Cognex smart camera-based 3D scanner

Collaborative work
of
Hongyi Fan, Peter Walecki and Gabriel Taubin

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Overview

- We use Cognex smart camera and associated software, Cognex In-sight Explorer to implement a linear laser based 3D scanner.
- The processing are done within the camera itself.
- This prototype can be extended to more sophisticated scanner.

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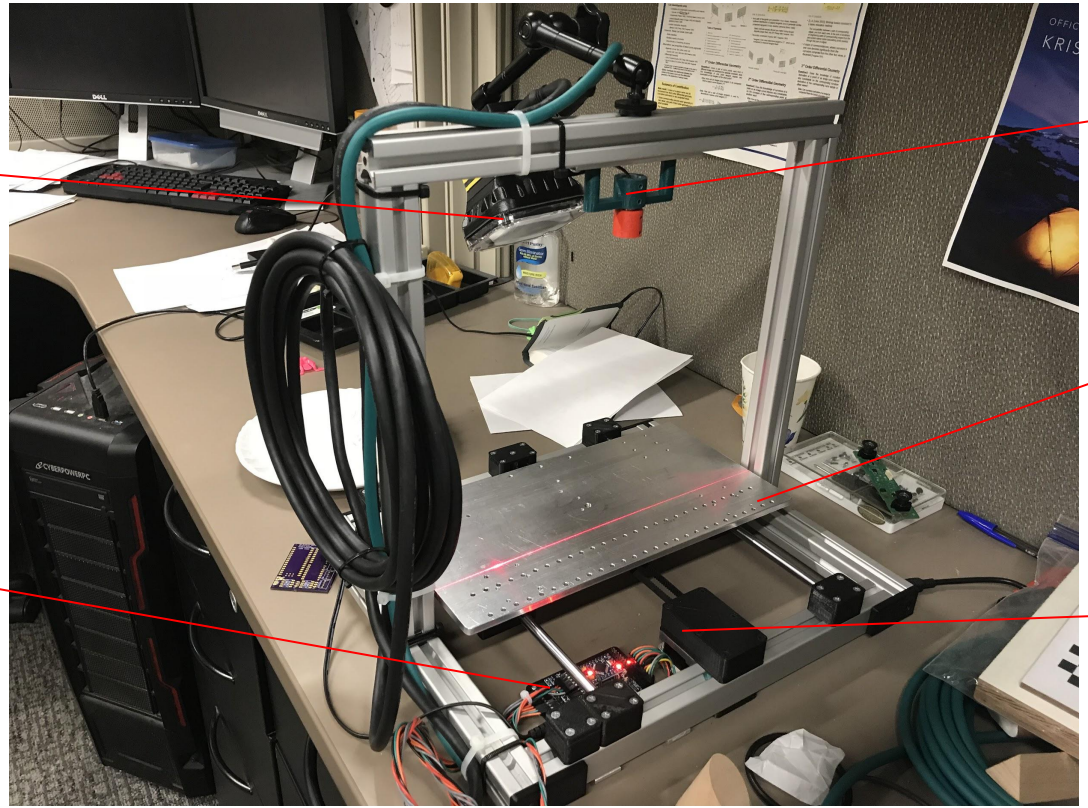
System Structure



Hardware Structure: Construction Details

COGNEX

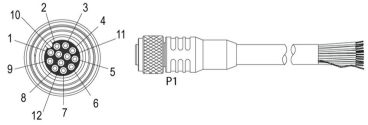
In-Sight® 7600/7800 Series Vision System

Reference Guide

10/10/2017
Version: 5.5.0.62

Breakout Cable

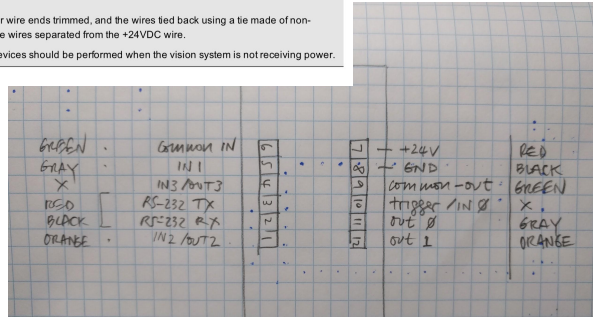
The Breakout cable provides connections to an external power supply, the acquisition trigger input, general-purpose inputs, high-speed outputs, and RS-232 serial communications. The Breakout cable is not terminated.

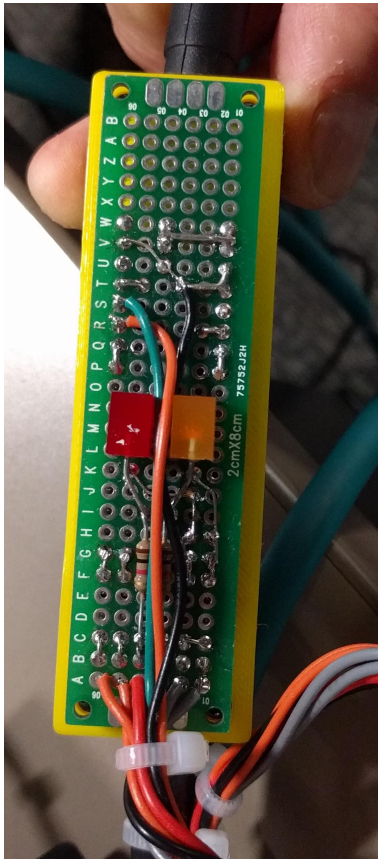


Pin#	Signal Name	Wire Color
1	IN 2 / HS OUT 2	Yellow
2	RS-232 TRANSMIT[1]	White/Yellow
3	RS-232 RECEIVE[2]	Brown
4	IN 3 / HS OUT 3	White/Brown
5	IN 1	Violet
6	COMMON IN	White/Violet
7	+24VDC	Red
8	GND	Black
9	COMMON OUT	Green
10	TRIGGER	Orange
11	HS OUT 0	Blue
12	HS OUT 1	Grey

