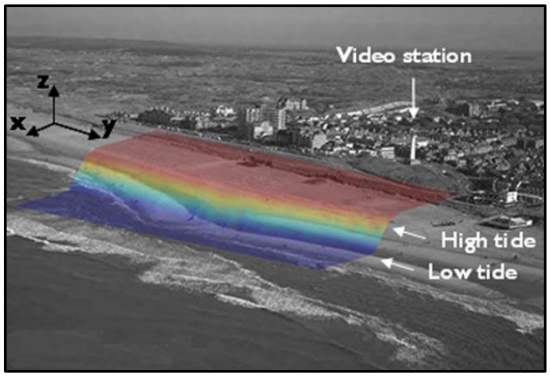
Water Research Laboratory

Coastal Engineering- Video Imaging

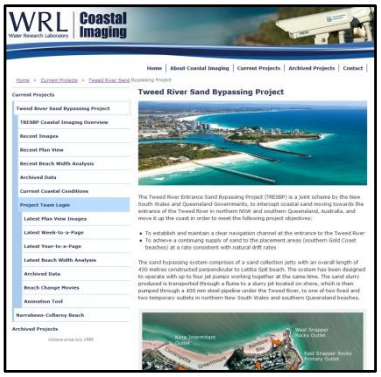
Overview

Coastal imaging is a remote sensing technology that provides coastal managers, engineers and scientists with accurate, real-time measurements of coastal features and processes. The Water Research Laboratory's (WRL) Coastal Imaging Systems remotely measure: wave speed and direction, water depth, wave runup, beach use, rip geometry, wave height, shoreline and sand bar geometry and beach erosion/ recovery volumes. Coastal imaging enables frequent and simultaneous measurement of these parameters across several kilometres of coastline and the provision of succinct data summaries for planning and management decision support.

Coastal Imaging Cameras



Coastal Imaging Survey Data

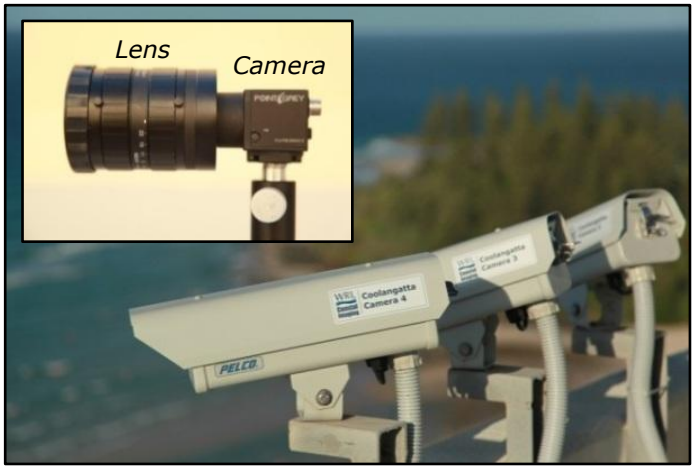


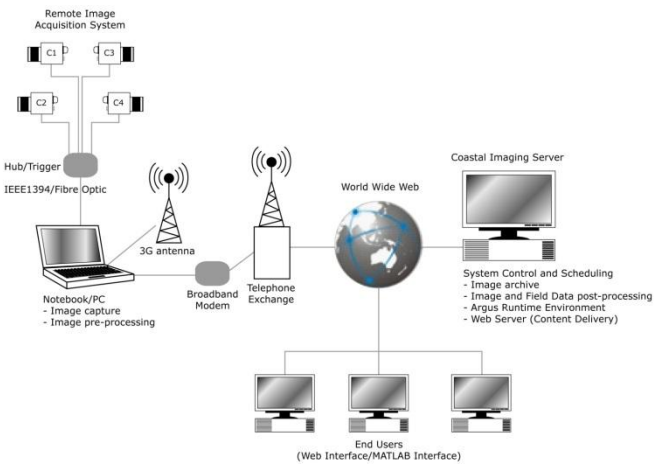
Online Data Delivery Service

The applications of coastal imaging are numerous. Engineering and scientific studies can be conducted at the desired spatial and temporal scales of interest. Coastal conditions can be automatically identified and quantified in real-time and reported online. Example applications include the performance evaluation of sub-aqueous beach nourishment, the assessment of dune erosion during heavy storm conditions, the evaluation of near-shore wave spectra, performance and overtopping assessments of coastal structures, and the evaluation of pre- and post-construction environmental impact and performance of structures including breakwaters, groynes, moles etc.

Technology

Coastal imaging involves the scientific analysis of calibrated video image data collected using specialised video imaging equipment installed on a high structure. A coastal imaging system incorporates high resolution lenses and video cameras, advanced mathematical models, quality control procedures and sophisticated image processing software. WRL's coastal imaging systems provide both qualitative and quantitative measurements, manage sources of measurement error, reduce data storage requirements and provide convenient interfaces to control all aspects of the coastal imaging operation.





