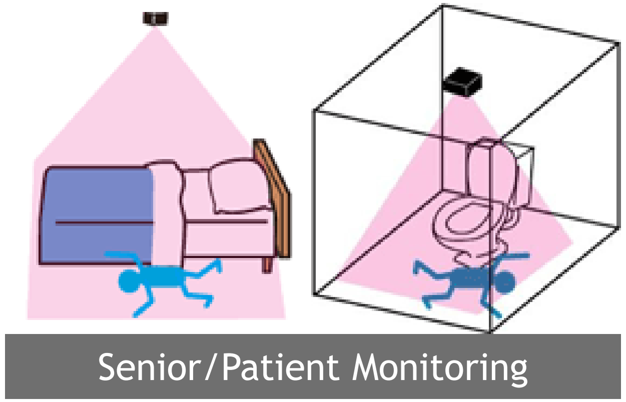


People Counting


Palletizing/de-palletizing

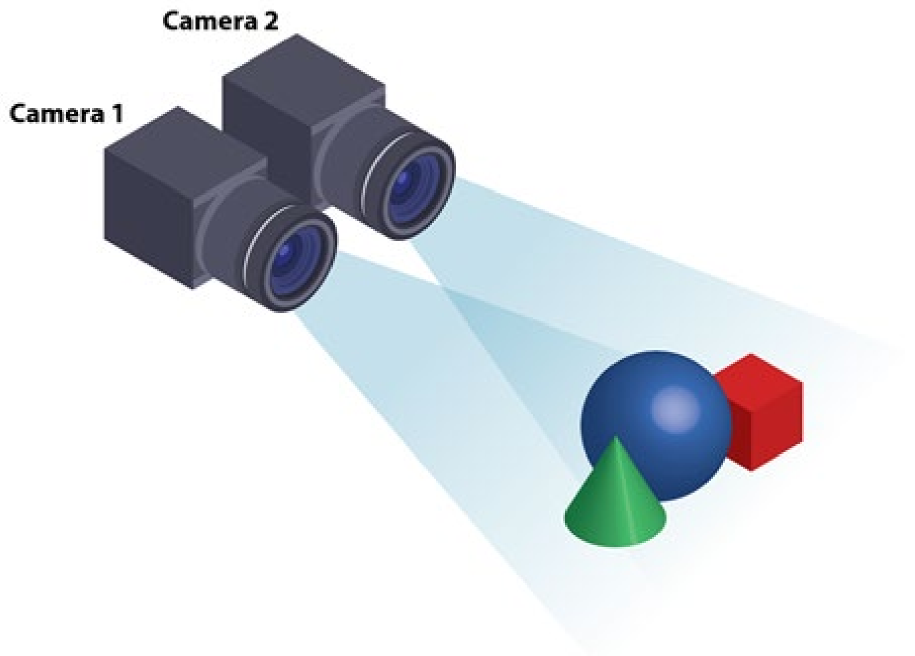
Warehouse Robot


Metrology


Senior/Patient Monitoring

3D SENSING TECHNIQUES

STEREO VISION
• Extracts depth information by matching the same point in two images • Can use a pattern projector to add texture • Suffers from occlusion – object seen by one camera but not the other

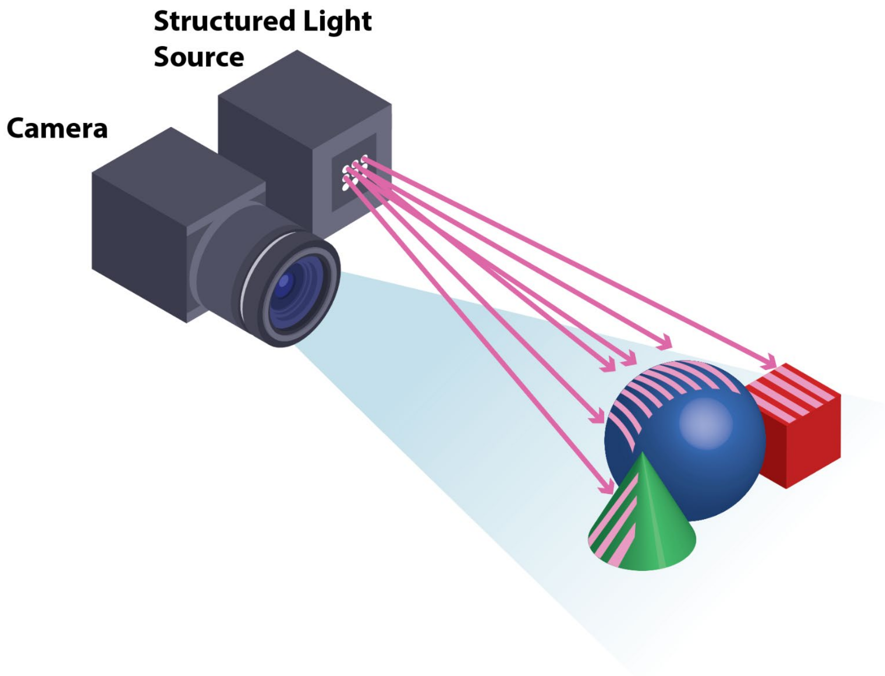


Example: Intel® RealSense™ D415

3D SENSING TECHNIQUES

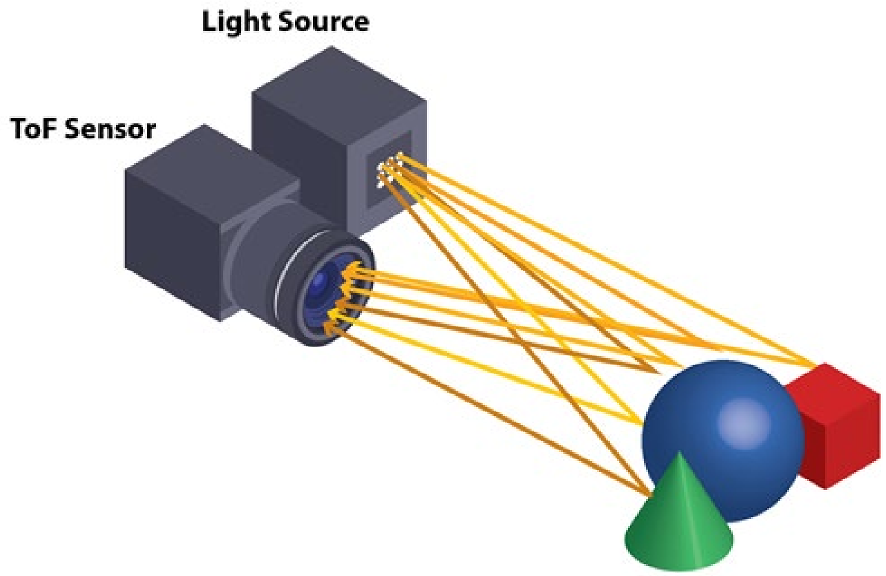
STRUCTURED LIGHT

- Projects a light pattern on the object. Uses the pattern distortion on the object to reconstruct the object shape
- Light source can be laser, IR or visible light
- Higher quality measurement but requires calibration and resolution limited by light source



