Geophysical Research Abstracts
Vol. 19, EGU2017-2009-1, 2017
EGU General Assembly 2017

Development of an intelligent hydroinformatic system for real-time monitoring and assessment of civil infrastructure

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With the effects of climate change becoming more apparent, extreme weather events are now occurring with greater frequency throughout the world. Such extreme events have resulted in increased high intensity flood events which are having devastating consequences on hydro-structures, especially on bridge infrastructure. The remote and often inaccessible nature of such bridges makes inspections problematic, a major concern if safety assessments are required during and after extreme flood events. A solution to this is the introduction of smart, low cost sensing solutions at locations susceptible to hydro-hazards. Such solutions can provide real-time information on the health of the bridge and its environments, with such information aiding in the mitigation of the risks associated with extreme weather events.

This study presents the development of an intelligent system for remote, real-time monitoring of hydro-hazards to bridge infrastructure. The solution consists of two types of remote monitoring stations which have the capacity to monitor environmental conditions and provide real-time information to a centralized, big data database solution, from which an intelligent decision support system will accommodate the results to control and manage bridge, river and catchment assets. The first device developed as part of the system is the Weather Information Logging Device (WILD), which monitors rainfall, temperature and air and soil moisture content. The ability of the WILD to monitor rainfall in real time enables flood early warning alerts and predictive river flow conditions, thereby enabling decision makers the ability to make timely and effective decisions about critical infrastructures in advance of extreme flood events. The WILD is complemented by a second monitoring device, the Bridge Information Recording Device (BIRD), which monitors water levels at a given location in real-time. The monitoring of water levels of a river allows for, among other applications, hydraulic modelling to assess the likely impact that severe flood events will have on a bridges foundation, particularly due to scour. The process of reading and validating data from the WILD and BIRD buffer servers is outlined, as is the transmission protocol used for the sending of recorded data to a centralized repository for further use and analysis.

Finally, the development of a centralized repository for the collection of data from the WILD and BIRD devices is presented. Eventually the big data solution would be used to receive, store and send the monitored data to the hydrological models, whether existing or developed, and the results would be transmitted to the intelligent decision support system based on a web-based platform, for managing, planning and executing data, processes and procedures for bridge assets. The development of intelligent hydroinformatic system is an important tool for the protection of key infrastructure assets from the increasingly common effects of climate change.

Acknowledgement
The authors wish to acknowledge the financial support of the European Commission, through the Marie Curie Industry-Academia Partnership and Pathways Network BRIDGE SMS (Intelligent Bridge Assessment Maintenance and Management System) - FP7-People-2013-IAPP- 612517.