Note:

- Cables are sold separately.
- Exposed wires can be cut short or wire ends trimmed, and the wires tied back using a tie made of non-conductive material. Keep all bare wires separated from the +24VDC wire.
- I/O wiring or adjustments to I/O devices should be performed when the vision system is not receiving power.





InSight 7802 Discrete I/O Hardware

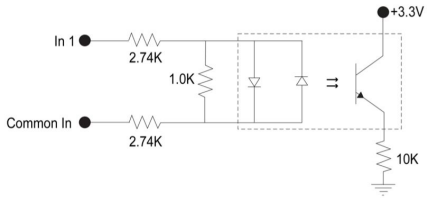
General-Purpose Inputs

The vision system features three[1] built-in general-purpose inputs, which are optically isolated. The inputs can be configured as either NPN (current sinking) or PNP (current sourcing) lines.

Specification	Description
V_{IH}	±15 — ±28 V
V_{IL}	0 — ±5 V
I_{TYP}	@ 12 VDC, 2.0 mA
	@ 24 VDC, 4.2 mA
Delay	1.11ms maximum latency between leading edge of trigger and start of acquisition. Input pulse should be minimum of 1ms wide.

For NPN lines, to utilize an input, connect **Common In** to +24V and connect **In 1** to the output of the photoelectric sensor or PLC. When the output turns on, it pulls **In 1** down to 0V, turning the opto-coupler on.

For PNP lines, to utilize an input, connect **In 1** to the output of the detector and connect **Common In** to 0V. When the output turns on, it pulls **In 1** up to +24V, turning the opto-coupler ON.



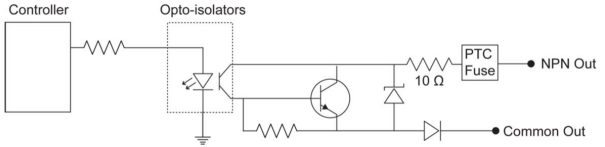
26.4V Max. across input pins - Transition approximately 12V (Min.)

High-Speed Outputs

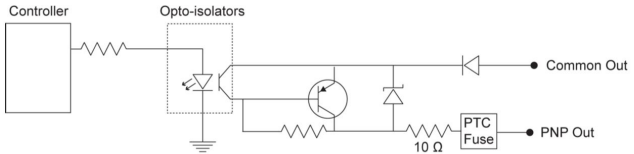
The vision system features four[1] built-in, high-speed outputs, which are optically isolated. The high-speed outputs can be used as either NPN (current sinking) or PNP (current sourcing) lines.

Specification	Description
Voltage	26.4V maximum through external load
Current	50mA maximum sink current
	OFF state leakage current 100µA
	External load resistance 240 Ohms to 10K Ohms
	Each line rated at a maximum 50mA, protected against over-current, short circuits and transients from switching inductive loads. High current inductive loads require external protection diode.
Delay[2]	10µs (maximum due to opto-isolators turning ON).

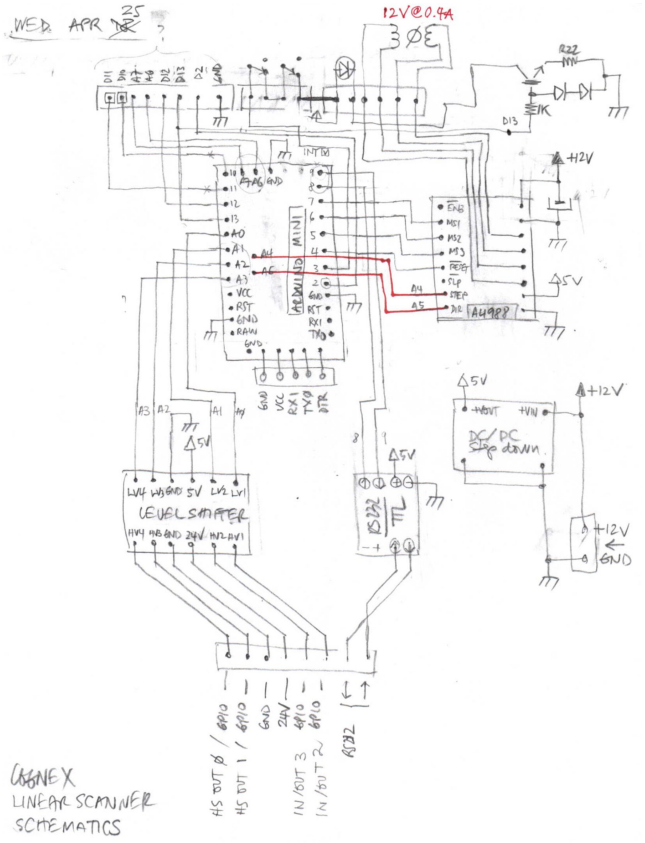
For NPN lines, the external load should be connected between the output and the positive supply voltage (<26.4V). The output pulls down to less than 3V when ON, which causes current to flow through the load. When the output is OFF, no current flows through the load.