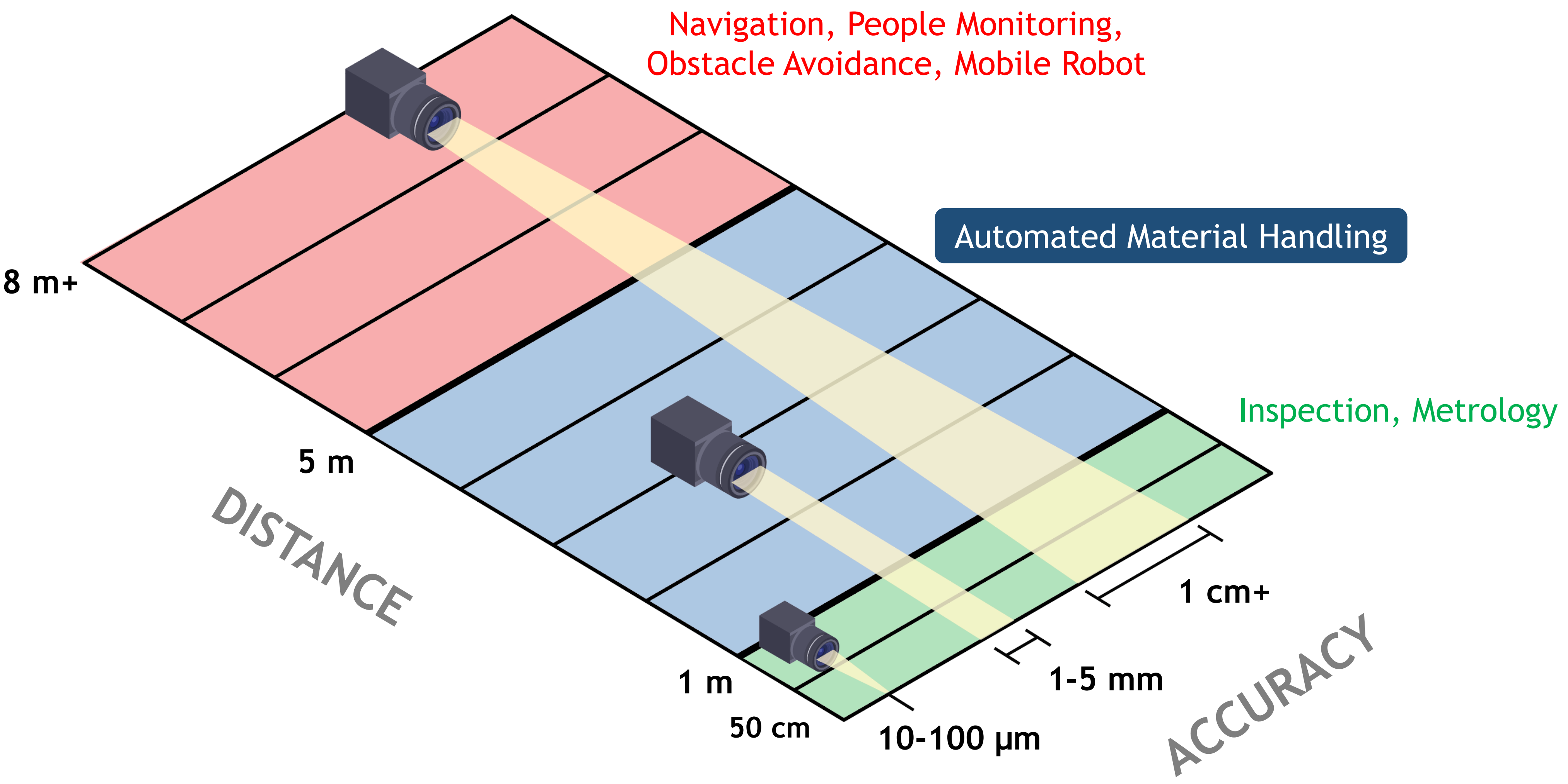
3D SENSING TECHNIQUES

TIME OF FLIGHT
• Measures time it takes for the emitted light to be reflected. Two techniques, one measure time directly, one measures phase difference of the emitted and received signal. • Light source can be laser, IR or visible light • Multipath - emitted light is reflected from more than one path • Less expensive and no in field calibration required



Example: Microsoft Kinect 2

MARKET SEGMENT BY APPLICATION



AUTOMATED MATERIALS HANDLING

Challenges with existing solutions in automated materials handling

- Sensitive to ambient light
- Challenges with certain packaging
- High precision systems are expensive
- Some systems require in-field calibration required
- High CPU resources needed for depth processing

Sensitivity to sunlight from window or factory doors open/closing

Challenges with capturing depth data for packaging that are shiny, reflective or clear

CURRENT SOLUTIONS FOR MATERIAL HANDLING

	STEREO VISION (PASSIVE)	STRUCTURED LIGHT	TIME-OF-FLIGHT
Working Distance	Limited by baseline	Limited by baseline	Scalable with light source
Depth Accuracy	Low	High	Medium
Depth Map Resolution	Limited by texture of scene	Limited by light pattern	Full resolution
In-field Calibration Needed	Sometimes	Sometimes	No
Size	Increase with working distance	Increase with working distance	Compact
Cost	Low	High	Medium

SONY DEPTHSENSE

SONY → Acquire in 2015 → SoftKinetic

- Sony has combined SoftKinetic's ToF technology with its own backside-illuminated technology to create the IMX556
- Sony's backside-illuminated technology has better light collection efficiency in NIR compared to front-illuminated sensors
- Phase detection speed is improved, enabling higher modulation frequency

Sony DepthSense IMX556PLR CMOS	
Sensor Size	8mm diagonal (1/2 type)
Resolution	640 (H) x 480 (V), VGA
Pixel Size	10 um (H) x 10 um (V)
Framerate	60fps @ full resolution

VALUE PROPOSITION

HIGH RESOLUTION & HIGH SPEED

640 x 480 @ 60 fps, higher resolution than most ToF cameras

INCREASED PRECISION

Standard deviation σ < 2.5mm at 1m distance

BETTER PERFORMANCE WITHOUT PAYING MORE

Lower cost compared to 3D cameras with similar performance

Helios ToF 3D Camera Prototype
55mm x 55mm x 76mm

LUCID HELIOS TOF 3D CAMERA

PRELIMINARY DATA

Features	
Working Range	Three operating modes 1. Less than 1.5m with 100MHz modulation frequency 2. Less than 3m with 50MHz modulation frequency 3. Less than 6m with 25MHz modulation frequency
Accuracy	< 5mm from 0.3m to 1.5m in Mode 1 (preliminary)
Precision	Sigma < 2.5mm at 1m in Mode 1 (preliminary)
Lens Field of View	65° x 46° (nominal)
Illumination	4 x VCSEL laser diodes @ 850nm
Digital Interface	1 Gigabit Ethernet with M12 connector IEC 61076-2-109
GPIO Interface	8-pin M8 connector IEC 61076-2-104
I/O ports	1 input, 1 output, 2 bidirectional
Dimension	55 x 55 x 76mm
Lens Mount	Integrated S-mount lens
Operating Temperature	-10⁰ to 50⁰ C
Weight	280g
Power Consumption	TBD
Conformity	CE, RoHS, FCC, WEEE, Eye safety IEC 60825-1:2014

Features	
Compliance	GigE Vision 2.0, GenICam 3D
Exposure Control	Manual, Auto, External Trigger Signal
Synchronization	via PTP
User Sets	1 Default, 2 Custom
Output Formats	3D Point Cloud, Intensity and Confidence
OS Support	Windows and Linux
Software Support	Arena SDK, C++, C and C#