Left – Coastal Imaging Cameras in Position (Inset: Lens and Camera). Right - Schematic of an Entire Coastal Imaging System

WRL Coastal Imaging Services

WRL provides design, build, installation, and training services for coastal imaging systems. These services are built around the Argus video system, a proven hardware and software system architecture that has been used by researchers, engineers and managers around the world for the last 25 years. For clients requiring turnkey solutions we provide customised versions of our Coastal Imaging Server to automate various tasks such as field data processing, image analysis, data quality control and online reporting. Our hardware and software systems can be provided as a standalone service or be integrated into a customised data delivery service.

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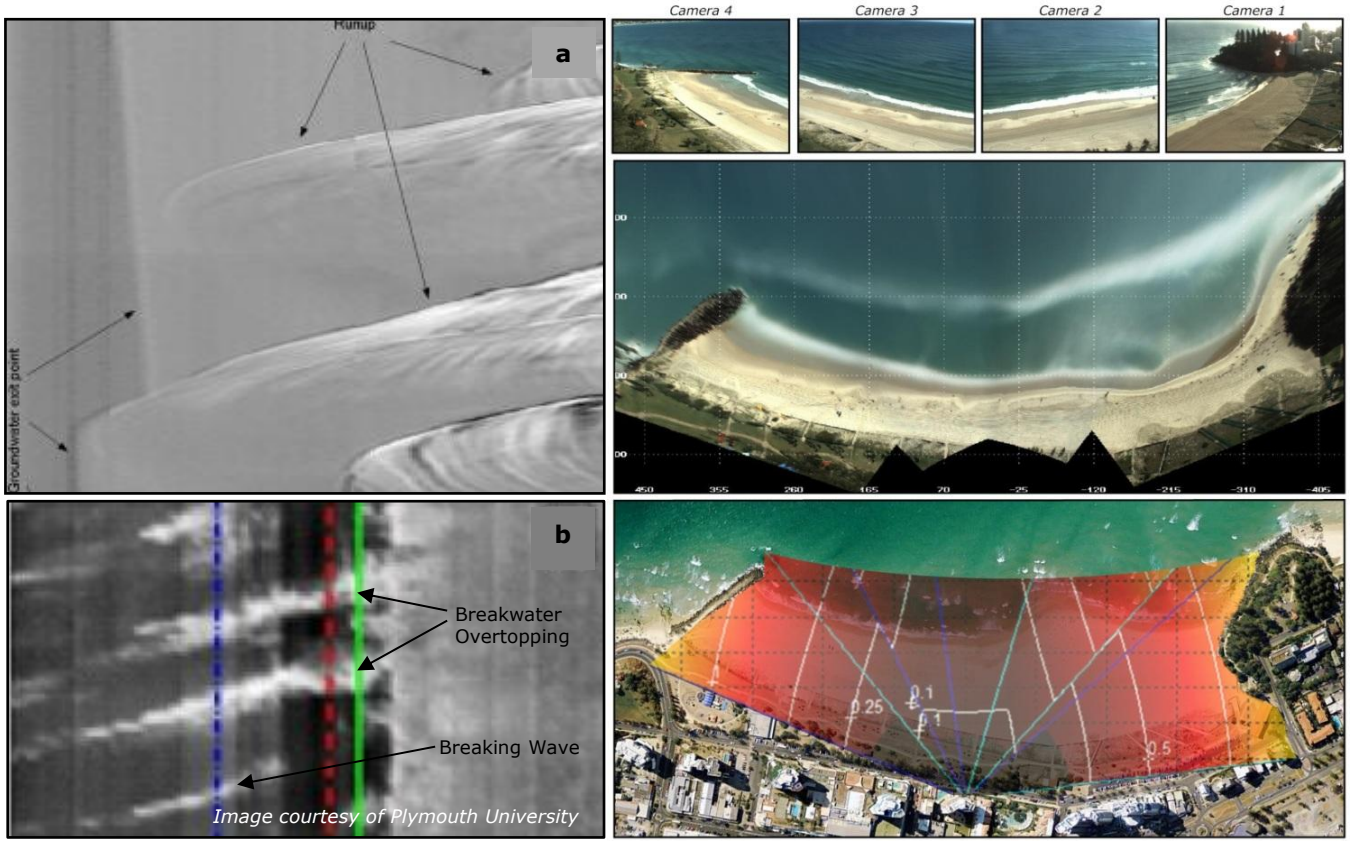
Image Products

Argus systems collect and produce a range of quantitative and qualitative image products. Standard image collection products include photos (snap-shots), time-exposures (timex), variance-exposures (min and max) and time-stacks. Any of these standard image products can then be merged and re-projected to observe and measure coastal conditions and processes at the desired viewing angle. A typical application is the re-projection of images from oblique to plan view to emulate the acquisition of accurate satellite- and ortho-imagery at very high frequency.

