MULTISENSE SL

COMPACT & ACCURATE 3D DATA COLLECTION

MultiSense SL 3D Sensor

At less than 3 kg, the SL provides high resolution stereo, two-axes of laser scanning and video imagery – all combined into a correlated data stream.

Carnegie Robotics®

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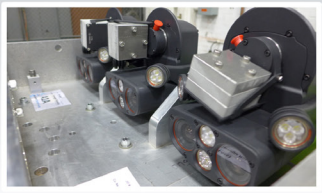
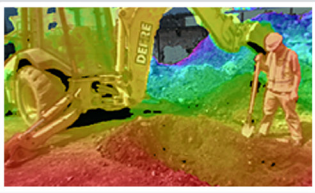
KEY FEATURES



Rugged Design

The SL is designed and tested for harsh environments. Carnegie Robotics subjects each sensor to a battery of vibration and thermal tests as part of its quality process.

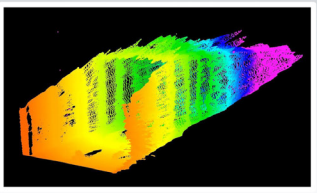


Dense, Low Latency Stereo Imagery

The stereo portion of the MultiSense SL can find over 11 million feature matches every second. If desired, the stereo point cloud can be augmented by overlaying color image data onto the point cloud—resulting in compelling, very low latency, life-like 3D data sets.

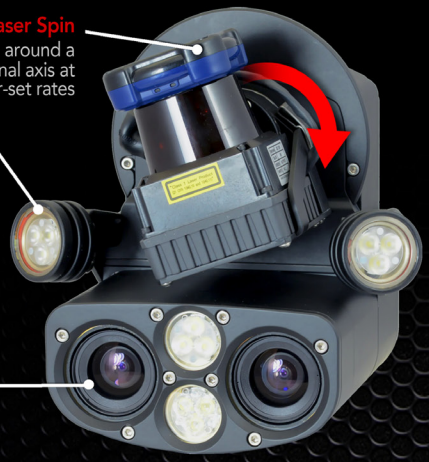
Three Data Options

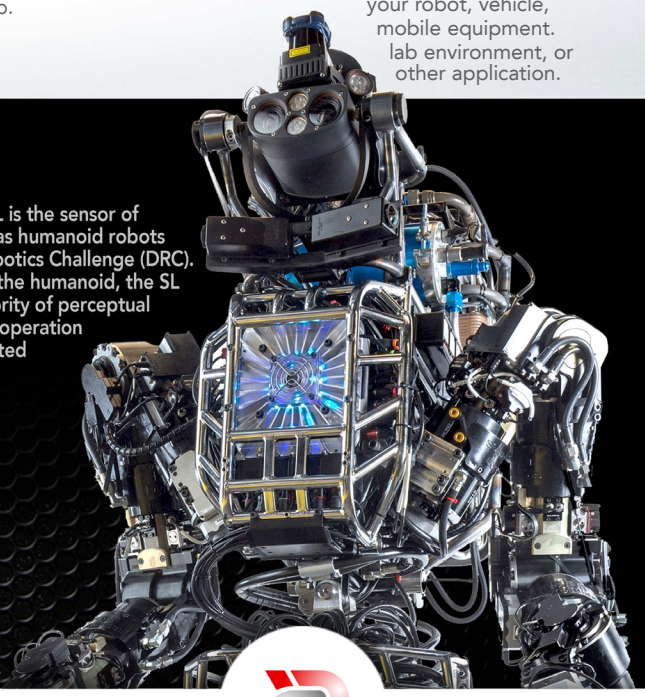
3D point clouds from both the spinning laser and the stereo camera are accurately aligned and colorized onboard the sensor. The stereo sensor provides extremely dense "full frame" range data at high frame-rates, which is complemented by high accuracy data, at lower rates, from the spinning laser. The sensor can also output standard color video.



More Points, Less Hassles

Our easy to use ROS-based API and tools allow you to view live image and 3D range data; adjust laser, camera, and stereo parameters; log data; playback logs; check the unit's calibration; and change the sensor's IP address. An open-source C++ library and Gigabit Ethernet interface make it easy to integrate live data into your robot, vehicle, mobile equipment. lab environment, or other application.