GIGE VISION AND GENICAM 3D SUPPORT

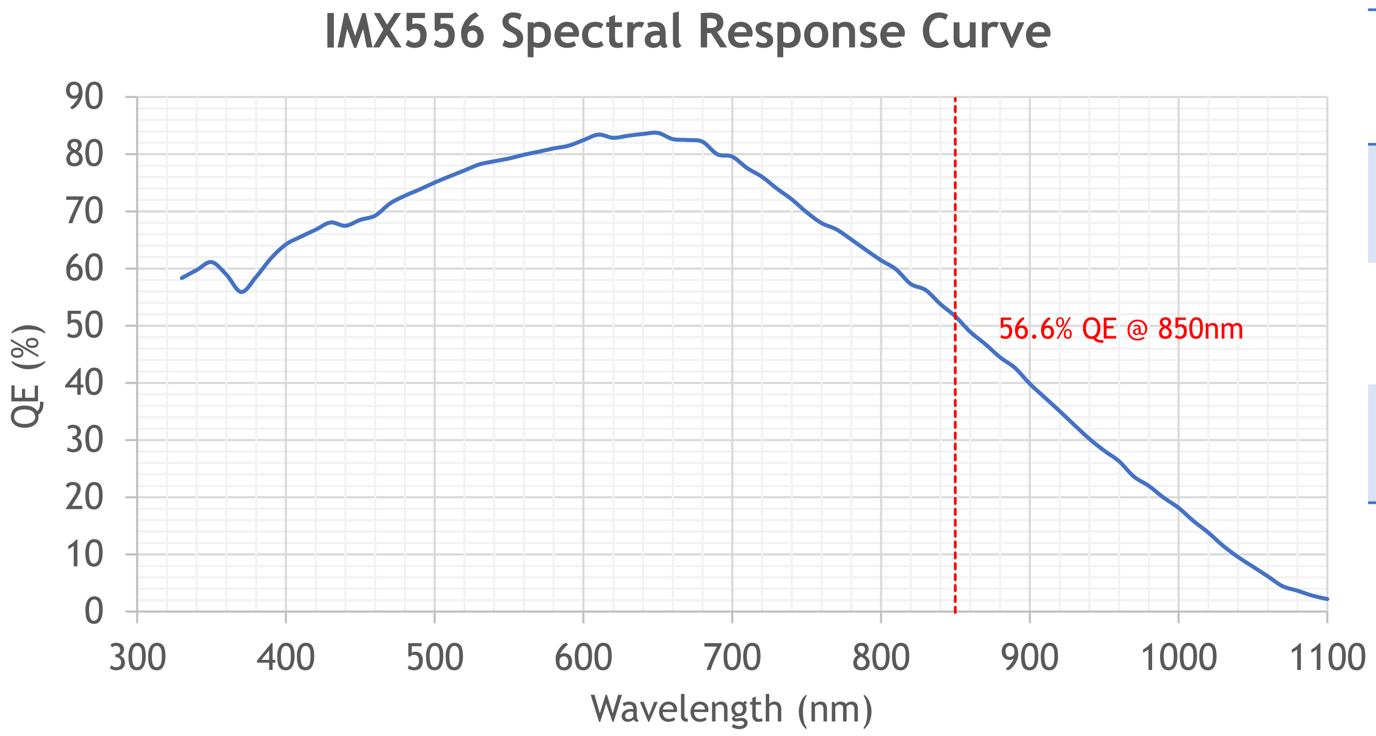
Pixel Format	Description
Coord3D_ABC	Coordinate of the 3D image data with C being the depth data
Coord3D_A	Coordinate of the 3D image data with coordinate A only
Coord3D_B	Coordinate of the 3D image data with coordinate B only
Coord3D_C	Coordinate of the 3D image data with coordinate C only
Confidence	Confidence of the pixel value
RGB8	False color for depth visualization (red=closest, blue=furthest)

Arena SDK

- Camera control and image acquisition
- Data visualization such as point cloud, depth map, confidence map

EMVA DATA

PRELIMINARY DATA

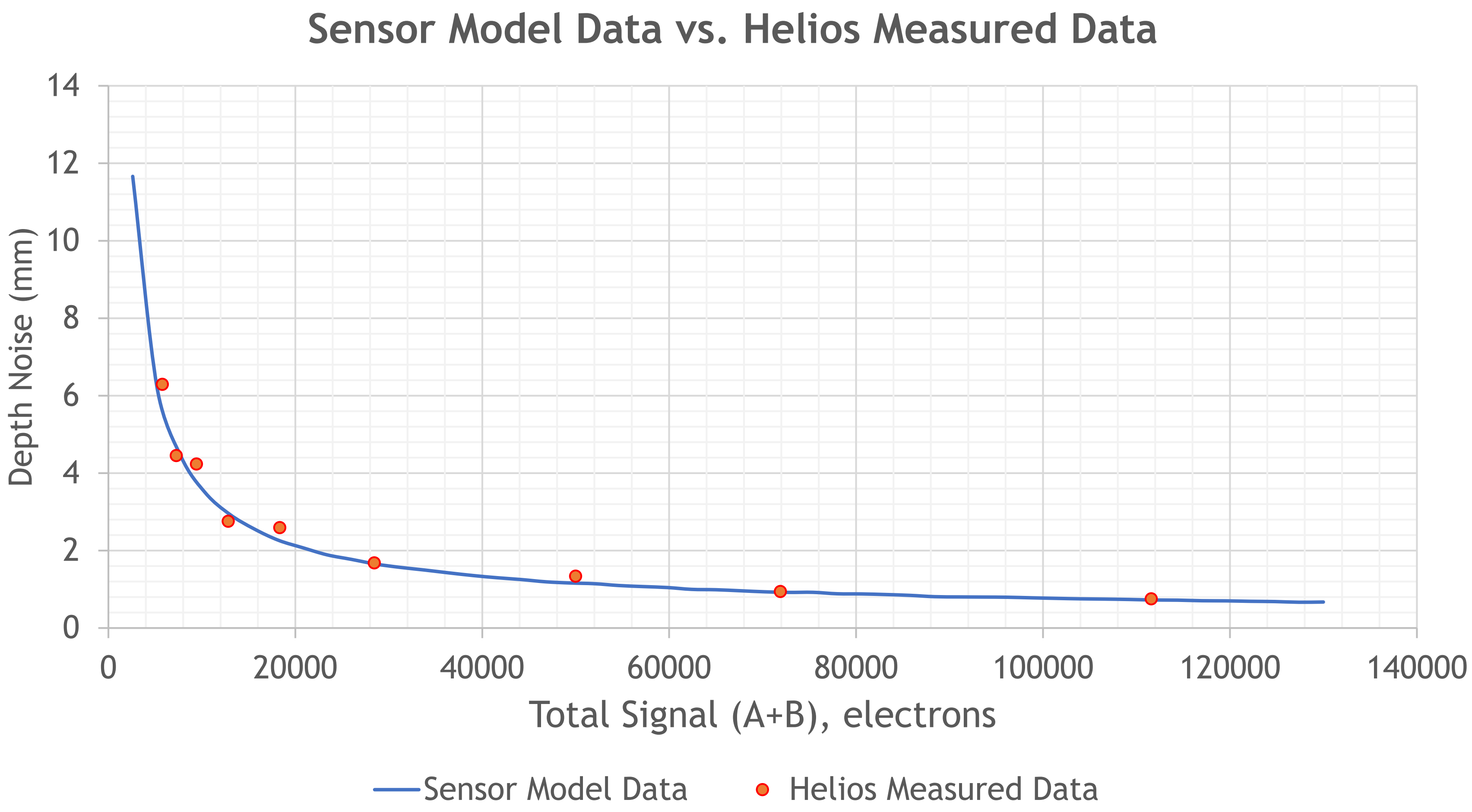


	A+B Mode	A	B
Saturation Capacity	271508 e-	134718e-	138638 e-
Temporal Dark Noise (Read Noise)	117.3 e-	81.5 e-	83.0 e-
Dynamic Range	67.05 dB	63.9 dB	64.0 dB

