



Elevated
Robotic Services

Sensing Algae - A Case Study using Robotics

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About Us

- Gathering information for clients
- Hard to access areas, remote areas, difficult to obtain information
 - Air
 - Ground
 - Water
- Service provider for the operation of unmanned aerial systems
- Consulting in service robotics
- Deliver the right information for the job through a network of manufacturers and other service providers

The Client



- SARDA – Smoky Applied Research & Demonstration Association
- Agriculture and environmental applied research
- Address agricultural run-off for the past few years with insufficient information
- Educate farmers in ways of preventing run-off and improving the condition of lands near water

Problem Statement



- Algae detection in lakes
 - Agricultural run-off causes a build-up of nutrients (nitrogen, phosphorous, etc.)
 - Summers in Alberta have seen an increase in algae in lakes
 - Finding the source of the run-off through early detection of algae and/or nutrient concentrations
 - Hand sampling is time intensive and does not provide sufficient data

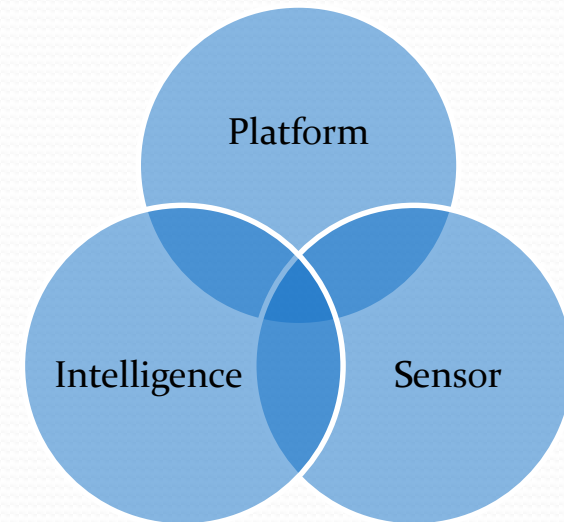
Constraints

- Budget
- On-demand information
- Repeatable
- Results easily understood

Solution Design

- Platforms to carry sensors
- Sensors for data collection
- Intelligence to control platform and/or sensors

Often interdependent and not always available for all variations.



