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Potentiality of a velocity profiler to investigate sewers: results of laboratory experiments

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Abstract
Sewer inspections are usually done with CCTV. For a decade, emerging techniques have been developed and drones seem to offer new opportunities. The use of a velocity profiler is investigated in this study in order to identify and quantify velocities distributions created by lateral connection along a pipe. Disturbances created by such connections are detectable but further investigations are required to quantify the discharge from the lateral connection.

Keywords
Velocity, monitoring, 3d interpolation, inspection

INTRODUCTION
In order to propose a new inspection technique, the FOULC project (Fast Over-scanning of Underground and Linear Constructions) aims at the development of an amphibious drone to inspect sewers without creating disruption in the sewage service. The velocity/turbidity profiler (Ubertone, UB Flow) might be a part of the monitoring platform. This sensor has been set up on a rotating (around the horizontal axis in order to scan the full wet section) laboratory facility and tested: the present paper describes the experiments, the methods used to convert raw data to a 3D velocity distribution along a flume.

MATERIALS AND METHODS

Experimental setup
Based on a system previously designed (Clemens *et al.*, 2014), built and tested for a laser profiler, the profiler has been fixed on a rotating platform and its position (distance, shift, pitch, yaw and roll angles) is calculated based on measurements from three laser distance meters (Dimetix, FLS-C10) and a 3 MPix camera (Allied Vision Technology, Manta GC282C). This system (Fig. 1, left) has been installed on a moving platform, guided along a hydraulic flume of 50 m, specially prepared (with windows including lateral connections, Fig. 1 right).

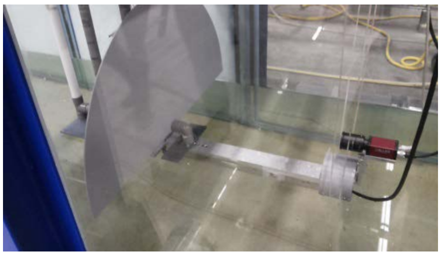


Figure 1. Experimental setup (left) and the flume (right).

Data processing

Creation of the velocity cloud. With the recorded position and rotation of the profiler (Clemens *et al.*, 2014) and its characteristics (Ubertone, 2014), cell positions (coordinates of measured volume) can be placed in a 3D field. The cloud of raw data is created.

Interpolation and construction of the velocity distribution. This method is mainly based on the four steps one proposed by Tsubaki *et al.* (2012): *i)* data filtering to remove artefacts in raw data, *ii)* isotropic gridding, *iii)* anisotropic gridding and *iv)* continuity correction.

RESULTS AND DISCUSSION

The first results show that irregular velocity distributions can be measured by the set up (Fig. 2).

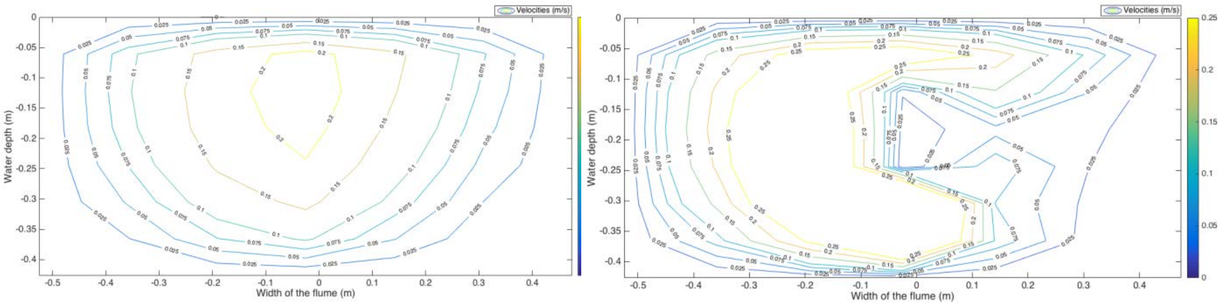

Figure 2. Velocity distribution downstream (left) and at (right) a lateral connection: Waterfall, diameter 100 mm, height 0.52m, discharge of 0.49 L/s. Discharge in the flume: 120 L/s, water level: 0.426 m.

For most the tested lateral connections, with various discharges, effects on the velocity distribution are visible.

CONCLUSIONS AND PERSPECTIVES

Effects of lateral connections are detectable with the velocity profiler and the applied method. Based on experiments, an analysis will be performed in order to better understand the limitations of this new method. Based on streamlines and velocity distributions, a method will be developed to quantify the discharge from the lateral connection.

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