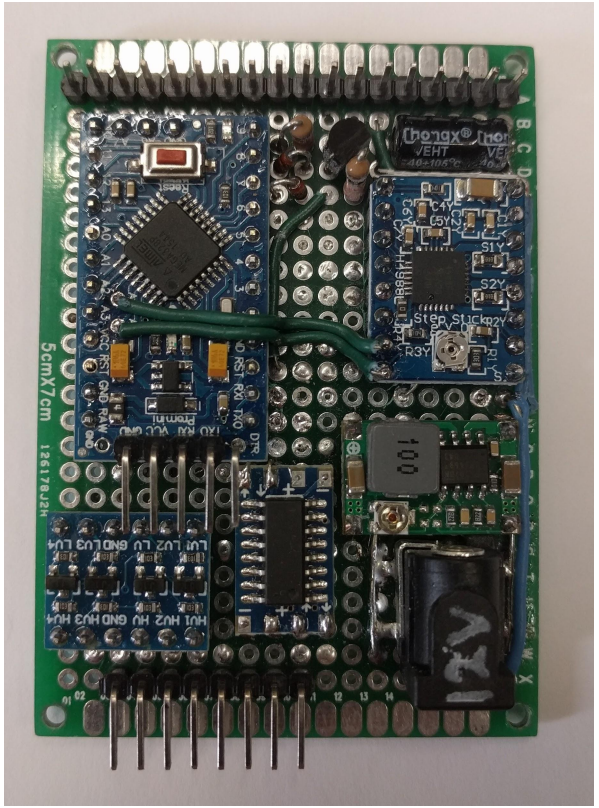


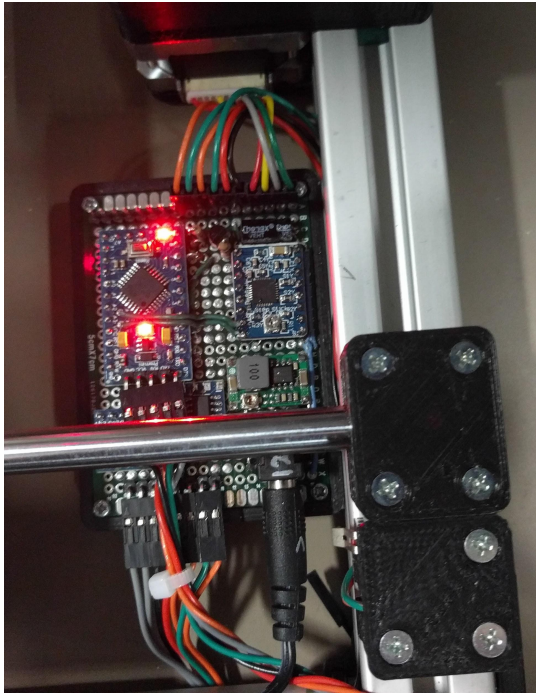
For PNP lines, the external load should be connected between the output and the negative supply voltage (0V). When connected to a 24VDC power supply, the output pulls up greater than 21V when ON, and current flows through the load. When the output is OFF, no current flows through the load.



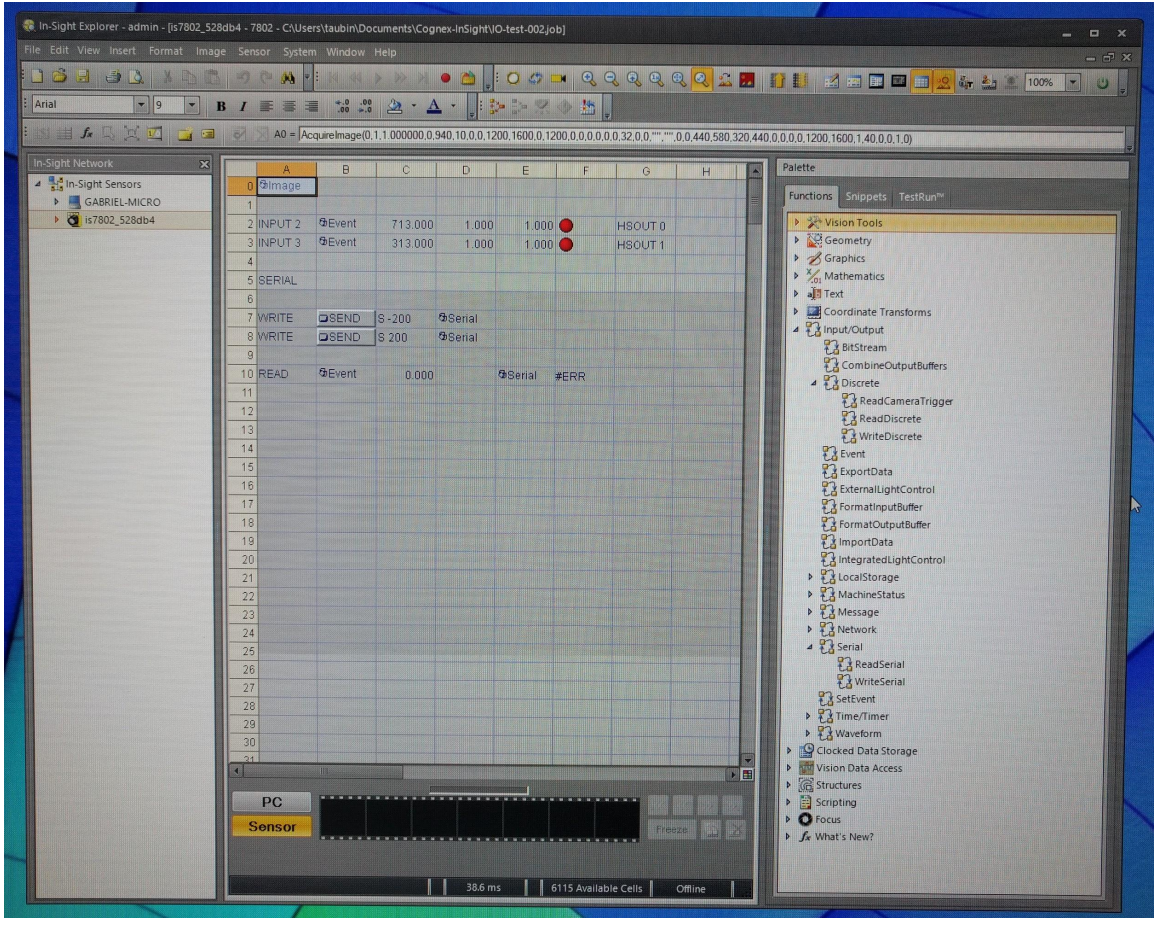
InSight 7802 / Arduino Hardware Interface



