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News Release

SMART-guarding water resources with first-of-its-kind holistic sensor

- Innovative and holistic low-cost LEDIF provides in-situ, real-time optical sensing of water chemistry
- Boosts protection of water resources by providing multi-species contaminants and natural substances detection utilizing a proprietary tri-optical design
- Improves efficiency and accuracy of chemical assessment of reservoir and marine waters

LEDIF (left, 1st pix) is placed inside the Autonomous Underwater Vehicle (AUV) dubbed the NUS ARL STARFISH and launched at a reservoir.

1. Singapore – Researchers at the Singapore-MIT Alliance for Research and Technology (SMART) [新加坡-麻省理工学院科研中心] have developed a low-cost and compact multi-platform compatible sensors that provides a **holistic** solution for the monitoring of water resources. Like a "lab-on-a-chip", this sensor dubbed 'LEDIF', is a powerful "lab-on-AUV" (see picture above) that would go a long way in reinforcing efforts in safeguarding water resources while potentially improving the efficiency and accuracy of monitoring water quality.

2. LEDIF (LED-Induced Fluorescence) [二极管引发荧光] is a field-deployable tri-optical instrument that uses a combined optical technology to identify and quantify contaminants and natural substances in water. This combined optical technology includes:
(a) Fluorescence – Emission of light by a substance that has absorbed light or other electromagnetic radiation
(b) Absorbance- Quantitative measure expressed as a logarithmic ratio between the radiation falling upon a material and the radiation transmitted through a material
(c) Scattering - Irregular dispersal of waves or particles

   LEDIF pioneers the theme of "bringing lab to water" with an automated standalone tri-optical holistic technology featuring both multi-excitation and broadband sources to enable "lab-like" water chemistry assessment to be performed in-situ to monitor water resources in real-time.

Holistic solution

3. LEDIF (see Factsheet) is capable of detecting, measuring and 3-D mapping contaminants (e.g., oil spill, carcinogen hydrocarbons) when put on-board autonomous platforms. Beyond contaminants, it is capable of detecting natural substances (e.g. algae, coloured dissolved organic matter) in marine and urban environments; and climate-related sensing. Commercially available in-situ sensing probes are usually limited to physical water properties or target a specific chemical.

4. Beyond being inside a 'Yellow Submarine' [as shown in picture of the STARFISH autonomous underwater vehicle which is developed by the Acoustic Research Laboratory of the Tropical Marine Science Institute at the National University of Singapore (NUS)], the LEDIF is actually compatible with multi-platforms (e.g. Autonomous Surface Vehicles, fixed platform, and portable mode of sensing) to provide both 3-D chemical mapping and long-term continuous monitoring. These applications are important in helping to ensure that waters resources are clean from industrial pollution, oil spills and harmful algae growth.

5. Currently, most high precision organic matter detection procedures involve laboratory analysis of water samples, which would probably be time-consuming and costly. Grab water samples at specific spots may also fail to adequately capture the spatio-temporal variability, which may hold the key to understanding the biogeochemical processes in water bodies. In recent years, in-situ water quality instruments installed on water bodies have helped to provide continuous, real-time data, but are typically limited in spatial coverage due to their fixed locations.

6. Dr Kelvin Ng Chee-Loon (黃智倫), Research Scientist at SMART Centre for Environmental Sensing and Modeling (CENSAM), said: "LEDIF, our proprietary technology has myriad applications from detecting accidental and intentional pollution for implementing immediate counteractive action to quantifying natural occurring substances for research studies; providing a holistic solution capable of 24/7 surveillance of water resources. Beyond detection, its ability to provide a 3-D chemical mapping of the entire water body (which can be as large as 2 soccer fields), empowers agencies to better monitor the water situation on a large scale in the long term."

7. Professor Harold Hemond, SMART Principal Investigator and the William E. Leonhard Professor of Engineering at MIT, said: "Having worked on this technology for the past 5 years, we are confident that our research will translate into a very powerful tool for industries and governments alike in safeguarding and protecting our environment and water resources."

8. This research is based on the paper "A multi-platform optical sensor for in situ sensing of water chemistry". The abstract can be found at http://aslo.org/lomethods/free/2012/0978.html. The AUV deployment conducted locally was done in collaboration with the Acoustic Research Laboratory of the Tropical Marine Science Institute at NUS (more on NUS ARL STARFISH can be found at http://arl.nus.edu.sg/twiki/bin/view/ARL/STARFISH). The research is funded by the Singapore National Research Foundation (NRF), Prime Minister's Office, Singapore under its Campus for Research Excellence And Technological Enterprise (CREATE) programme.

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FACTSHEET

What is LEDIF?

LEDIF (LED-Induced Fluorescence) [二极管引发荧光] is a compact optical instrument utilizing fluorescence, absorbance and scattering principles for measurement. With dimensions of 20x20x15 cm, it can be packaged inside a compact enclosure and mounted at a fixed location or platform (such as buoy) or placed submerged underwater for long-term monitoring, having 3G/4G real-time data communication capability, and allowing users to automate defined tasks based on operation needs and literally empowering them with an automated optical laboratory in the water.

Its applications are varied and include the detection of the following:

Targeted Chemical Species	**Significance**	**Application**
Chlorophyll	*Measure of Algae Blooms*	Detection of Blue-Green Algae
Humic	*Chlorination*	Water Filtraton Plant
	Photochemistry	Photoreduction
	Correlated to Dinoflagellate Blooms	Prediction of "Red-Tide"
	Natural Tracers	Indicative of origination of water mass
Fluorescein Rhodamine	*Tracers*	Detection of water movements
High-Molecular-Weight HCs	*Contaminants due to* ***P*** *olycyclic* ***A*** *romatic* ***H*** *ydrocarbons*	Detection of petroleum spills, leakage from old-city gas plants, etc. Pyrene pollution
Uncharacterized Fluorescence	*Warning Signal for lab-based followup*	Pollution from detergents, whitening agents, and adverse components of natural water

3-D chemical mapping

LEDIF is capable of 3-D chemical mapping which optimises spatial observation of contaminants, thereby playing a pivotal role in identifying contaminant hotspots, among other benefits (see below). It can be mounted on an Autonomous Underwater Vehicle (AUV) such as the NUS STARFISH or MIT Reef Explorer vehicles to obtain the 3-D map.

Benefits of 3-D mapping:

(1) Determining the source of contamination

(2) Study effects of ambient conditions on targeted chemical

(3) Optimising the placement of long-term continuous monitoring sensor

(4) Filling out void of data in space quickly using autonomous mobility capability of platform (e.g. AUV)