Platforms



<http://www.bostondynamics.com/>



<http://www.bostondynamics.com/>



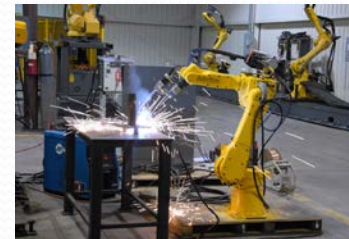
<http://www.seamor.com/>



www.egemin-automation.com



<http://www.inuktun.com/>



<http://www.robots.com/>



<http://electronicdesign.com/displays/real-robots-lego-mindstorm-nxt>



Reuters



<http://mad-science.wonderhowto.com/>



<https://www.sensefly.com>



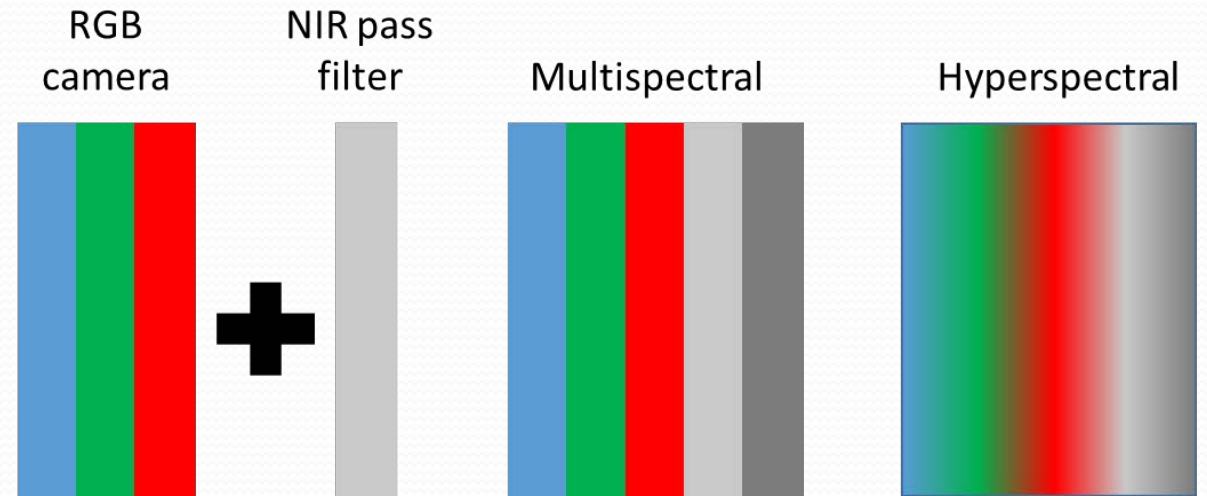
<http://aerialtronics.nl>

Sensors for Data Collection

- Sonar
- Geiger counter
- Lasers
- Vibration detection
- Chemical sensor
- LiDAR
- GPS
- Hyperspectral camera
- Multispectral
- Near infrared
- Thermal infrared
- Visible light (RGB) camera/video

Selection of Sensors

- RGB + NIR
 - Low cost
 - Vegetation detection
- Multispectral
 - Vegetation detection
 - Chlorophyll-a content, concentration of cyanobacteria (blue-green algae)
- Hyperspectral
 - High cost
 - Concentration of chlorophyll-a & phosphorous, turbidity, many other parameters



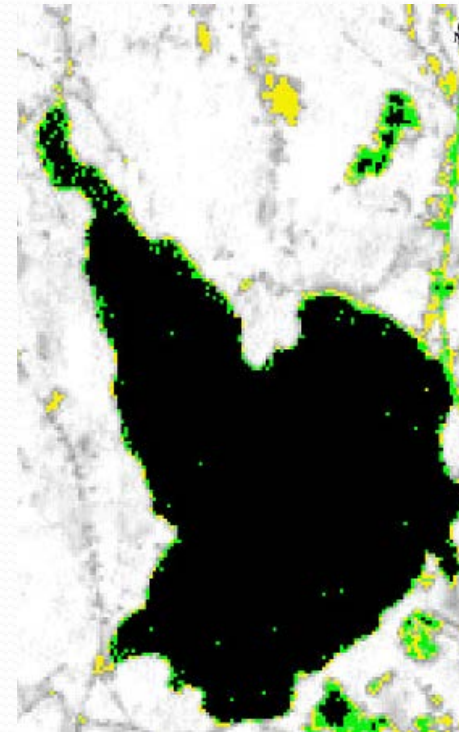
Previous Sensing of Algae



Multispectral
ETM+ data



NDVI



Selection of vegetation
pixels

Data → Information

- Processing
 - Each sensor acquires unique data that requires a different processing approach
 - Expertise
- Presentation
 - Understandable
 - Usable

Intelligence

- None
 - Manned
 - Manually remotely operated
- Some
 - Automatic
 - Autopilot
- Autonomous
 - Self-learning

Matrix of possibilities

		Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
PLATFORM	Satellite	X	X						
	Manned Aircraft			X	X	X			
	UAV						X	X	X
SENSOR	RGB & NIR	X		X			X		
	Multispectral		X		X			X	
	Hyperspectral					X			X
INTELLIGENCE	Manual			✓	✓	✓			
	Remotely Operated						✓	✓	✓
	Automatic	✓	✓				✓	✓	✓
PROCESSING	In-house	✓	✓	✓	✓		✓	✓	
	Consultants					✓			✓

Evaluation

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Costs	Low	Medium	Medium	Medium	High	Low	Medium	High
Resolution	Low	Low	Medium	Medium	Medium	High	High	High
Info Availability	On revisit period	On revisit period	Any	Any	Any	Any	Any	Any
Relative Information/Results	Low	Medium	Low	Medium	High	Low	Medium	High

Testing the solution...

- Solution choice
 - UAV with RGB + NIR pass filter, automatic flight path
- Ground truthing



Questions?