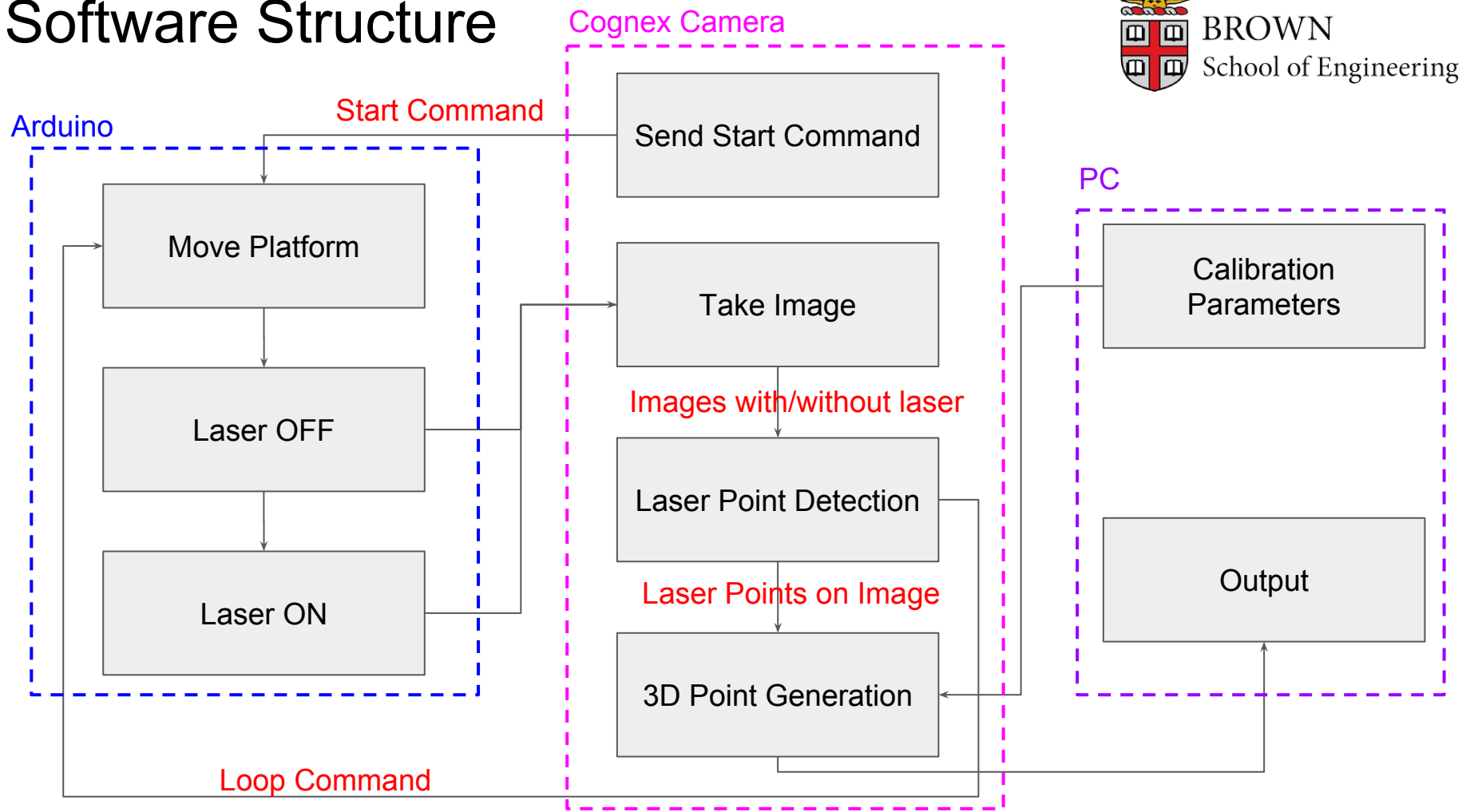




Hardware Structure: Communications



Software Structure



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Software Structure: Cognex Camera