MODEL RESULTS

PRELIMINARY DATA

Simulated conditions:
- 80% modulation contrast
- 82 e- read noise
- 10 bit quantization



TEMPORAL PRECISION

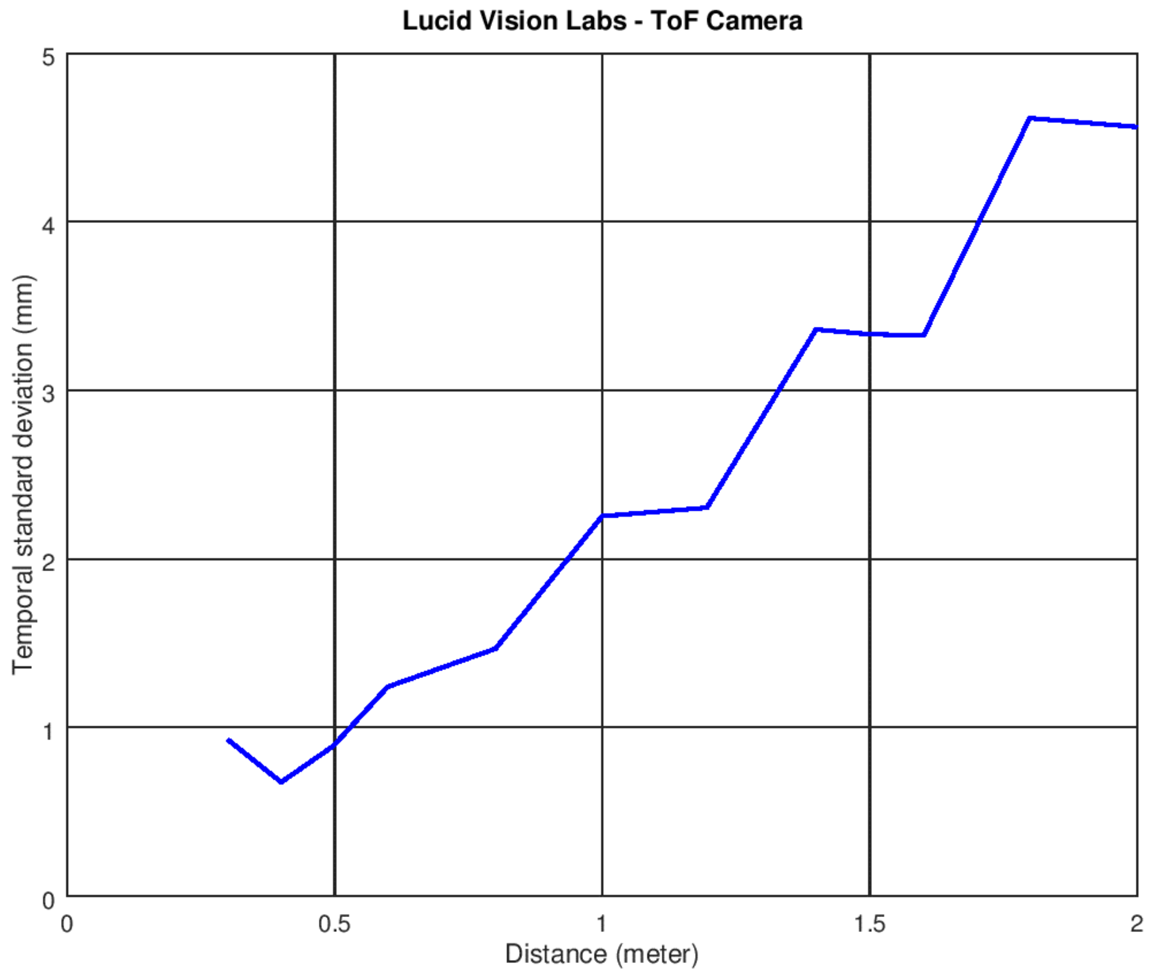
PRELIMINARY DATA

Test Conditions

- 4 lasers, at 1W optical power each
- Room light off
- Exposure time = 1000 us for all tested distances except for 30 cm
- 11x11 pixels in image center
- Standard deviation over 100 images

