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Development of a miniaturized “smart-sphere” for environmental hydraulics and geomorphology applications

Cameron Houston (1,2), David Muir (2), Jon Trinder (3), and Manousos Valyrakis (1)

(1) Water Engineering Lab, School of Engineering, University of Glasgow, Glasgow, United Kingdom, (2) Electronics and Electrical Engineering, School of Engineering, University of Glasgow, Glasgow, United Kingdom, (3) School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom

Non-intrusive particle motion monitoring techniques can be useful in robustly identifying particle transport (Diplas et al. 2010, Valyrakis and Pavlovskis 2014). This study aims to develop a smaller “smart-sphere” (following from earlier designs, Valyrakis and Alexakis 2016), to allow tracking the activity of particles resting on a riverbed surface, due to interactions with the near bed turbulent flow or other solid particles impinging on it during sediment transport, finding a wide range of application, from sediment transport monitoring to the destabilization of channel bed surfaces and scouring of infrastructure, such as bridge piers. To get data from laboratory and real world conditions, a new custom made miniaturized design of 3cm diameter is produced. This is a data-logging device encapsulated in a spherical shell, which can rest on top of the riverbed surface to simulate the response of natural pebble, exposed to rough boundary flow hydrodynamics that can set it into motion along the river. The main data logged are all the inertial axes (including acceleration and angular displacement).
Challenges will include, ensuring adequate power to achieve useful logging durations for the range of applications envisaged. At this time 2x120mAh 3.7v rechargeable lithium coin cells are used allowing the “smart-sphere” to record for at least hours. Sensors can log data at a desired frequency, with all supporting components (CPU, memory) being able to accommodate this. The circuit consists primarily of a 9-axis Invensense motion sensor capable of accelerometer and gyroscopic measurements up to 450Hz, a 16MB flash chip, with an Atmel ARM microcontroller acting as the middleman, configuring and extracting data from the sensor and formatting it appropriately for storage on flash media. Supporting embedded components include battery protection and charging, and a 3v buck converter. The outer casing of the device is designed to be robust (fully waterproof and capable of sinking to a useful depth of at least up to 10m, while optimally the device does not have to be opened in normal operation mode).

References

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