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An intelligent and integrated equipment and distributed system based on spectroscopic surrogates and data-driven models for water quality anomaly alarming and source identification: automatically supervising urban rivers and drainage system

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Urban water pollution control is a major city problem challenged the new round of urbanization and sustainability in developing countries. For example, Shenzhen city, China invests 100 billion Chinese yuan per year for urban water environment remediation projects. How to make effective operation and maintenance on catchment water quality control is challenging local governments and operating company and it is an important task to make sure sustainability of governance effectiveness. As the increasing trends of the fusion between emerging information technology and environmental science, it is necessary to integrate enabling technologies to build novel intelligent supervising system based on environmental models and monitoring infrastructures.

This paper designed a novel system including hardware, software and the monitoring network to detect water quality anomaly and identify the potential pollutant release sources on drainage system and receiving water. The core component of the system is an in-situ intelligent equipment integrating a high-frequency water quality sensor module, a data communication and transmission module, spectroscopic detector module, a card type master computer with fixed environmental models, and a power management module, etc.

The sensor module tends to establish a linear or gray-box model of surrogate relationship between normal water quality parameters and specific chemical from the pollutant sources. Rapid forecasting of historical water quality baseline employed data-driven models like ARIMA, Facebook Prophet, and wavelet-ANN within a fixed time window. The anomaly, transient water quality events, was detected by forecasting baseline error distributions and thresholds of the calibrated model. Spectroscopic detecting employed 3D fluorescence, Raman scatter and ultra-violet technology. PARAFAC and self-organizing map (SOM) were used to analyze the real-time results of spectroscopic response. Computer vision and other figure matching algorithms were developed to identify most probable pollution sources from the spectroscopic database, which is previous established. A three level monitoring network was designed to capture the potential confidential release on the drainage system.

This pilot system is currently installed in a 5 km river section of Maozhou River, Shenzhen, China. As shown by numerical experiments and artificial field tracer experiments, the response time and accuracy of the water quality anomaly detection, and source identification is acceptable. More practical issues on the application are going to be discussed. This smart system automatically supervise the pattern and drivers of water quality changes in urban rivers and drainage system. It provides a promising framework and tools for river operating companies and administrators achieving the critical water quality standards.