Geophysical Research Abstracts
Vol. 16, EGU2014-12829, 2014
EGU General Assembly 2014

A new sensor system for accurate and precise determination of sediment dynamics and position.

Georgios Maniatis (1,2), Trevor Hoey (1), Joseph Sventek (2), and Rebecca Hodge (3)

(1) School of Geographical and Earth Sciences, University of Glasgow, (2) School of Computing Science, University of Glasgow, (3) Department of Geography, Durham University

Sediment transport processes control many significant geomorphological changes. Consequently, sediment transport dynamics are studied across a wide range of scales leading to application of a variety of conceptually different mathematical descriptions (models) and data acquisition techniques (sensing). For river sediment transport processes both Eulerian and Lagrangian formulations are used. Data are gathered using a very wide range of sensing techniques that are not always compatible with the conceptual formulation applied.
We are concerned with small to medium sediment grain-scale motion in gravel-bed rivers, and other coarse-grained environments, and: a) are developing a customised environmental sensor capable of providing coherent data that reliably record the motion; and, b) provide a mathematical framework in which these data can be analysed and interpreted, this being compatible with current stochastic approaches to sediment transport theory.

Here we present results from three different aspects of the above developmental process.

Firstly, we present a requirement analysis for the sensor based on the state of the art of the existing technologies. We focus on the factors that enhance data coherence and representativeness, extending the common practice for optimization which is based exclusively on electronics/computing related criteria. This analysis leads to formalization of a method that permits accurate control on the physical properties of the sensor using contemporary rapid prototyping techniques [Maniatis et al. 2013].

Secondly the first results are presented from a series of entrainment experiments in a 5 x 0.8 m flume in which a prototype sensor was deployed to monitor entrainment dynamics under increasing flow conditions (0.037 m3.s-1). The sensor was enclosed in an idealized spherical case (111 mm diameter) and placed on a constructed bed of hemispheres of the same diameter. We measured 3-axial inertial acceleration (as a measure of flow stress), with sampling frequency 4 to 10Hz, for two different initial positions over a range of slopes (from 0.026 to 0.57). The results reveal forces during the pre-entrainment phase and show the effect of slope on the temporal characteristics of the process.

Finally we present results from the simulations using a mathematical framework developed to integrate the inertial-dynamics data (corresponding to the above experimental procedure and sensing conceptualization) [Abeywardana et al. 2012] with the mathematical techniques used in contemporary localization applications [Zanella et al. 2012]. We specifically assess different signal filtering techniques in terms of: a) how informative they are regarding the complexity of sediment movement; and, b) how possible it is to reduce rapidly accumulating errors that occur during sensing and increase positional accuracy.

References

Maniatis, G.; Hoey, T.; Sventek, J. Sensor Enclosures: Example Application and Implications for Data Coherence. J. Sens. Actuator Netw. 2013, 2, 761-779.

Abeywardana, D. K., A. P. Hu, and N. Kularatna. "IPT charged wireless sensor module for river sedimentation detection." Sensors Applications Symposium (SAS), 2012 IEEE. IEEE, 2012.

Zannella, Fillipo, and Angelo Cenedese. "Multi-agent tracking in wireless sensor networks: implementation." WSEAS Int. Conf. on Information Technology and Computer Networks (ITCN). 2012.