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Communication and Image Triggering Module:

A	B	C	D
Image	Step Length	10.000	SNS
	Scan Time	1300.000	MLOOP
	Start	H	Serial
	Enable Motor	EM	Serial
	Disable Motor	DM	Serial
	StartScan	MLOOP 1300	Serial
INPUT 2	Event	SNS 10	Serial

Trigger Image without laser (SERIAL)	Event	LatchImage	1300.000	
Trigger Image with laser (INPUT3)	Event	LatchImage	1300.000	0.000

Software Structure: Cognex Camera

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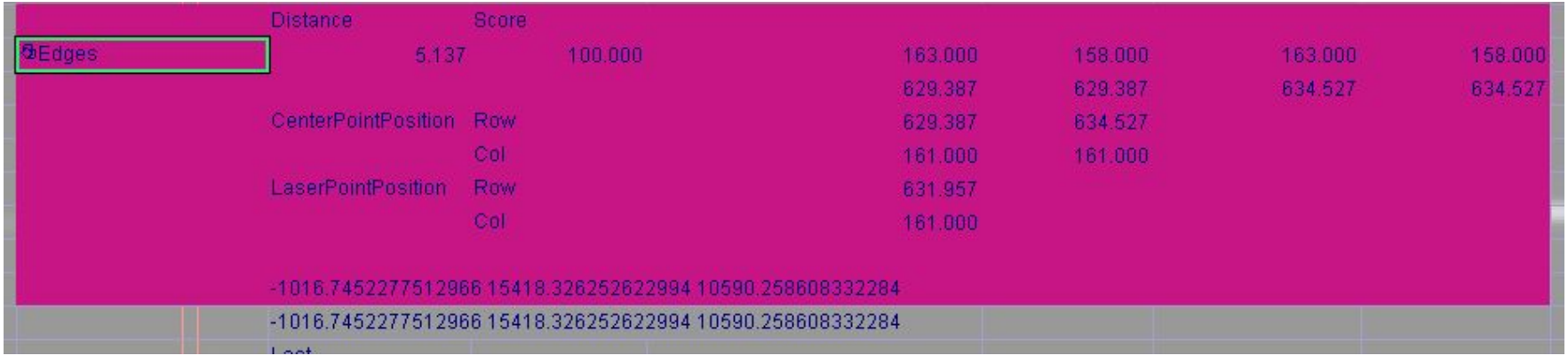
Laser Point Detection Module



Software Structure: Cognex Camera

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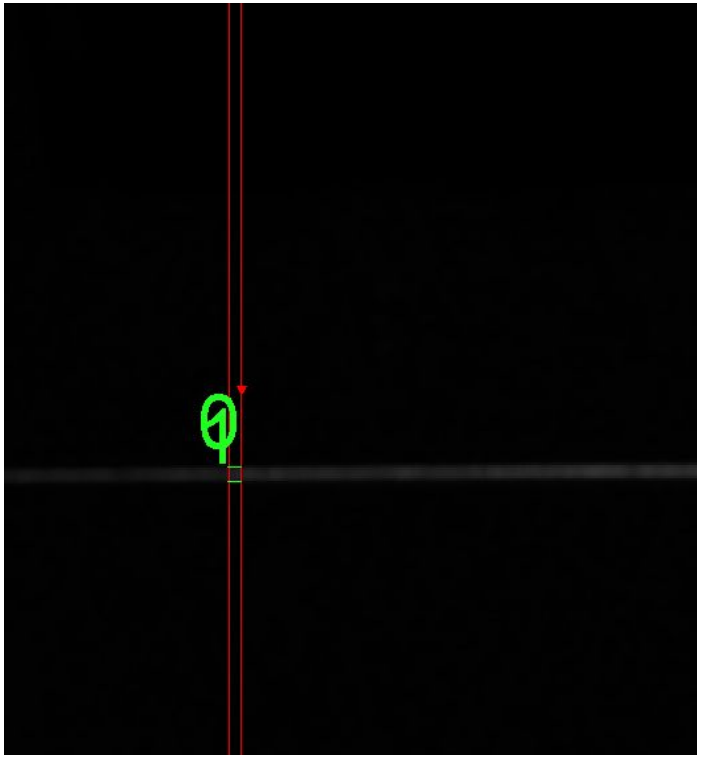
Laser Point Detection Module - Use FindSegments Function



