Zebedee

Zebedee is a handheld 3D mapping system, which consists of a lightweight laser scanner with 15–30m maximum range (dependent on surface reflectivity and environmental conditions) and an industrial-grade MEMS inertial measurement unit (IMU) mounted on a simple spring mechanism. As an operator holding the device moves through the environment, the scanner loosely oscillates about the spring, thereby producing rotational motion that converts the laser’s inherent 2D scanning plane into a local 3D field of view. With the use of proprietary software, the six degree of freedom sensor trajectory can be accurately and continuously calculated from the laser and inertial measurements in real-time, and the range measurements can be projected into a common coordinate frame to generate a 3D point cloud. Zebedee has evolved from (and alongside) general research into 3D localization and mapping for autonomous robots. The main technical details are described in an IEEE Transactions on Robotics article. The technology is now commercially available as ZEB1 and its sister device ZEB REVO through our partner, GeoSLAM. Please contact zebedee@csiro.au with any inquiries.

Note: Chrome users, if you can’t see any video below, click on the Shield Icon on the righthand side of the URL address bar to allow external content.

Example Mapping Applications

• **3D Mapping of Questacon** — The Questacon – the National Science and Technology Centre, is located on the southern shore of Lake Burley Griffin in Canberra, Australia. It is a large centre with more than 200 interactive exhibits relating to science and technology. Here are the results of a scan conducted in September 2012 acquired during a 14min walk inside and around the centre. The data was downloaded and processed in less than 30min.

• **ANZAC Square** — ANZAC Square is a public square in Brisbane, Australia that includes a memorial to the men and women who have represented Australia and New Zealand in overseas armed conflict. The site is heritage-listed and contains the Shrine of Remembrance, which houses an Eternal Flame.

• **HMQS Gayundah** — The HMQS Gayundah entered service in 1884 as a gunboat for the Queensland Maritime Defense Force as one of the first two ships commissioned for defense against a perceived Russian threat. She later served in the Royal Australian Navy as HMAS Gayundah before being decommissioned and sold for civilian use. The Gayundah was beached in 1958 as a breakwater at Woody Point in Redcliffe, Queensland.

• **Forests and Trees** — Zebedee has been used to map a variety of forest environments around the world. With Zebedee, forest environments can be captured relatively quickly by walking through them while continuously scanning.

• **Opéra-Théâtre de Clermont-Ferrand** — The Opera-Theatre of Clermont-Ferrand, France was built between 1891 and 1894. It hosts music, dance, and theatrical performances, including the Orchestre d’Auvergne. The facility reopened in 2013 after a 7-year renovation project and currently seats 600 people.
• HMAS J3 WWI Submarine — HMAS J3 is one of six J-class submarines that served in WWI and subsequently gifted by the British Royal Navy to the Royal Australian Navy after the war. After a refit, it saw limited use in Australia, and was scuttled as a breakwater in Port Phillip Bay, Victoria in 1926. Read More...

Awards
• Winner of the 2014 CSIRO Medal for Scientific Excellence
• Winner of the 2013 ANSTO Eureka Prize for Innovative Use of Technology
• Winner of the 2013 Australian National iAward for Research and Development
• Winner of the 2013 Queensland iAward for Research and Development

Publicly Accessible Datasets
• R. Zlot and P. Borges, Muttoa Stick Shed: Zebedee 3D Data Collection, CSIRO Data Collection, 2015, DOI: 10.4225/08/554c57830d673.
• R. Zlot, P. Borges, and G. Bell, Royal Exhibition Building: Zebedee 3D Data Collection, CSIRO Data Collection, 2015, DOI: 10.4225/08/554c5c0d0e610.
• R. Zlot, Wellington Caves: Zebedee 3D Data Collection, CSIRO Data Collection, 2015, DOI: 10.4225/08/553eee63cc584.
• R. Zlot, Cliefden Caves: Zebedee 3D Data Collection, CSIRO Data Collection, 2015, DOI: 10.4225/08/554c628401d73.
• R. Zlot and M. Bosse, Jenolan Caves: 3D Data Collection.
• R. Zlot and M. Bosse, Mt Coot-tha Forest and QCAT 3D Point Cloud Datasets, CSIRO Data Collection, 2013, DOI: 10.4225/08/5137014e577dc.