Results

- σ = 2.25 mm at 1 meter
- σ = 4.56 mm at 2 meters



SPATIAL PRECISION

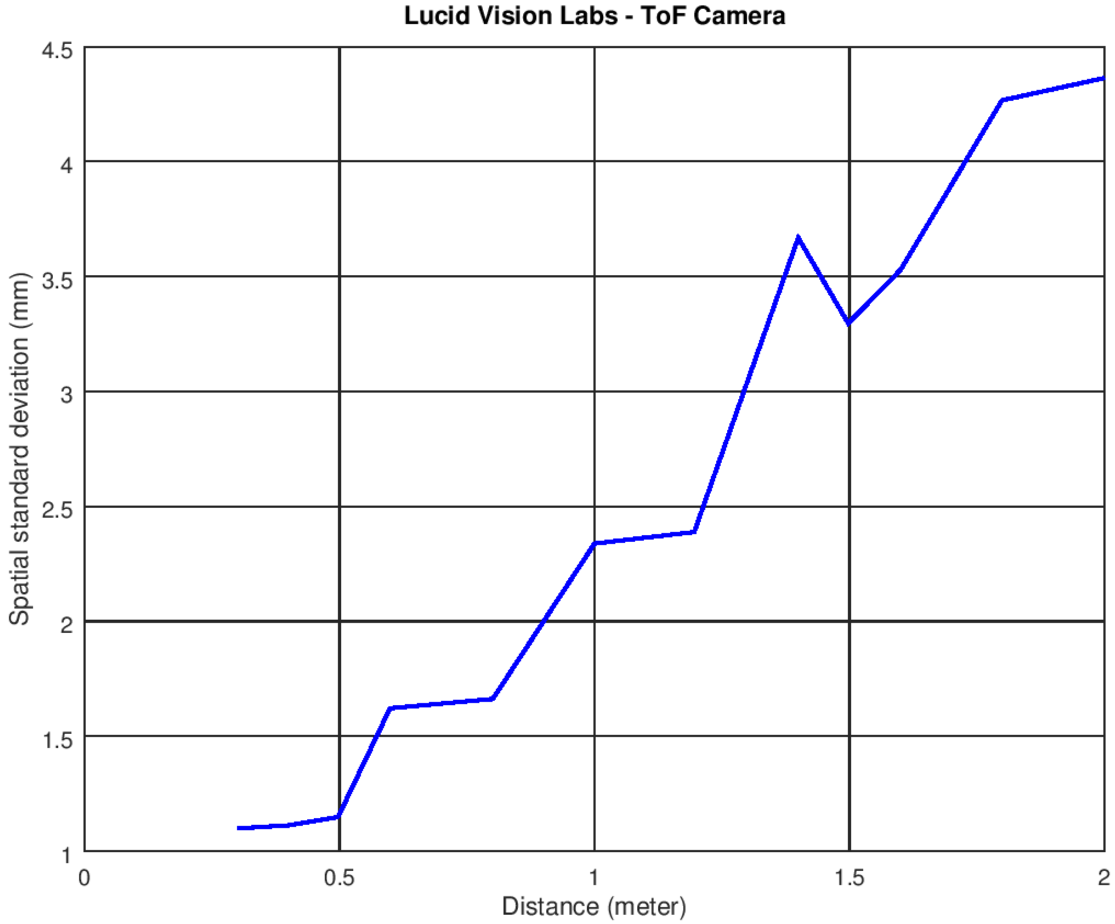
PRELIMINARY DATA

Test Conditions

- Same conditions as previous
- Standard deviation over 11x11 pixels in image center