Software Structure: Cognex Camera

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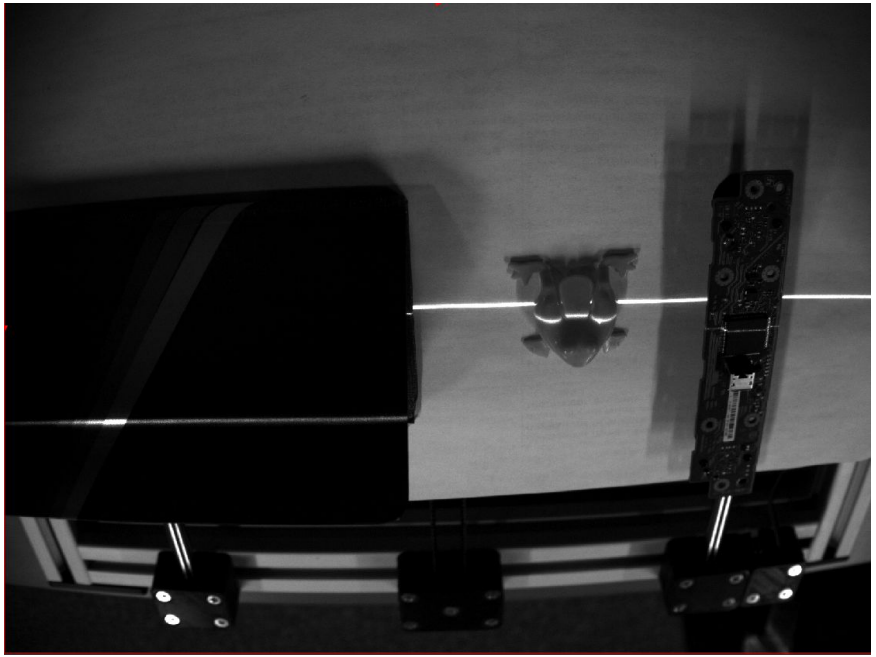
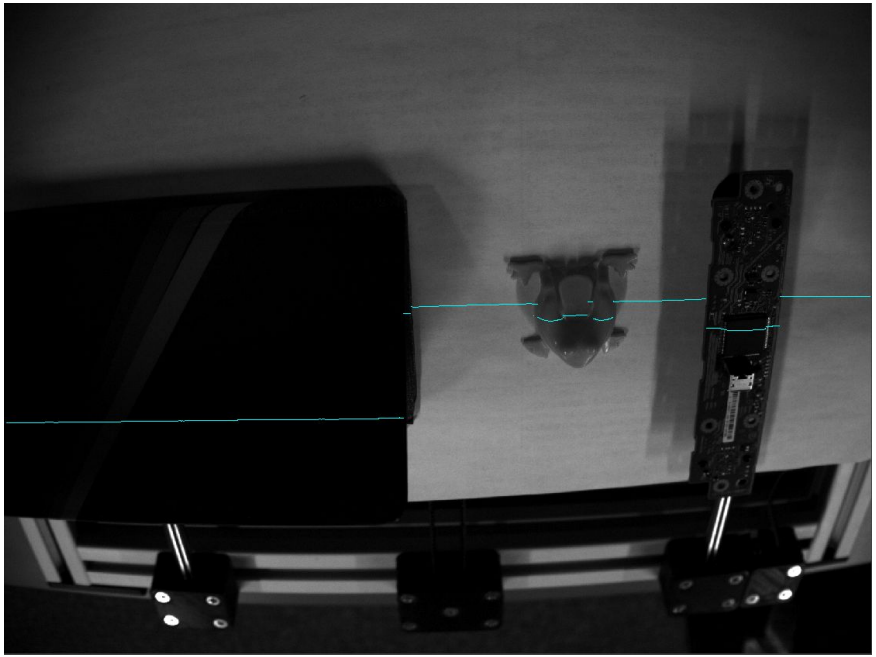
Laser Point Detection Module - Use FindSegments Function





Software Structure: Cognex Camera

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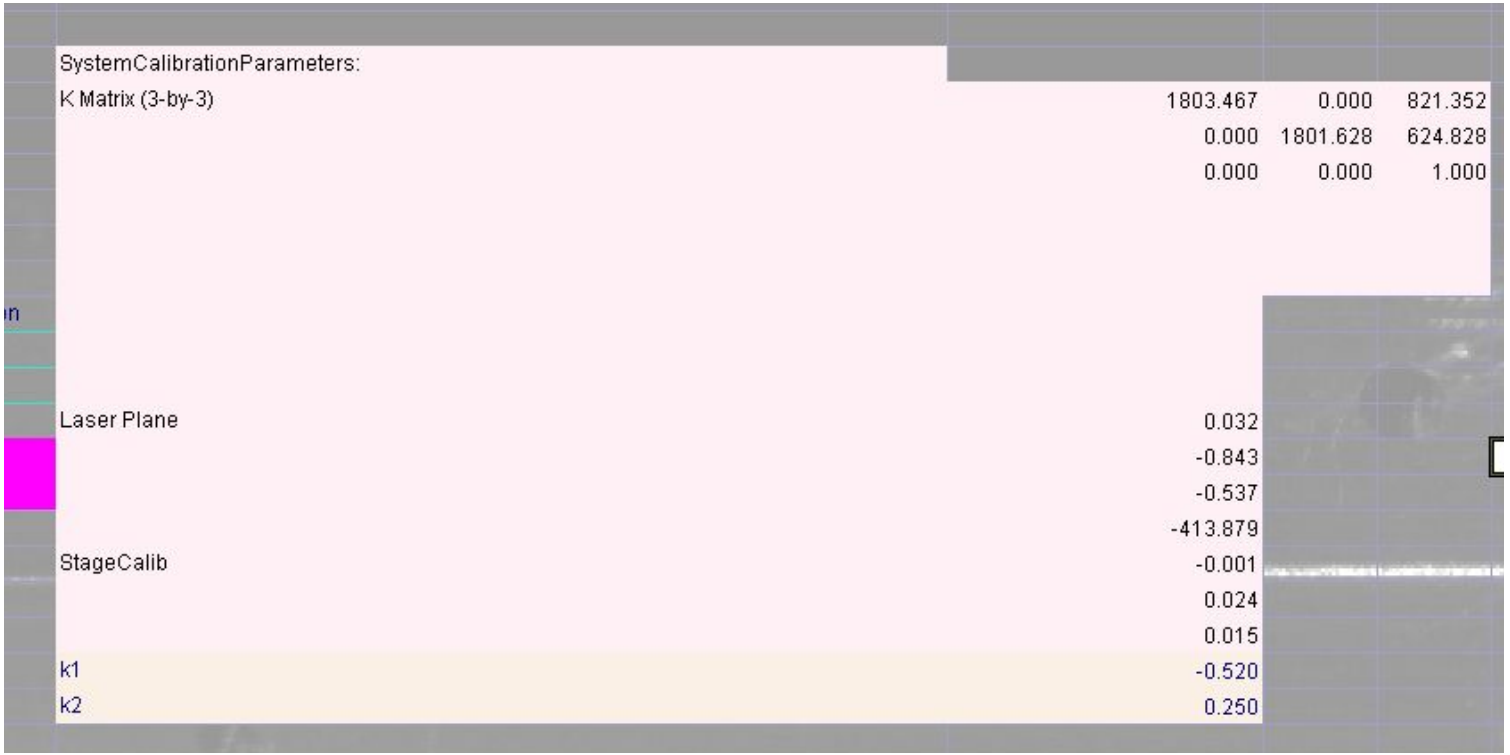
Calibration Parameters



