

Demonstrating the Performance of a Real-Time Optical Colorimetric Sensing Device for Monitoring the Marine Environment

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Introduction:

The research objective is to develop a cost-effective event detection sensing system to inform targeted sampling by traditional means and act as a decision support tool. The Optical Colorimetric Sensor (OCS) uses an array of LEDs to detect change in water coloration and alert to events. A prototype comprises the following features: an LED array light source, photodiode detectors, robust deployable design, GSM communication and antifouling measures. The system has been evaluated using laboratory and field measurements. The system is robust and deployable in the aquatic environment. The OCS shows potential to detect events in the environment due to a pollution.

Monitoring aquatic environments is necessary to ensure their sustainability and health. Key research drivers are European directives such as the Water Framework Directive, the Bathing Water Directive and the Marine Strategy Framework Directive. The Inherent optical properties (IOP), such as colour can be related to biological content of environmental waters. Fig.1 shows a red tide, commonly caused by *Karenia brevis* and *Alexandrium* [3]. Fig. 2 shows a green tide, commonly caused by Cyanobacteria [4].



Figure 1: Red tide, Donegal Ireland 2012 [1]



Figure 2: Green Tide QingDao China 2011 [2]

Prototype 1: Features

- Laboratory version.
- LED array light source (IR, red, amber, green, blue).
- Photodiode detectors (90 ° and 180 ° to the light source).
- Short-range wireless communications.

Prototype 2 : Features

- Field version.
- Robust deployable design
- Antifouling measures
- GSM communications

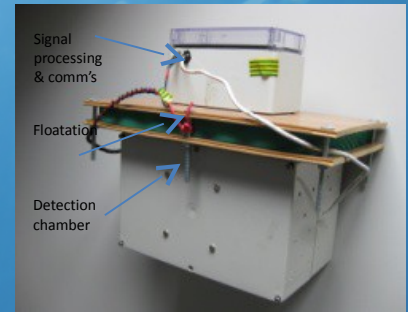


Figure 3: Photograph demonstrating Prototype 1

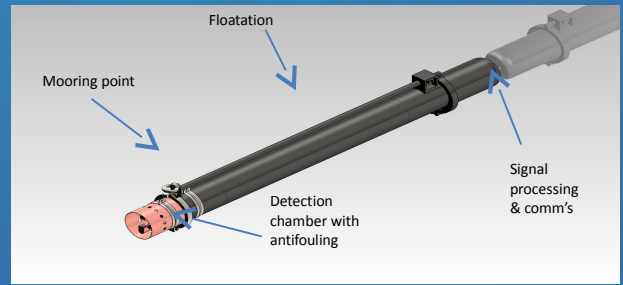


Figure 4: CAD drawing of Prototype 2

Initial testing:

Initial responses studies were studied using a series of concentrations of food dyes in tap water (v/v), analysis of environmental samples (Marine and freshwater) were then performed.

Results:

Figures 5 & 6 show the system response (per LED) to concentrations of red dye (Ponceau 4R E124), and green dye (Tartrazine E102, Green S E142) in tap water. The percentage attenuation refers to the reduction in light transmission through the sample from a baseline of transmission in tap-water. The system demonstrates sensitivity to dye concentration and colour. A clear differentiation between environmental samples is illustrated in Figure 7.

Conclusion:

- The OCS shows promising results for marine environmental applications.
- Prototype 2 system is robust and deployable in the aquatic environment.
- OCS shows potential to detect events in the environment.

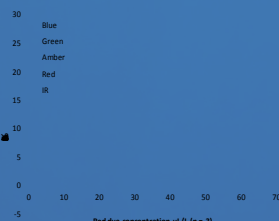


Figure 5: Response to red dye

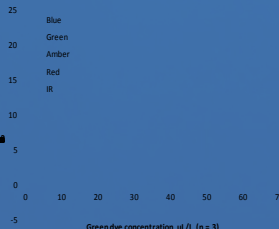


Figure 6: Response to green dye

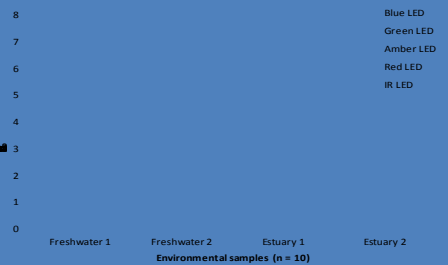


Figure 7: Response to environmental samples

References:

- [1] <http://www.belfasttelegraph.co.uk/news/local-national/republic-of-ireland/algae-tide-destroying-shellfish-16183834.html>, Accessed 2012 (August)
 - [2] <http://www.agu.org/pubs/crossref/2011/2011JC007512.shtm>, Accessed 2012 (August).
 - [3] J. T. Turner, V. Roncalli and P. Cimmiello, 2012, "Biogeographic Effects of the Gulf of Mexico Red Tide *Dinoflagellate*KareniaBrevis on Mediterranean Copepods," Harmful Algae, 16(0).
 - [4] M.T. Madigan, J.M. Martinko, P.V. Dunlap, and D.P. Clark, *Brock Biology of Microorganisms*, 12th edition, 2009, Pearson, San Francisco, United States
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