MTAC FACT SHEET

Smart Pipe: Nanosensors for Monitoring Water Quantity and Quality in Public Water Systems

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A 2009 study by the American Society of Civil Engineers (ASCE) showed that 7 billion gallons of clean, treated drinking water disappears every day, mostly due to old, leaky pipes and mains. The amount is enough to serve the population of California in daily water usage. The approximate dollar cost, given varied water rates in different U.S. regions, is $20 to $100 million daily. Unfortunately, America's drinking water systems face an annual shortfall of at least $11 billion to replace aging facilities that are near the end of their useful lives and to comply with existing and future federal water regulations. Moreover, leaking systems have wasted not only dollars but also priceless natural and energy resources for future generations.

This research project was initiated to develop the concept of a sensor unit to improve water supply infrastructure via a highly advanced, cost-efficient monitoring system. We have developed a "Smart Pipe" prototype: a multi-sensor unit to monitor water flow and quality using state-of-the-art nanotechnology. Each 2.5 by 2.5 millimeter base unit includes sensors for pressure, temperature, and flow velocity (Figure 1). The Smart Pipe is connected to a wireless processor and antenna for transferring monitoring data to a Command Center console (Figure 2) in real time.

System development included hardware, software, and experiments. Each component was designed considering the feasibility of the manufacturing process, practical usage, and cost efficiency. Detailed specifications of the hardware and software are available upon request, or by visiting the project Web site at: http://www.isws.illinois.edu/gws/sensor/smartpipe/. The live demonstration with field material was conducted by embedding the sensor units inside several 2-inch PVC pipes, which were installed into a scaled-down water supply pipe network. The video of this live demonstration is available at: http://www.youtube.com/watch?v=8xSlLCScIqw.

The Smart Pipe prototype has been designed as a module unit with an expandable monitoring capability for additional sensors should they become available in the future, such as water-quality sensors for arsenic, nitrate, or radium. With several Smart Pipes installed in critical sections of a public water system, real-time monitoring will automatically detect flow rate, pipe pressure, stagnant points, slow-flow sections, pipe leakage, backflow, and water quality without altering flow conditions in the pipe. Moreover, applying this technology at an affordable cost will help small and/or rural public water systems with government water quality standards implementation, capacity development, and water systems operations.

Further study is recommended to improve this prototype via real-life application that includes study of the frequency of required maintenance, fouling investigation, measurement calibration, real-time data communication software, manufacturing cost efficiency, long-term stability, and precision and accuracy assessment for commercial-grade production.

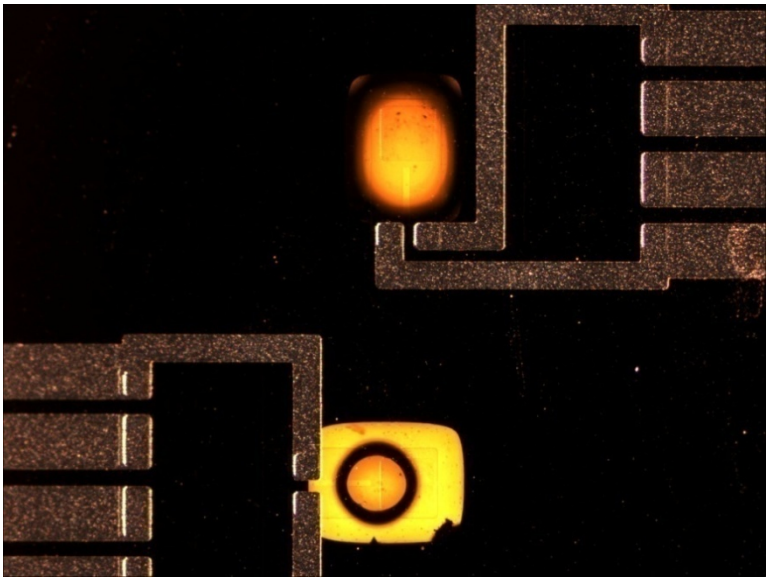

Figure 1. Photos of the temperature sensor (above) and the flow sensor (below) taken by microscope

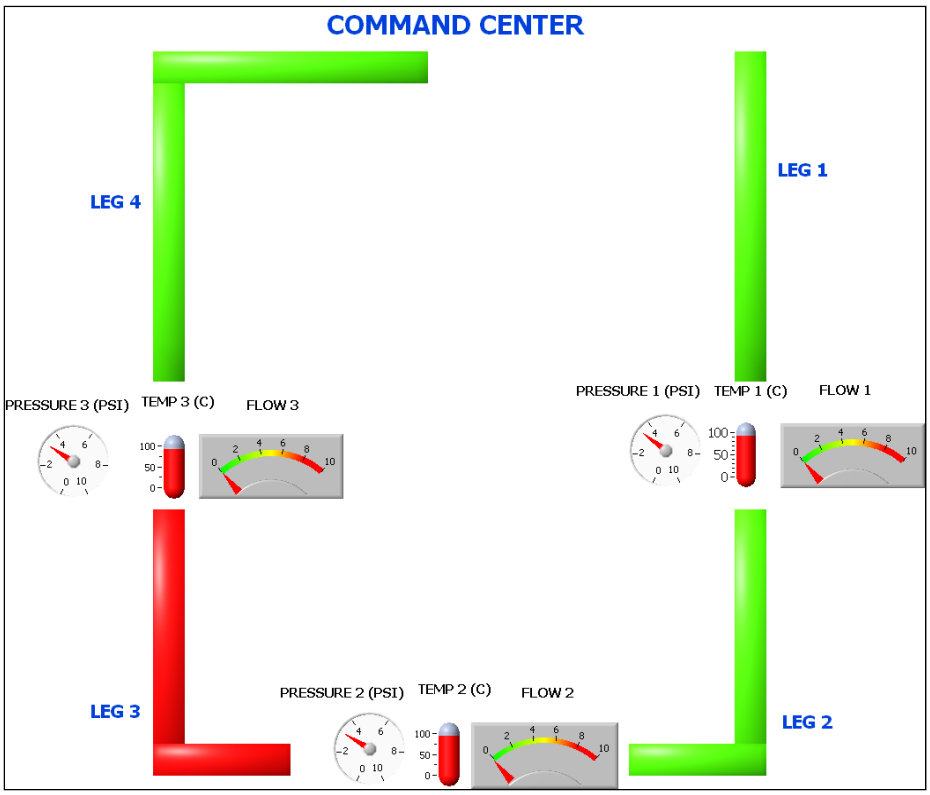

Figure 2. A screen shot of the Command Center console with pipe layout. The red pipe indicates a leaking section based on real-time monitoring.