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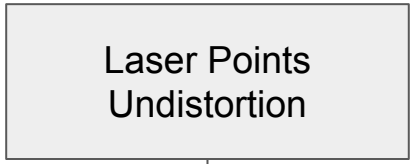
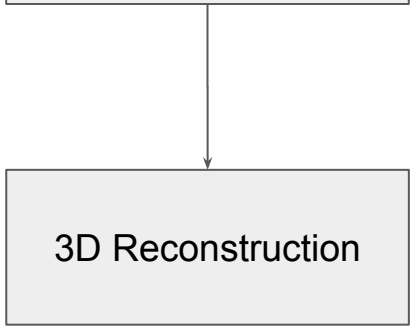
Reconstruction Module - Done in Javascript Script





$$x_u = x_d(1 + k_1 r^2 + k_2 * r^4)$$
$$y_u = y_d(1 + k_1 r^2 + k_2 * r^4)$$

$$r = \sqrt{x_d^2 + y_d^2}$$

$$p_{laser} = \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} \quad v_{platform} = \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} \quad \lambda = \frac{d}{\begin{bmatrix} a \\ b \\ c \end{bmatrix} \cdot p_{image}}$$

$$p_{3D} = \lambda p_{image} + t v_{platform}$$

Reconstruction Results

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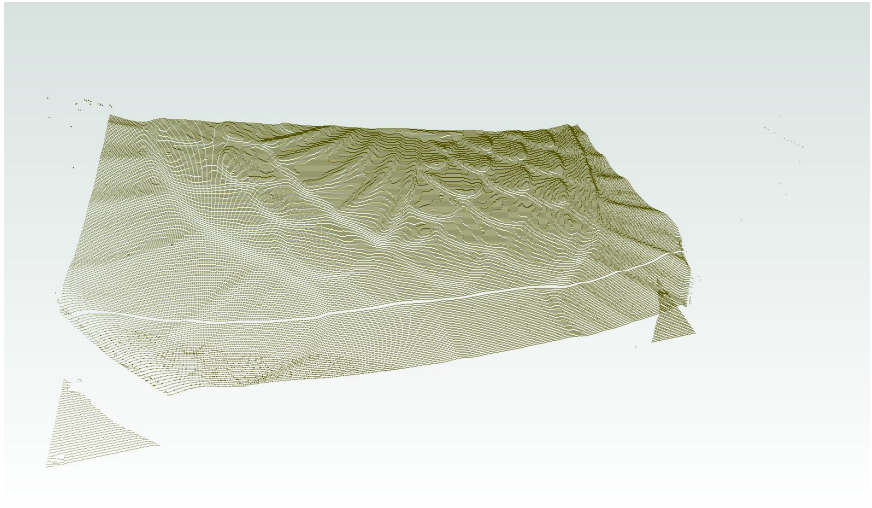