Snap shot | *Time Expose Image* | *Variance Images (Min)* | *Variance Images (Max)*

Snap-shot images are useful for characterising the beach at a particular point in time while timex images identify the average conditions over a short period of time. In a high energy environment this makes timex images an ideal source of quantitative, non-subjective information concerning shoreline, bar and rip positions. Min and max images identify the minimum and maximum variance in pixel intensity. These images highlight beach activity, movement of shadows and the location of all breaking waves during the averaging process.

Time-stack image products record the variation in pixel intensity with time along select lines or points (called pixel arrays). WRL's Coastal Imaging System can then analyse the optical metrics stored within these images to infer wave speed and direction, runup, currents, water depth and other time dependent visual phenomena. Example time-stack image are shown in the left panel below. The x-axis plots distance off-shore. The y-axis plots the variation of pixel intensity with time.



Left: Time-stack images showing (a) wave runup and groundwater exit point, and (b) breakwater overtopping
Top right: Snapshot Images from camera 1-4 at Coolangatta, QLD, Australia on April 8th 2013
Middle Right: Merged and reprojected images from camera 1-4 at Coolangatta, QLD, Australia on April 8th 2013
Lower Right: Google Earth Image showing corresponding Argus cross-shore measurement resolution in metres per pixel

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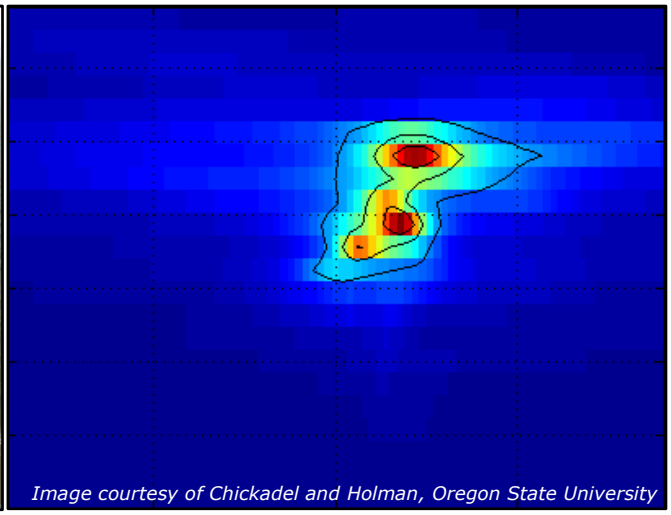
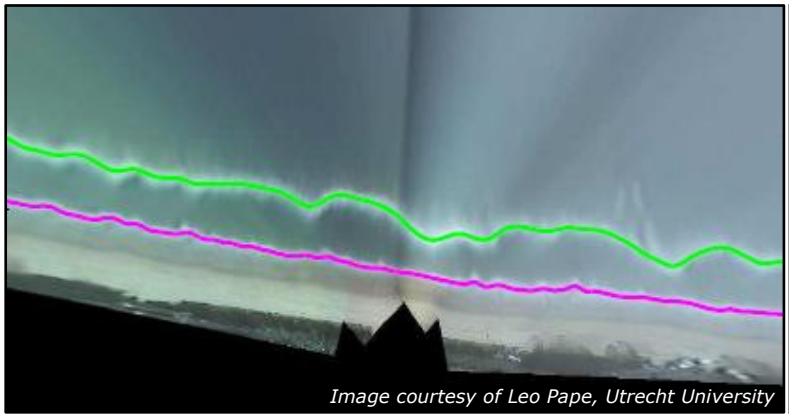
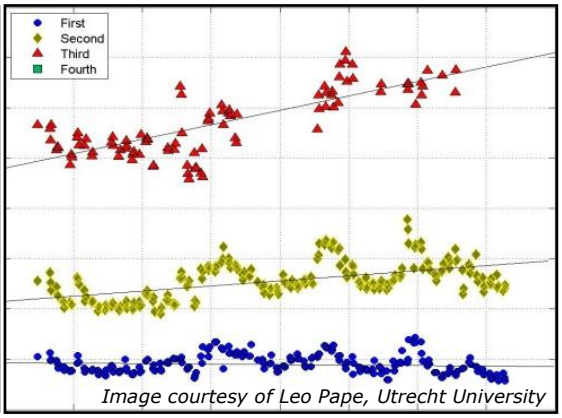
Applications

Coastal imaging data can support numerous scientific studies and coastal engineering assessments. Some example applications from international research groups are illustrated below. To learn more about WRL's past and current applications of coastal imaging in Australia please refer to the project pages of the WRL Coastal Imaging Website available at http://ci.wrl.unsw.edu.au/.

