An Autonomous and Self-Sustained Sensing System to Monitor Water Quality near Highways

by

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EXECUTIVE SUMMARY

This concept-exploration project successfully developed a prototype sensing system that is self-sustainable and can be used to autonomously, in-situ monitor environmental parameters in water bodies near highways. The system provides a method to rapidly, economically and safely measure environmental impact of highway construction and operation.

We used sensors, signal conditioning circuits, a microcontroller, two radio frequency (RF) transceivers, voltage regulators, microbial fuel cells, and a personal computer (PC) to develop the sensing system. The sensors are placed in the water and sense different water quality parameters; the signal conditioning circuits properly condition the signals from the sensors and provide the conditioned signals to the microcontroller; the microcontroller reads the signals from the signal conditioning circuits, processes the signals into data packets, and sends the data packets to a RF transceiver that is connected to the microcontroller; the RF transceiver sends the data packets to the RF transceiver that is connected to the PC; the PC, which can be placed in a laboratory or a office, can read the data packets from the RF transceiver and processes the water quality information contained in the data packets. The microbial fuel cells generate electricity for the sensing system using electrochemical reactions and naturally-occurring safe bacteria, whereas the voltage regulators stabilize and condition the output of the microbial fuel cells and provide properly regulated voltage to the sensors, the signal conditioning circuits, the microcontroller, and the RF transceiver connected to the microcontroller. The system was fully developed and tested and functioned mostly as expected (with a few lessons learned).

The innovation in the project lies in the coupling of online monitoring of water quality along highways with renewable and self-sustained energy generation, as well as the highly scalable microbial fuel cells specifically designed for water quality monitoring. While the technical concept has been successfully demonstrated, significant engineering improvements are needed to bring this technology to a market-ready state. The research team is in the process of filing a provisional patent to protect the intellectual property generated from this project, and funding will be pursued to support additional phases of this work, in order to further implement necessary improvements identified from this work (especially pertaining system capability, performance, reliability and cost-competitiveness) and to bring this technology to the marketplace and into practice.