Infrastructure Monitoring

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Proactive infrastructure monitoring and evaluation (PRIME): a new electrical resistivity tomography system for remotely monitoring the internal condition of geotechnical infrastructure assets

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We describe the development of a new low-cost, low-power, electrical resistivity tomography system (PRIME - Proactive Infrastructure Monitoring and Evaluation), designed particularly for the remote monitoring of infrastructure earthwork assets. PRIME is designed to provide continuous near-real-time information on the internal condition of the earthworks, helping to predict failures and enable timely intervention. Conventional asset monitoring involves examining the surface (either by people on the ground or from aerial photos) and using point sensors, such as moisture content and tilt meters, which only give information in the immediate vicinity of the sensor. But PRIME will use imaging for the volumetric tracking of moisture content changes and the detection of ground movement, thereby identifying problems at a much earlier stage.

The development of PRIME is driven by the increasing rate and severity of infrastructure earthwork failures. This is due to aging assets (many canal and rail earthworks are over a hundred years old) and more extreme weather events (e.g. the extreme UK rainfall during winter 2013-14). Asset failures are enormously expensive, costing hundreds of millions of pounds per year in the UK alone, not to mention risks to human health and disruption of services, transport systems and the wider economy. There is growing recognition among asset owners, managers, and consultants that remote monitoring technologies have the potential to reduce these costs and risks by providing continuous condition information and early warnings of failure.

To this end, PRIME hardware has already been successfully developed and is being demonstrated on two test sites within the railway and canal networks respectively: the first system has been installed on a railway cutting, which has been affected by instability; the second system is being used to monitor a leaking canal embankment. Here we describe the system architecture of the new monitoring instrument, system installation and operation, and the monitoring results from the two sites. In particular, we discuss the automation of the data processing and interpretation workflow, including data filtering, electrode displacement tracking (using the measured resistivity data), inversion, and automated image analysis (using computer vision approaches).

The goal of this work is to produce an integrated monitoring instrument and information delivery system – which operates automatically with minimal manual intervention - that can volumetrically track infrastructure asset deterioration and provide early warning of potential failure events.