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"Smart pebble" design for environmental monitoring applications

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Sediment transport, due to primarily the action of water, wind and ice, is one of the most significant geomorphic processes responsible for shaping Earth's surface. It involves entrainment of sediment grains in rivers and estuaries due to the violently fluctuating hydrodynamic forces near the bed. Here an instrumented particle, namely a "smart pebble", is developed to investigate the exact flow conditions under which individual grains may be entrained from the surface of a gravel bed. This could lead in developing a better understanding of the processes involved, while focusing on the response of the particle during a variety of flow entrainment events.
The "smart pebble" is a particle instrumented with MEMS sensors appropriate for capturing the hydrodynamic forces a coarse particle might experience during its entrainment from the river bed. A 3-axial gyroscope and accelerometer registers data to a memory card via a microcontroller, embedded in a 3D-printed waterproof hollow spherical particle. The instrumented board is appropriately fit and centred into the shell of the pebble, so as to achieve a nearly uniform distribution of the mass which could otherwise bias its motion. The "smart pebble" is powered by an independent power to ensure autonomy and sufficiently long periods of operation appropriate for deployment in the field. Post-processing and analysis of the acquired data is currently performed offline, using scientific programming software. The performance of the instrumented particle is validated, conducting a series of calibration experiments under well-controlled laboratory conditions.
"Smart pebble" allows for a wider range of environmental sensors (e.g. for environmental/pollutant monitoring) to be incorporated so as to extend the range of its application, enabling accurate environmental monitoring which is required to ensure infrastructure resilience and preservation of ecological health.