The MultiSense SL is the sensor of choice for the Atlas humanoid robots in the DARPA Robotics Challenge (DRC). As the "head" of the humanoid, the SL provides the majority of perceptual data used for teleoperation as well as automated control.

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Mechanical/Environmental	MultiSense SL	Note
Operating Temperature	-10 to 50 C	
Environmental Rating	IP67	
Dimensions (L x W x H)	13 x 13 x 18 cm	
Weight	2.6 kg	
Spindle RPM	1 to 50	
Electrical		
Voltage (nominal, maximum)	24-48 V; 18-55V	
Power (nominal, maximum)	18W; 45W	Nominal power at 25 RPM, no lighting; maximum power at 50 RPM, full lighting.
External Connector	Glenair Mighty Mouse, 801-009-07MT9-19PA	
Image Sensors		
Model	CMOSIS CMV2000 or CMV4000	Monochrome or IR sensor options also available.
Resolution	2048 x 1088 or 2048 x 2048	
Active Area	11.2 x 6 mm or 11.2 x 11.2 mm	Larger image area corresponds to CMV4000 imager.
Frame Rate	30 FPS max	
Sensitivity	5.56 V/lux-s	For monochrome imagers, Bayer filter on color imagers reduces sensitivity.
Color Filter Array	Bayer	
Lenses		
Focal Length	6.5 mm	
Field of View	80° x 49° (2MP sensor); 80° x 80° (4MP sensor)	
Aperture	Fixed at factory	Possible values: f1.4 to f16
Focus	Fixed at factory	
Illumination		
LED Illuminators	4	2 internal and 2 external.
Color Temperature	4100K	
Brightness	690 lm each	
Power	6 W per LED	LED power is at 100% duty, no strobing. Strobing is user-adjustable.
Field of View	Internal LED: 1 @ 18°, 1 @ 44°	
Synchronization	Continuous or Sync	Continuous illumination or synchronized to camera exposure.
Stereo Vision		
Algorithm	SGM	
Maximum Disparities	256	
Sub-pixel Resolution	1/16th pixel	
Peak Throughput	2 GPxD/s (Giga-Pixel-Disparities/second)	
Performance @ 2048 x 1088	7.5 FPS with up to 128 disparities	
Performance @ 2048 x 544	15 FPS with up to 128 disparities	
Performance @ 1024 x 544	30 FPS with up to 128 disparities	
Minimum Range	0.4 m	With 2048 pixel horizontal resolution, 256 disparities.
Laser Range Finder		
Model / Laser	Hokuyo UTM-30LX-EW	
Scan rate; Field of View	40 Hz; 270º	
Angular Resolution	0.25º (1081 samples per scan)	
Detection Range	0.1 - 30 m	
Accuracy (0.1 - 10 m)	+/- 30 mm	
Accuracy (10 - 30 m)	+/- 50 mm	
Multi-echo Capability	Up to 3 returns per sample	Current firmware only supports first return.
Triggering/Synchronization		
Ext Opto-isolated Input, Output	1x; 1x	
Time-base	Internal time-base with sub-microsecond resolution	Used to timestamp all outgoing data (including disparity maps and captured images).
Time Synchronization	External pulse input (e.g. Pulse-Per-Second) time system with host	PPS mutually exclusive with external trigger (due to limit of 1 external input). PPS signal sets sub-second time, while network message sets absolute time.
Camera Trigger Sources	Internal free-running; Network message; Ext trigger input	
Opto-isolated Output Sources	Synchronized to camera exposure; Pulse-per-second	Allows external cameras and illumination devices to be synchronized with internal camera exposure. Alternatively, external devices may be synchronized such that their exposures never overlap with internal camera exposure (for example, in order to support a structured illumination device that is only visible to some of the cameras).
Interface		
Network Interface	1 Gigabit Ethernet port (1000BASE-T)	Full-duplex only. Can auto-negotiate down to 10/100 speeds at significant impact to sustained camera framerate.
Throughput	Up to 120 MB/s	Achievable throughput depends on quality of host side Ethernet adapter/drivers.
Jumbo Frames	Up to 9000 bytes	Full frame rates may not be achievable without use of jumbo-frames.
Low-level Protocol	UDP/IP; IPv4 only	
IP Address Assignment	Static	
Device Discovery	Direct connect to known IP	
Application Interface (C++)	High-performance C++ API with support for blocking, polled and asynchronous (callback based) methods.	
Application Interface (ROS)	ROS-based API and tool set	View live image and 3D range data, adjust camera and stereo parameters, log and playback data, check calibration, and change IP address.
Image Formats	Grayscale, RGB, YCbCr; Packed, Planar; Various bit depths	Formats may be selected to optimize use of available network bandwidth. API can provide efficient automatic conversion to standard byte-aligned formats on host side.
Image Streams	Unrectified (left/right), Rectified (left/right), and Depth	
Laser Streams	Laser ranges, laser intensities, spindle angles	Spindle angles embedded in each laser scan message.