Results

- σ = 2.34 mm at 1 meter
- σ = 4.36 mm at 2 meters

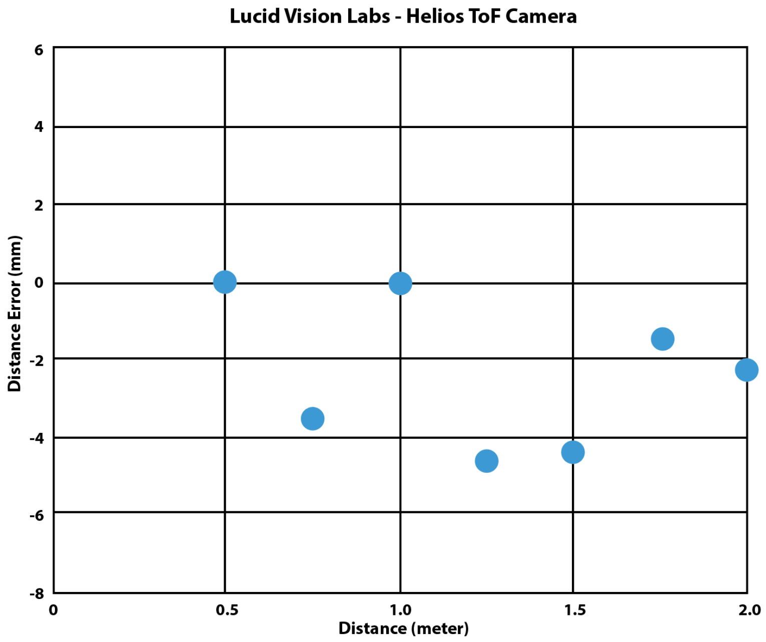


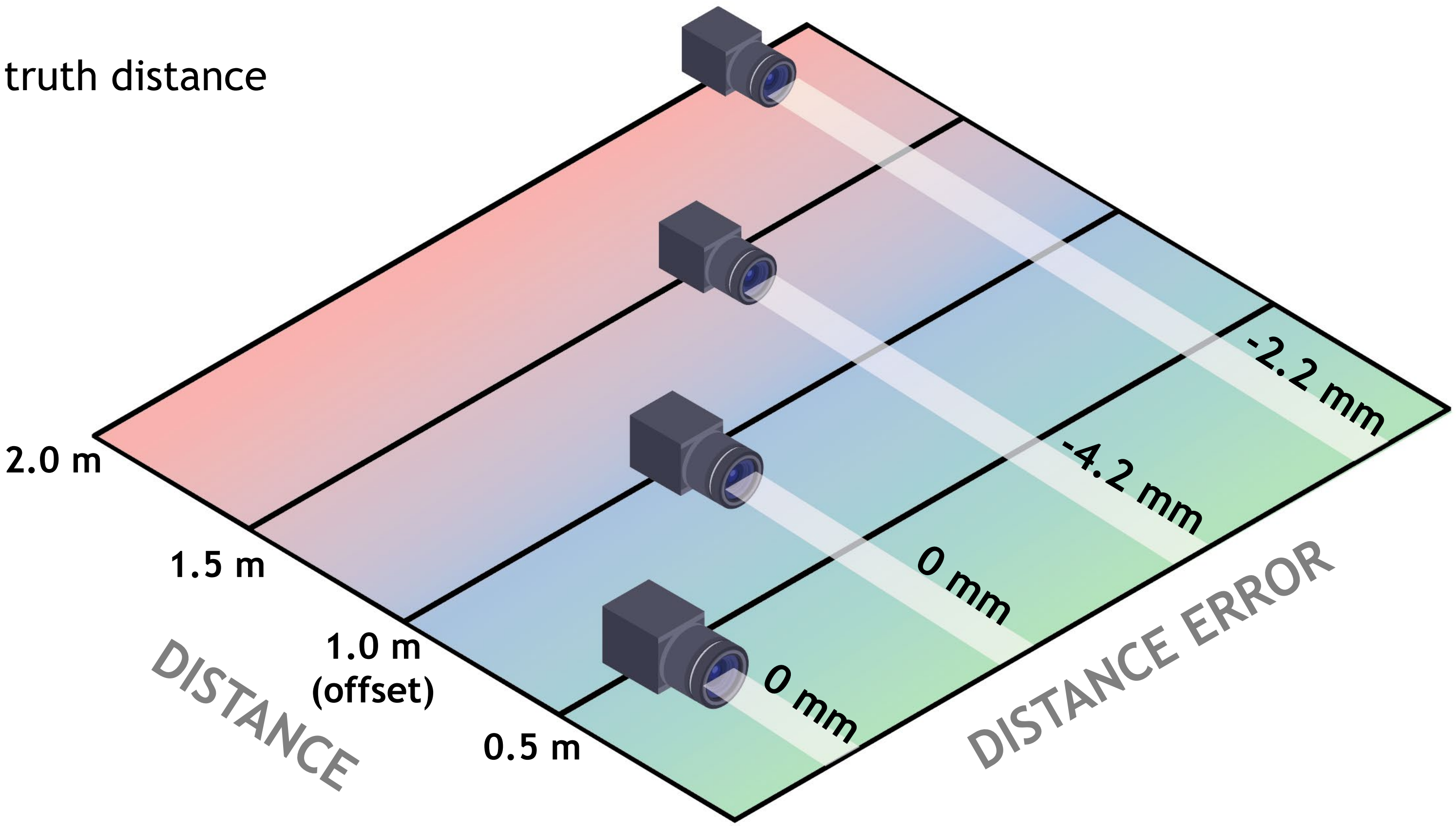
ACCURACY

PRELIMINARY DATA

Test Conditions

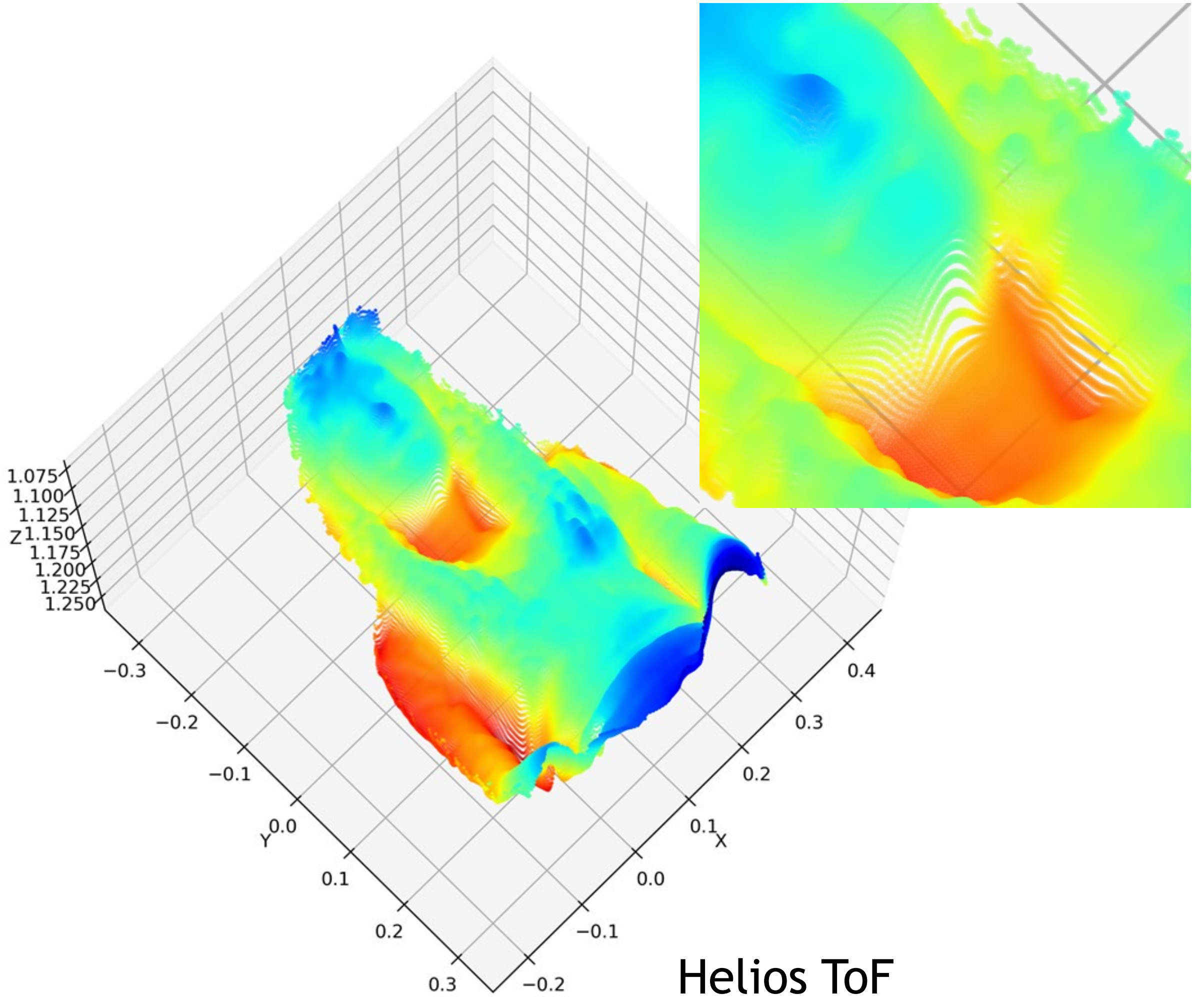
- Same conditions as previous
- Difference between measured and ground-truth distance
- Offset adjusted for 1 meter



