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A vision-based tool for the control of hydraulic structures in sewer system

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During rain events, the total amount of the wastewater/storm-water mixture cannot be treated in the wastewater treatment plant; the overflowed water goes directly into the environment (lakes, rivers, streams) via devices called combined sewers overflows (CSOs). This water is untreated and is recognized as an important source of pollution. In most cases, the quantity of overflowed water is unknown due to high hydraulic turbulences during rain events; this quantity is often significant. For this reason, the monitoring of the water flow and the water level is of crucial environmental importance.

Robust monitoring of sewer systems is a challenging task to achieve. Indeed, the environment inside sewers systems is inherently harsh and hostile: constant humidity of 100%, fast and large water level changes, corrosive atmosphere, presence of gas, difficult access, solid debris inside the flow.

A flow monitoring based on traditional probes placed inside the water (such as Doppler flow meter) is difficult to conduct because of the solid material transported by the flow. Probes placed outside the flow such as ultrasonic water level probes are often used; however the measurement is generally done on only one particular point. Experience has shown that the water level in CSOs during rain events is far from being constant due to hydraulic turbulences. Thus, such probes output uncertain information. Moreover, a check of the data reliability is impossible to achieve.

The HydroPix system proposes a novel approach to the monitoring of sewers based on video images, without contact with the water flow. The goal of this system is to provide a monitoring tool for wastewater system managers (end-users). The hardware was chosen in order to suit the harsh conditions of sewers system: Cameras are 100% waterproof and corrosion-resistant; Infra-red LED illumination systems are used (waterproof, low power consumption); A waterproof case contains the registration and communication system.

The monitoring software has the following requirements: visual analysis of particular hydraulic behavior, automatic vision-based flow measurements, automatic alarm system for particular events (overflows, risk of flooding, etc), database for data management (images, events, measurements, etc.), ability to be controlled remotely. The software is implemented in modular server/client architecture under LabVIEW development system.

We have conducted conclusive in situ tests in various sewers configurations (CSOs, storm-water sewerage, WWTP); they have shown the ability of the HydroPix to perform accurate monitoring of hydraulic structures. Visual information demonstrated a better understanding of the flow behavior in complex and difficult environment.