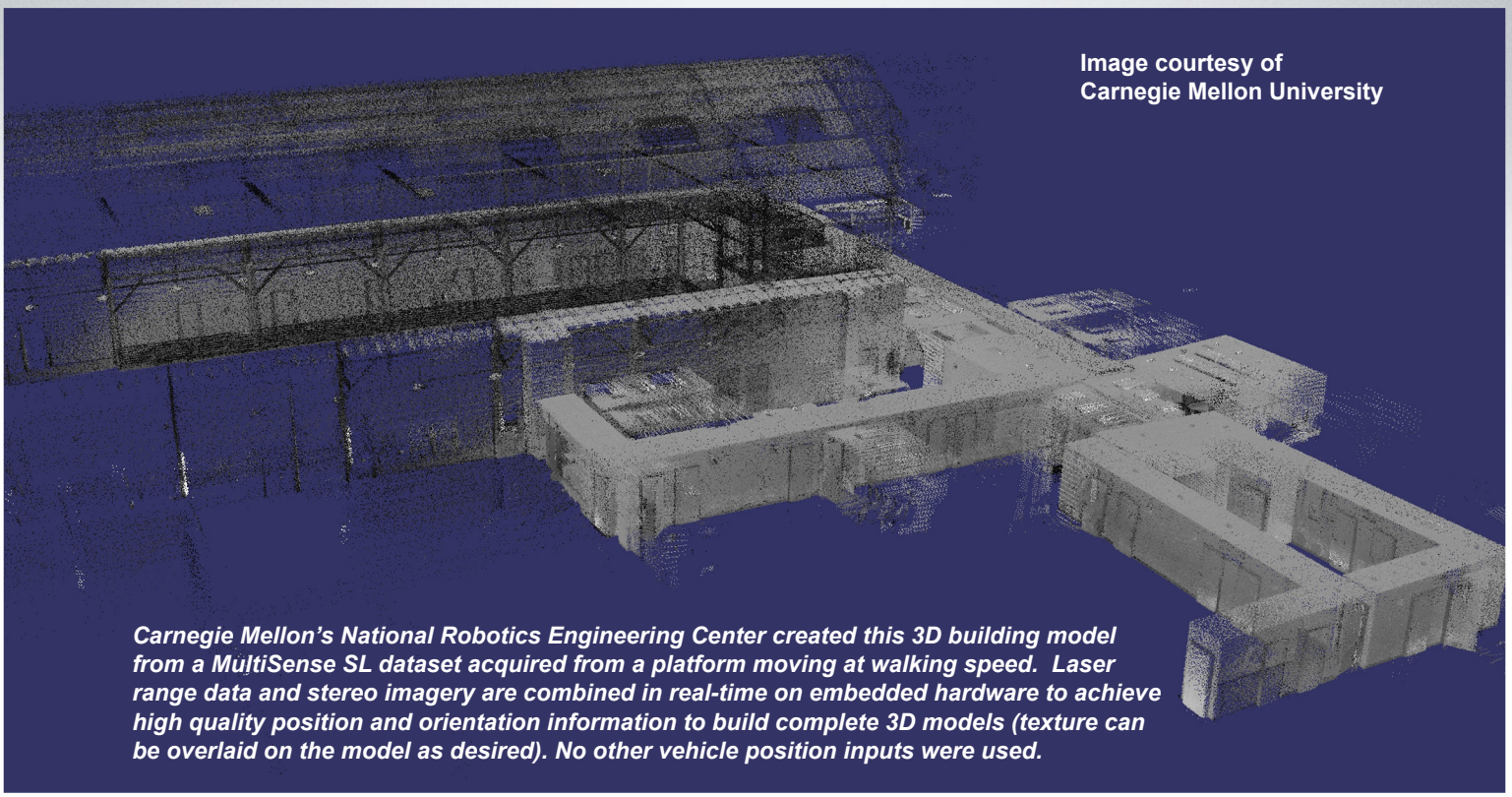


Image courtesy of
Carnegie Mellon University

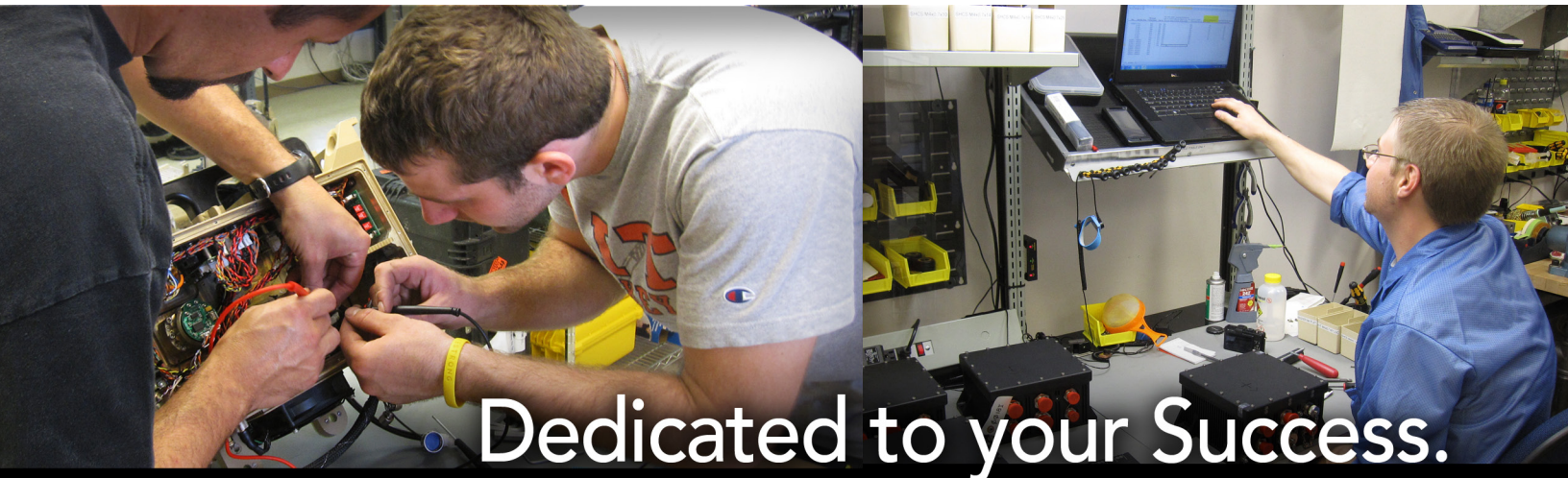
Carnegie Mellon's National Robotics Engineering Center created this 3D building model from a MultiSense SL dataset acquired from a platform moving at walking speed. Laser range data and stereo imagery are combined in real-time on embedded hardware to achieve high quality position and orientation information to build complete 3D models (texture can be overlaid on the model as desired). No other vehicle position inputs were used.

Our Story

Carnegie Robotics LLC (CRL) is a leader in building advanced robotics sensors and equipment for commercial, defense, agriculture and other applications. We design, manufacture and support highly reliable robotics systems and components that help improve productivity, reliability and safety, while reducing cost and increasing profitability for our customers. In 2010 CRL spun out of Carnegie Mellon University's National Robotics Engineering Center (NREC), one of the world's premier research and development organizations for advanced field robotics, machine vision and autonomy.

CRL was formed with the recognition that field robotics markets would not reach their potential until companies emerged who could effectively engineer, manufacture, supply and support the critical sensors, software and components that form robotic systems. We are driven to develop skills in engineering, manufacturing and testing of highly reliable and environmentally robust products.

Carnegie Robotics is more than a story or strategies. Our products are in operation throughout the world helping solve challenges in harsh military environments, production agriculture, underground inspection, and other applications. Our initiatives are aggressive, growing and focused by deep competencies.



Dedicated to your Success.

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