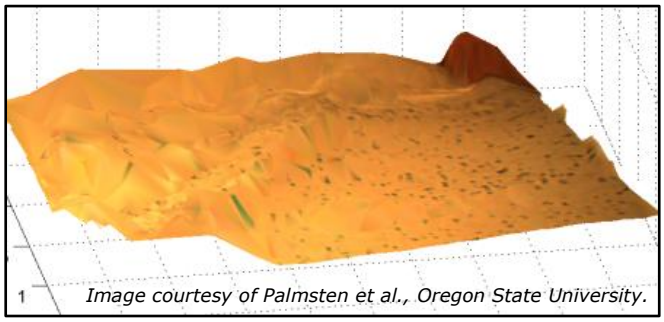


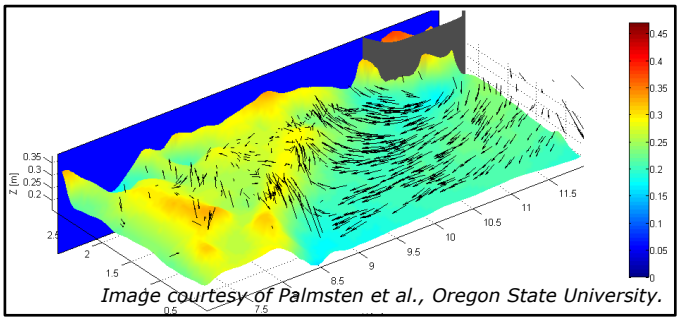
Left: Argus image showing optically sensed surface currents
Right: Fourier transform analysis of time stack image to yield directional wave spectra





Left: Monitoring of bar position and rip channels on a merged and reprojected image
Right: Trend analysis of cycles in bar / rip position





Left: Three dimensional stereoscopic image of water wave surface in a hydraulics laboratory
Right: Corresponding surface currents superimposed on a false colour image of the 3D water surface profile. Surface currents measured using Particle Image Velocimetry (PIV)

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Further Information

WRL have provided coastal imaging services to industry and research groups since 1999. To find out how your next coastal investigation could benefit from WRL's coastal imaging services please contact one of our coastal imaging experts.

Key WRL Personnel

Mr Matt Blacka

Matt has completed a Master of Engineering Science degree, with specialisation in Coastal Engineering and Management, and Bachelor of Engineering (Civil) degree, with first class honours in Coastal Engineering. He has nine years of experience working at the Water Research Laboratory, and has managed a range of projects primarily in the fields of coastal structures, coastal processes and hydraulic structures. Matt is also secretary of the Engineers Australia Sydney Division Coastal Ocean and Port Engineering Panel. Matt has been a part of WRL's Coastal Imaging team since 2006, and has managed the Coastal Imaging projects since 2009. He is experienced in all aspects of Coastal Imaging from station design and setup through to programming and analysis of image data.

Ms Erica Davey

Erica is a Project Engineer providing routine monitoring services for WRL's Argus Coastal Imaging Stations. Erica has worked on the Southern Gold Coast to deploy the Argus III video imaging system for the Tweed River Entrance Sand Bypassing Project. She holds a Bachelor of Engineering (Environmental) and a Bachelor of Science and is the recipient of the D.N. Foster Memorial Fellowship. Erica has worked on a variety of projects, ranging from coastal imaging and coastal process assessment to environmental investigations and boat wake wave assessments. She is particularly interested in the personal interface between engineering and the community. Her honours thesis investigating regional and global variations in rip current spacing and density was presented at the 2012 International Rip Current Symposium.

Dr Kristen Splinter

Kristen is a Research Associate at WRL and completed her PhD in 2009 at the Coastal Imaging Lab under the guidance of Professor Rob Holman at Oregon State University. Her research focuses on the application and development of remote sensing technologies to study the nearshore zone; specifically sand bar dynamics and sediment transport. Kristen came to WRL in 2011 and is a member of the 3-year ARC funded project *Australian Coastal Observation Network: Monitoring and Forecasting Coastal Erosion in a Changing Climate.* Her research focuses on the development of long term shoreline change models, as well as monitoring beach morphology at 10 sites along the NSW coastline and assessing the capability of video platforms to measure relevant surf zone parameters for coastal monitoring purposes.

Associate Professor Ian Turner

Associate Professor Ian Turner introduced coastal imaging to Australia in 1999 and continues to play an active role in ongoing coastal imaging projects. Ian is the Deputy Director (Research) of WRL and is responsible for the research direction and output. He is also a Senior Coastal Specialist in WRL's Coast and Estuary investigations group. Ian's current research interests include beach groundwater dynamics and sediment transport at the beach face, monitoring of coastal change and impacts of climate variability, coastal erosion control and coastal management, and coastal aquifer hydrogeology.

Recommended Reading

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