Newspaper / Magazine / Television
• Brisbane News (16 Mar 2016) - Marilyn Wallman murder cold case: Police return with 3D laser mapping device
• Laser Scanning Europe (23 July 2015) Zebedee scanner and PointCab software in use at Queensland police
• ABC LateLine (30 Jul 2015) - The new technology set to revolutionise crime fighting
• Gold Coast Bulletin (18 May 2015) – Gold Coast cops add hi-tech 3D laser scanner to CSI toolbox
• Brisbane Times (13 Apr 2015) – Queensland’s second oldest building enters international cyber ark for heritage protection
• Coast Australia – History Channel (12 Jan 2015) (S2E1 web extra)
• Digital Production Magazine (15 Oct 2014) – Walking mit Nutzwert (German language feature)
• The Australian (22 Aug 2014) – Jenolan Caves gets 6600 visitors
• ABC News (19 Aug 2014) – Thousands to explore Jenolan Caves online in Australia’s ‘biggest school excursion’
• Engineering & Mining Journal (7 July 2014) – The Surveyor’s 21st Century Tools
• Sydney Morning Herald (13 Apr 2014) – Real-life CSI tech trumps television gadgets
• The Age (27 Mar 2014) – Melbourne’s Shrine of Remembrance scanned in 3D using CSIRO’s Zebedee Tool
• The Guardian (14 Feb 2014) – Zebedee scanner lets police build 3D maps of crime scenes in minutes
• The Independent (14 Feb 2014) – Hand-held laser scanner creates 3D maps of crime scenes in minutes
• 9 News (13 Feb 2014) – Laser scanner dubbed ‘future of crime fighting’
• news.com.au (13 Feb 2014) – Qld crime fighter named after Zebedee
• Courier-Mail (13 Feb 2014) – Future of Queensland crime fighting is Zebedee Scanner
• Popular Mechanics (25 Sep 2013) – Laser Scanner Builds 3D Map of Leaning Tower of Pisa
• BBC Click (23 Sep 2013) – How 3D imaging is helping preserve history
• Huffington Post (19 Sep 2013) – 3D Mapping Creates Stunning in Images of Leaning Tower of Pisa’s Interior
• BRW (Business Review Weekly) (18 Sep 2013) – From Leaning Tower of Pisa to mining, architecture and security: how business can use CSIRO’s new 3D mapping gadget
• Courier-Mail (18 Sep 2013) – Aussie researchers make 3D map of Leaning Tower of Pisa scan using Zebedee
• BBC News (17 Sep 2013) – Tower of Pisa interior mapped in 3D
• ABC News (5 Sep 2013) – Eureka awards celebrate Australia’s top science researchers
• Channel 7 Queensland (4 Aug 2013) – The Great South East
• Reuters (30 Apr 2013) – Laser-powered Zebedee springs into Action
• Daily Planet – Discovery Channel Canada (24 Apr 2013) (only available in some regions)
• Sydney Morning Herald (20 Apr 2013) – Zebedee scanner lets police build 3D maps of crime scenes in minutes
• 9 News (13 Apr 2013) – CSIRO laser offers new view on heritage
• ABC News (11 Apr 2013) – Australian invention set to revolutionise surveying
• ABC Radio - Innovations (12 Mar 2013) – Handheld laser mapping device
• Queensland Times (16 Mar 2013) – German WWI tank in Ipswich for forensic analysis
• The Australian (20 Jan 2013) – Hand-held laser puts CSIRO on the map
• The Register (26 Dec 2013) – CSIRO mine safety tech becomes archaeological tool
• Adelaide Advertiser (25 Dec 2012) – CSIRO use 3D mapping to explore Koonalda Cave in South Australia
• Sydney Morning Herald (16 Dec 2012) – Jenolan Caves Sheltering Climate Secrets
• New Scientist (13 Dec 2012) – In search of the world’s oldest cave etching