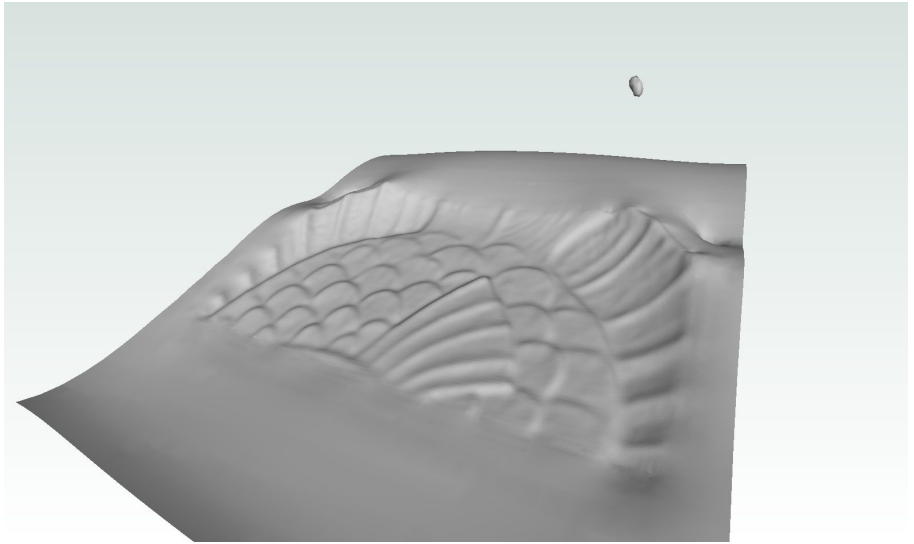

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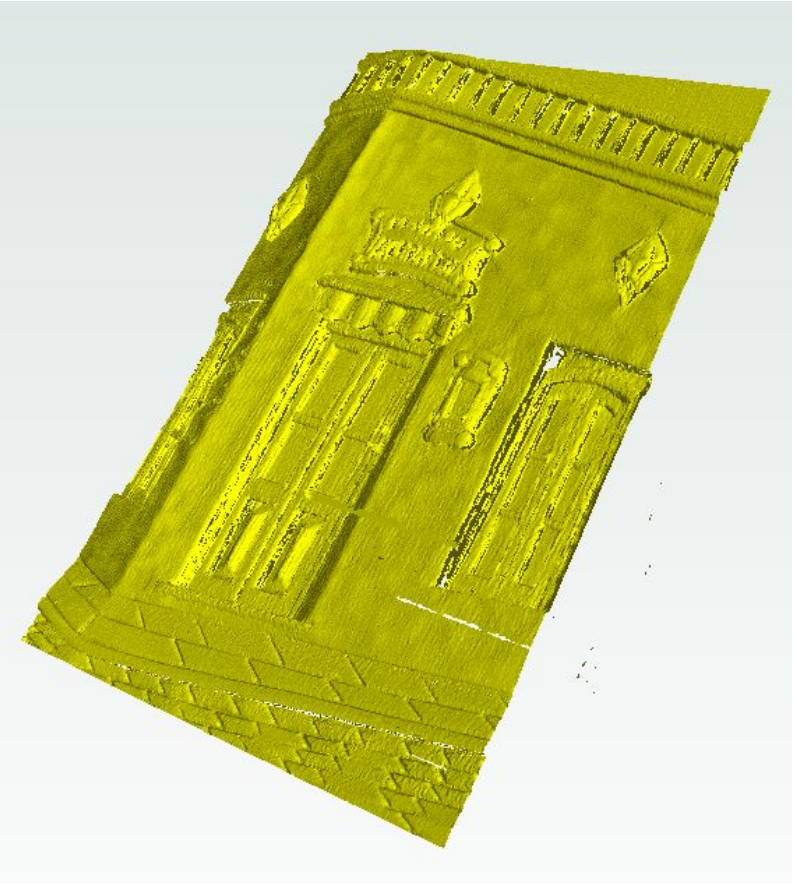

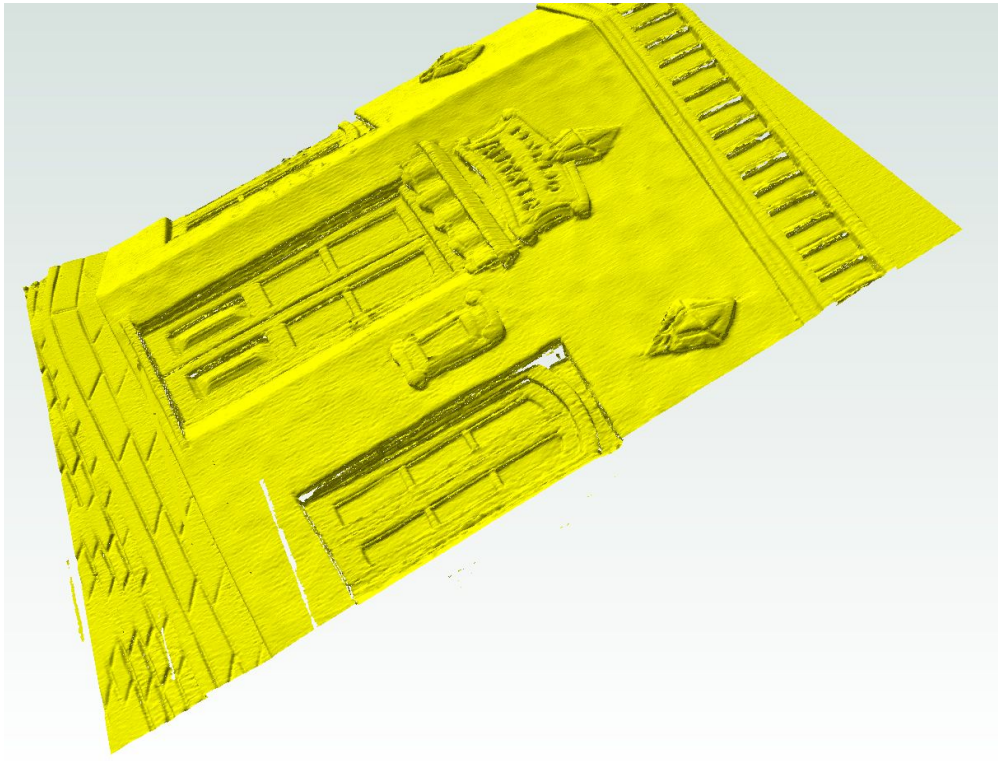

Reconstruction

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