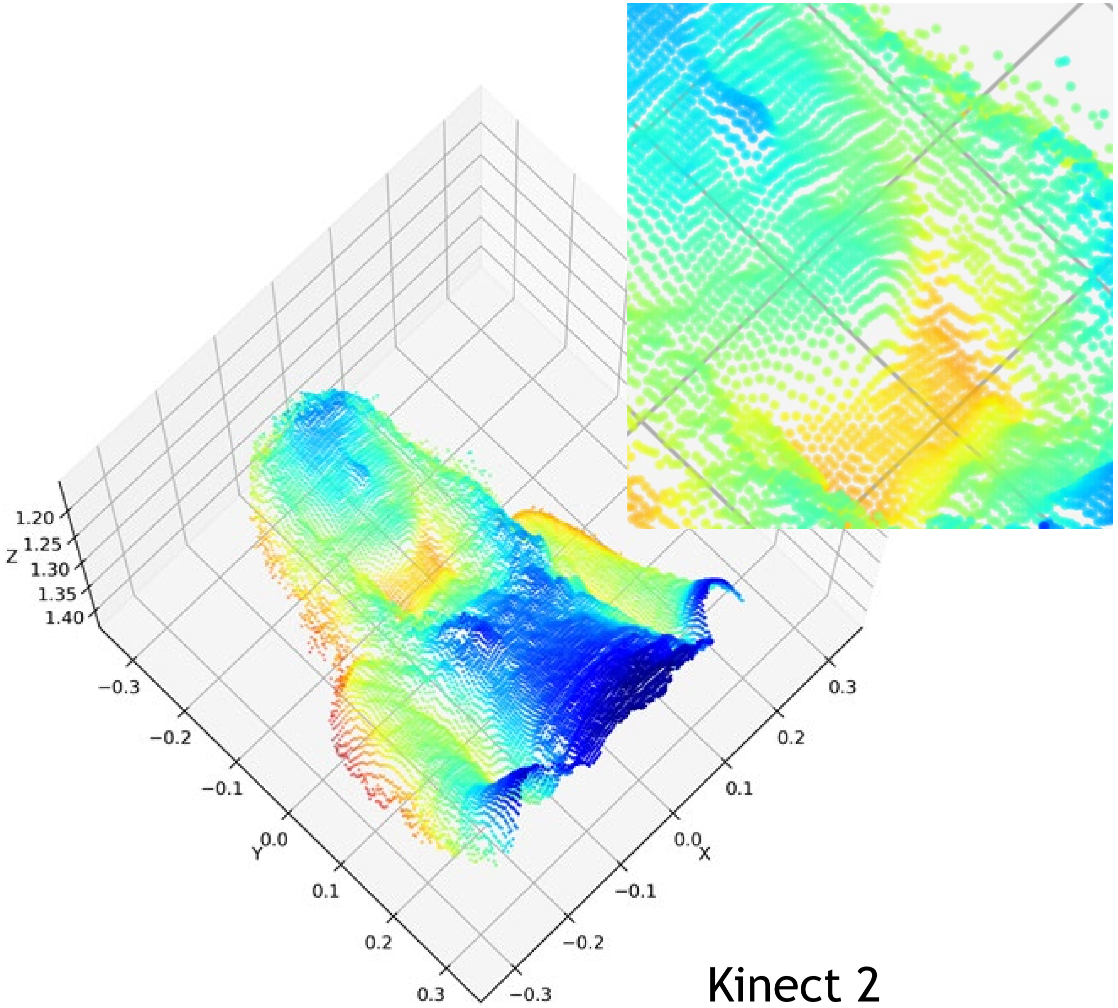


COMPARED TO KINECT2

PRELIMINARY DATA



Helios ToF

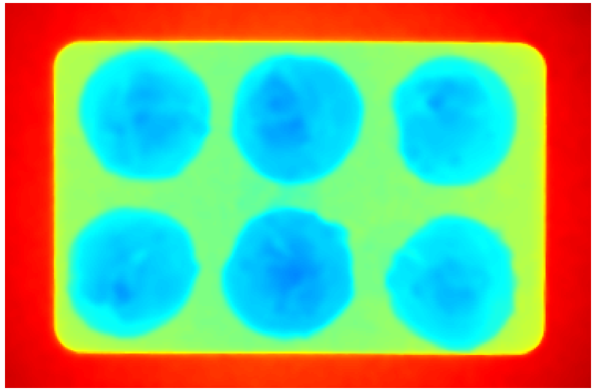


Kinect 2

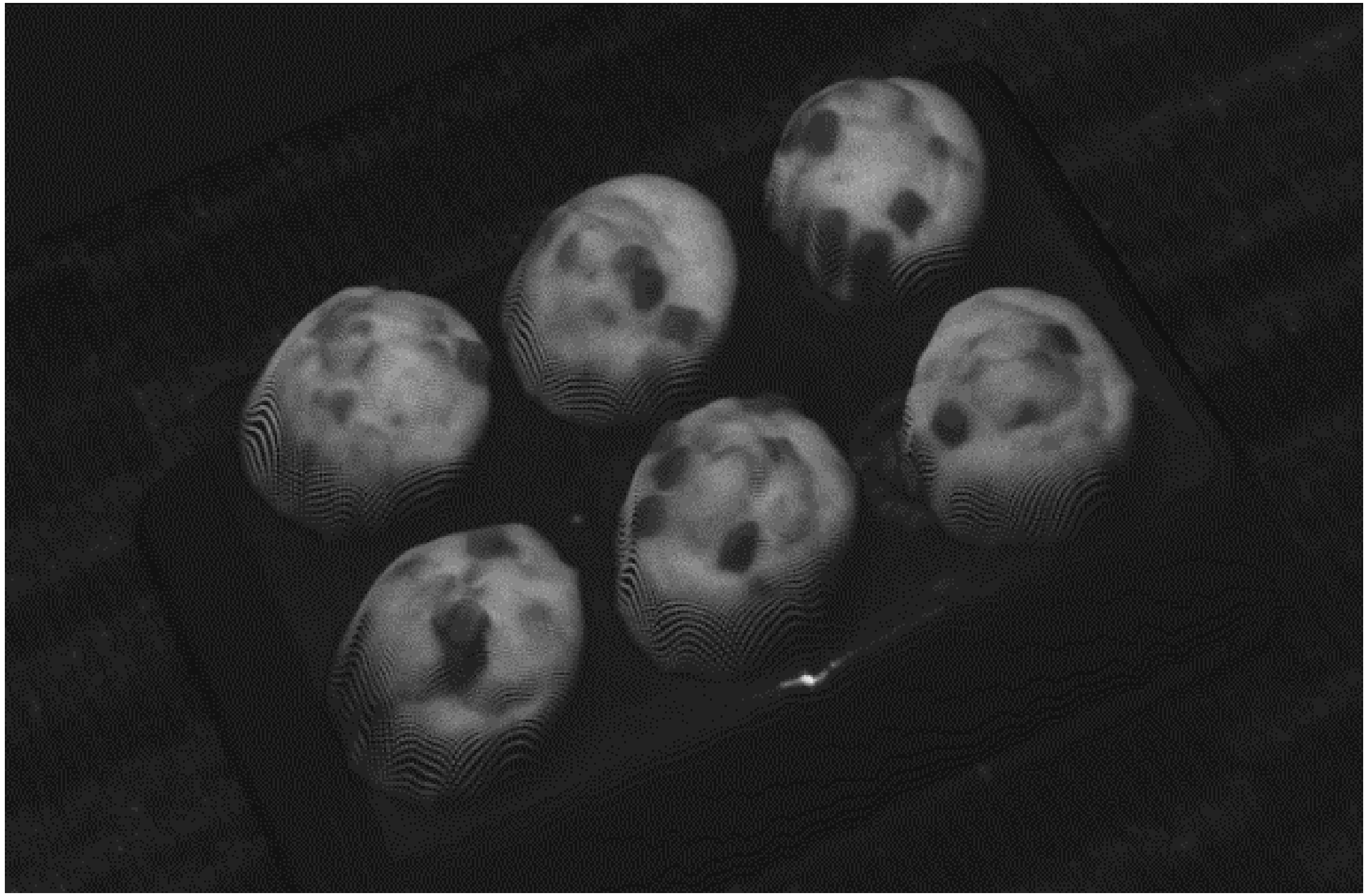
SAMPLE IMAGES

PRELIMINARY DATA

Sample object: Muffins



Depth map, top view

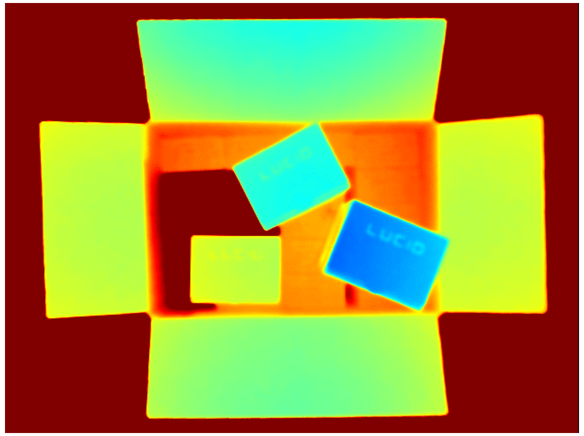


Point cloud, angled view

SAMPLE IMAGES

PRELIMINARY DATA

Sample object: Boxes



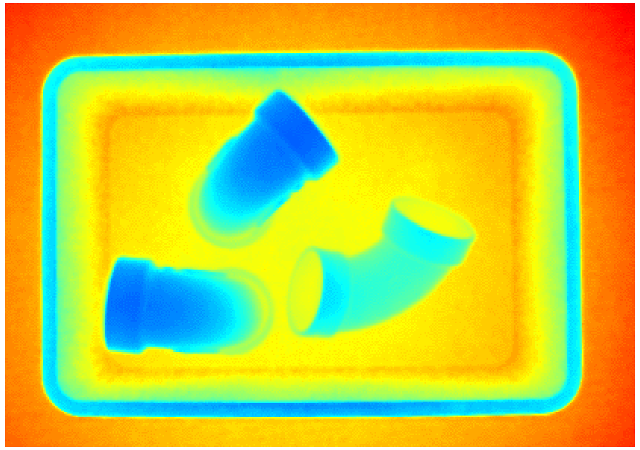
Depth map, top view

Point cloud, angled view

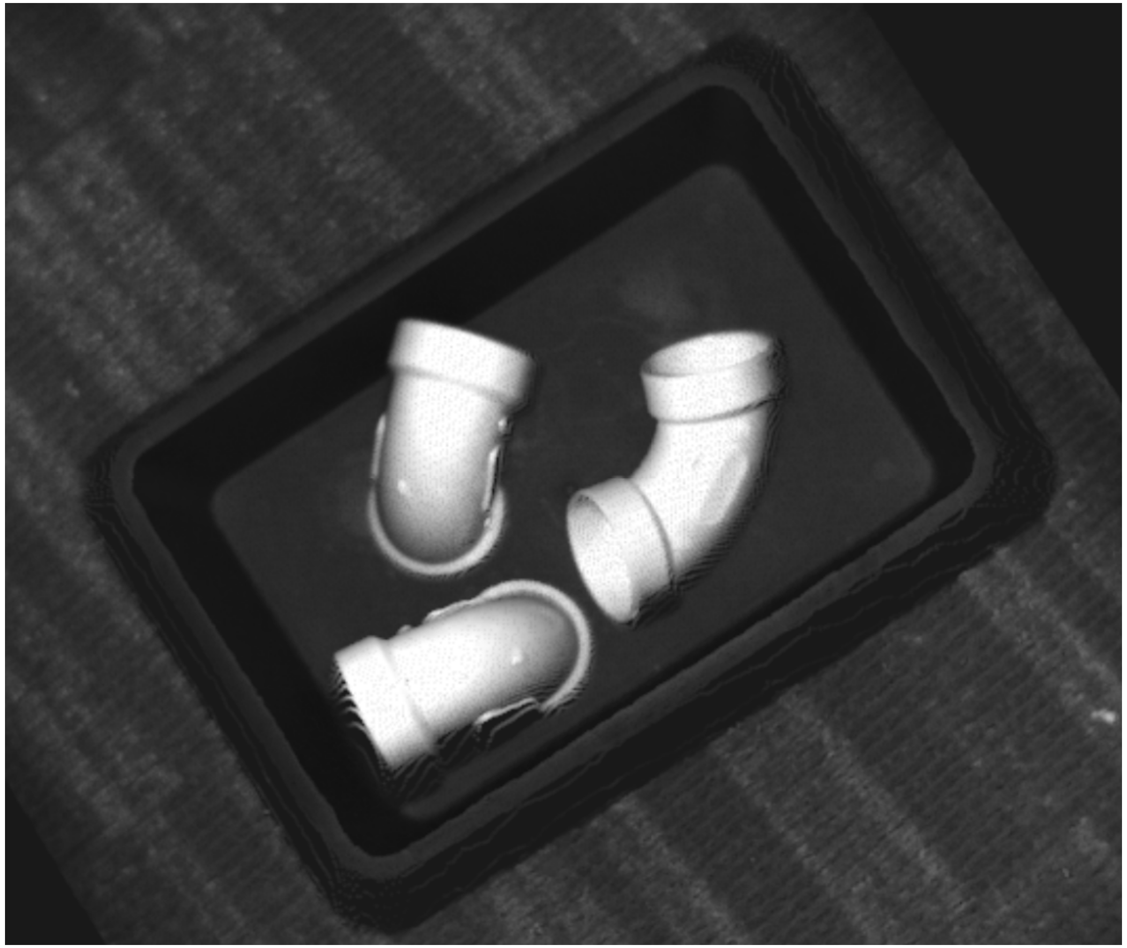
SAMPLE IMAGES

PRELIMINARY DATA

Sample object: PVC pipes



Depth map, top view