Web Articles, Media Releases, and Blogs
• SPAR3D 2015 Test Driving the SurphSLAM
• Top 3 trends for SPAR 2016: Zeb Revo (April 2016)
• Brisbane Time 2016 - Marilyn Walkman murder cold case police return with 3d-laser-mapping device
Science Network Western Australia (17 Apr 2015) – Rare tidal movements expose Kimberley dinosaur tracks
GIScafe (13 Apr 2015) – COWI Measure Building Plans 10-Times Faster with GeoSLAM’s Game-Changing Survey Solutions
LiDARNews (10 Apr 2015) – ZEB1 vs. Tape and Disto: Measured Building Survey Accuracy Comparison
LiDARNews (12 Sep 2014) – ZEB1 Laser Scanner Helps New Zealand Scientists Measure Forest Stands
LiDARNews (29 Jun 2014) – ZEB1 Laser Scanning Helps Find New Zealand’s Deepest Gold Mine
Western Australia State Heritage Office (4 Jul 2014) – Students to Capture Historic Lands of the Midwest
fkguide.com (2 June 2014) – Meet Zebedee: Handheld LIDAR Scanning
American Surveyor (9 Apr 2014) – ZEB1 Handheld Scanner Outperforms Terrestrial Laser Scanning in Chile
WA Museum Blog (8 Apr 2014) – Zebedee and CSIRO visit the WA Museum
CNET (18 Feb 2014) – Queensland police mapping crime scenes with 3D scanner
LiDARNews (15 Feb 2014) – ABRACADABRA—A Wave of a Magic LIDAR Wand
ZDNet (14 Feb 2014) – Queensland Police to use CSIRO's Zebedee to map crime scenes
slashdot (13 Feb 2014) – Australian Police Deploy 3D Crime Scene Scanner
wired.co.uk (13 Feb 2014) – Laser-mapping crime scenes officially a thing
ComputerWorld (13 Feb 2014) – Queensland Police to map crime scenes with 3D scanner
Mining.com (2 Jan 2014) – ZEB1 Laser Scanner Put Through its Paces at Worlds Deepest Gold Mine
LiDARNews (11 Dec 2013) – 3D Laser Mapping’s ZEB1 Mobile Scanner puts New Zealand's Qntfi on the Map
AmeriSurv (27 Nov 2013) – Formby Surveys Declare ZEB1 Mobile Mapper ‘Game Changer’
ComputerWorld (04 Nov 2013) – ‘Freeing’ Robots: From 3D mapping to autonomous systems
Global Construction Review (30 Oct 2013) – First 3D map of Leaning Tower heralds new era in scanning
Discovery News (22 Sep 2013) – Tasty Tech Eye Candy of the Week (Sept 22)
CNET.com.au CRAVE (20 Sep 2013) – Tower of Pisa mapped in 3D For the first time (video)
CNET News (17 Sep 2013) – Leaning Tower of Pisa 3D-mapped with handheld laser
LiDARNews (14 Aug 2013) – Ze1 Wins Australian Innovation Award
Queensland Mining and Energy Bulletin (12 Jun 2013) – 10 of the Best Technological Revolutionaries
The Conversation (28 May 2013) – Scanning for Suspicious Packages Just Got Easier
LiDARNews (27 Apr 2013) – ZEB1 Product Review
vision-systems.com (16 Apr 2013) – Zebedee images Australian leper colony
csironewsblog (13 Apr 2013) – Keeping the past in the future with breakthrough 3D mapping technology
GeoDatapoint (12 Mar 2013) – 3D Laser Mapping Poised for Growth in North America
GeoInformatics (Feb 2013) – Mobile Mapping Goes Underground
GeoInformatics (11 Dec 2012) – 3D Laser Mapping Launches Mobile Indoor Mapping System
Spar Point Group (21 Nov 2012) – Indoor Mapping Grows up Fast
Spar Point Group (20 Nov 2012) – From prototype to product in six months
Spar Point Group (9 Nov 2012) – 3D Laser Mapping launches new mobile indoor mapping system
Quality Digest (02 Jul 2012) – Look Ma, No Targets: Simultaneous Localization and Mapping
Boeing.com (21 May 2012) – The Art of Aerospace
LiDAR News (July 2012) - CSIRO: Moving Mobile Mapping Indoors

**Publications**


**Commercial Product (ZEB1)**

The *Zebedee* system was developed by CSIRO, Australia’s national science agency, and is licensed to GeoSLAM (a UK-based startup company) who manufacture the units. The commercial version of *Zebedee* is called ZEB1 and its sister device, the ZEB REVO are now available from several distributors worldwide. If you are interested in using or purchasing ZEB1 or ZEB REVO, then please contact GeoSLAM or your regional distributor.