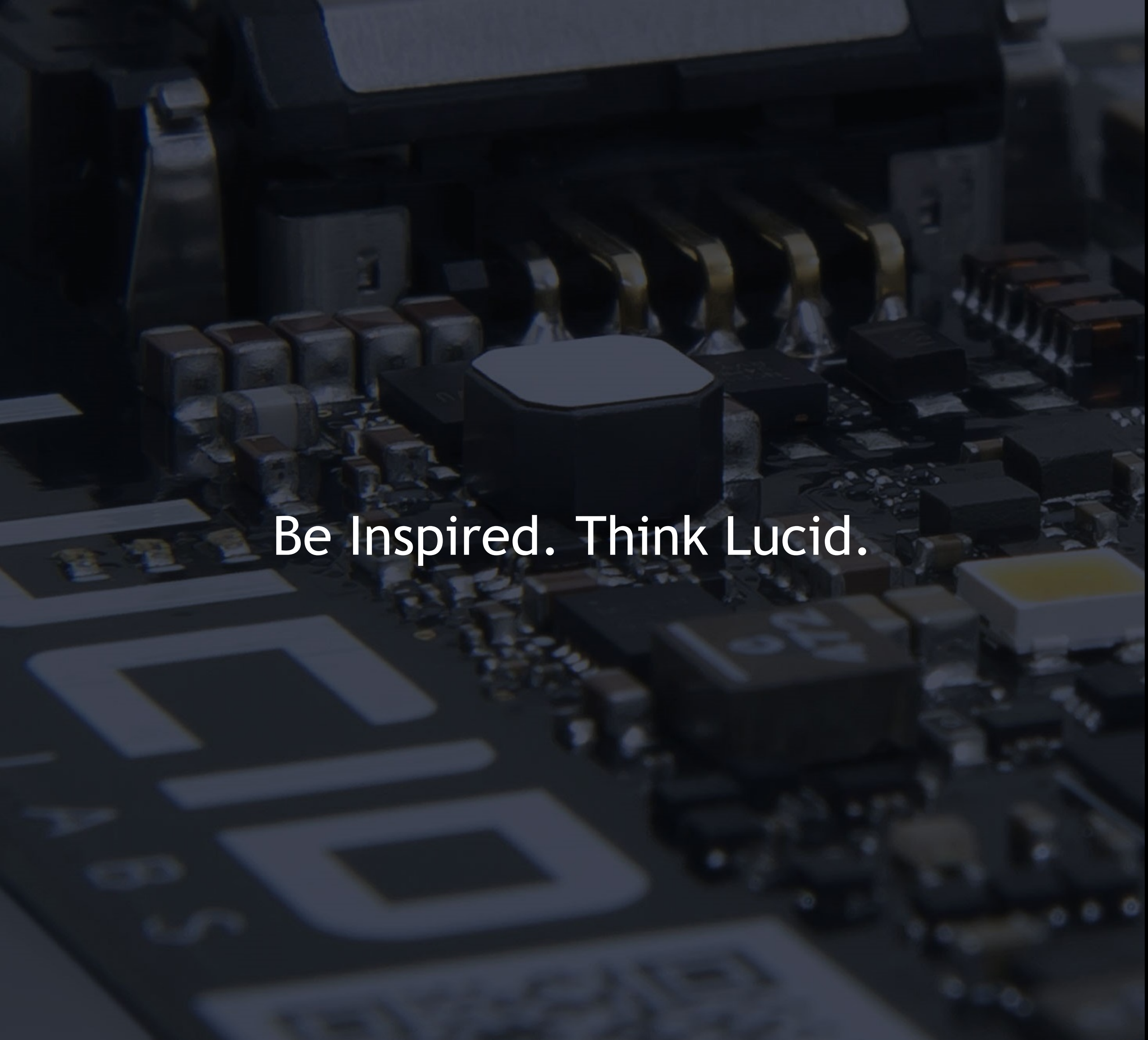
Point cloud, angled view

WHO IS LUCID

- LUCID Vision Labs is a new company that designs and manufactures innovative machine vision products that creatively leverage new technology to deliver exceptional value to our customers.
- Founded in January 2017 in Canada, first product shipped in March 2018
- Headquartered in Canada, with regional sales and support offices in Germany, Japan and China

Headquarter in Richmond, BC, Canada
Engineering, sales, support, and manufacturing

European office in Ilsfeld, Germany
Sales and support



THANK YOU

COME TO BOOTH 1C62 FOR LIVE DEMONSTRATION