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Crucial infrastructure monitoring in the frame of the PROION Project

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Abstract

A research project under the acronym “PROION” is being executed by a consortium of Greek companies and Research Institutes. The project aims to develop an electronic platform for the continuous monitoring of critical national infrastructures in the broader area of the Corinthian Gulf inside the Greek Supersite called Enceladus. Enceladus Supersite is the most active tectonic and seismic area in Europe and includes geographically the urban centers of Athens, Corinth and Patras (> 50% of the country's population), tourist resorts, some of the most important archaeological monuments in the country and some very important infrastructures such as Mornos and Evinos dams, Rion Antirrio Bridge etc. Thus, there is a great need to develop reliable cost-effective system, which integrate remote sensing data, in situ measurements and advanced methods for infrastructure monitoring. Monitoring is based on the combination of instrumental and remote sensing measurements along with soft computing in order to generate an innovative decision-making and decision-support tool.

1. Introduction

Climate change has emerged as a global challenge with serious consequences for both humans and environment. In this context, infrastructure monitoring constitutes a vital issue, that requires the development of reliable cost-effective systems, in which remote sensing data, field measurements and advanced methods are integrated. “PROION” is a research project, focused on the development of a platform for the continuous monitoring of high priority infrastructure (public infrastructure, dams, bridges, etc.) in a highly -tectonically and seismically- active area (Fig. 1.). The project is financially supported by the European Union and the Hellenic government. The monitoring procedure is based on the integration of instrumental and remote sensing measurements along with soft computing algorithms, aiming at generating an innovative decision- making and support tool.

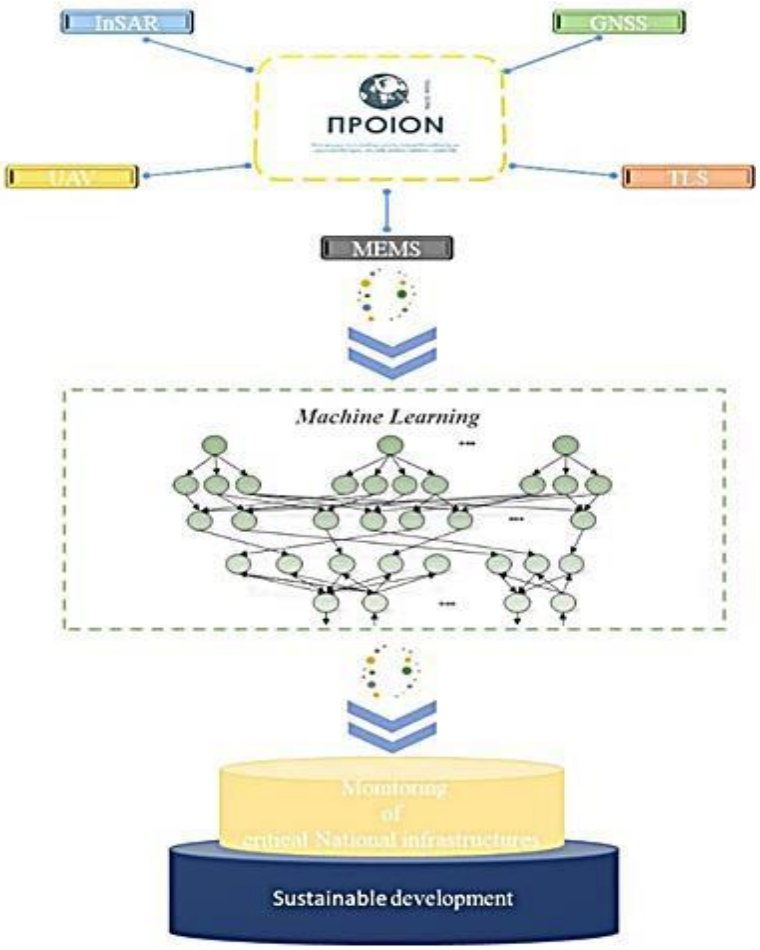

Figure 1: Architecture of PROION project.

1.1 Observation Sites

Three areas were selected to be the test sites of PROION project. The first one is the building of the Department of Geology, in the University of Patras Campus. Every day more than 200 hundred students and faculty members spend plenty of hours inside the building. Thus, it is a very crowded spot that should be monitored for safety reasons. The second test site is the Asteri Dam located about 12 km south-west of the city of Patras in the northwestern part of the Peloponnese Peninsula (Greece). The dam was built to secure the freshwater supply for three different municipalities (municipality of Patras, Erymanthos, and Dytiki Achaia). As the third study area, we have selected an active landslide in Krini village, Western Greece. The specific landslide was investigated for the first time in 1985 by the Greek Geological Survey (IGME). As described in [1] the Krini landslide is a large earth flow with a mainly E-W slope-parallel displacement trend.

2. PROION Architecture

2.1 Remote Sensing Activities

Multidisciplinary remote sensing data and methodologies like Unmanned aerial Vehicles, Terrestrial Laser Scanning and Interferometric SAR are combined over the three test sites. In particular, a Vertical Takeoff and Landing (VToL) UAV purchased in the frame of PROION project is used for the accurate 3D mapping. Moreover, the precise 3D representation of the test sites

was performed using a Leica P50 laser scanner. TLS and UAV point clouds will be utilized as 3D base map of the test sites. Repeated campaigns are planned in order to monitor the stability of each observation area. In addition, Sentinel-1 SAR images will process via Persistent Scatterer Interferometry (PSInSAR) technique in order to detect and map any possible deformation. In this framework, three trihedral corner reflectors were designed in the GIS and Remote Sensing Laboratory, University of Patras.

2.2 Accelerometers

A new three-axis accelerometer was developed and constructed in the frame of Proion Project by European Sensor Systems. The response of the accelerometer was checked through a series of tests carried out at the Seismic Simulator Laboratory of the Departments of Civil Engineering at the University of Patras. After the calibration of the accelerometer prototype, three sensors are installed in the three test sites and the recordings are collected and processed using a Matlab script.

2.3 Low cost GNSS

In this project we designed a low-cost instrumentation set that includes a multi-GNSS dual-frequency chip (Ublox F9P module) mounted on a Raspberry-Pi 4 board together with an industry-standard MEMS accelerometer. The GNSS data are collected via 4G wireless channels, are quality-checked and finally processed using an open-source software. The daily multi-GNSS files are available from the NOA web server with a latency of a few hours.

2.4 Soft computing algorithms

Civil infrastructure monitoring such as bridges, tunnels, roadways are some cases that have benefited from the application of soft computing algorithms [2]. The project “PROION” will attempt to use classic machine learning techniques along with fuzzy logic based techniques to combine data from different data sensing sources to assess the state of several important infrastructures.

2.5 Web platform

At the implementation phase, a dedicated PROION web platform will be developed. As a main PROION component, the platform will also act as a portal for the end-users to interact with the project’s data and results. The platform’s main aspect it to manage the data deriving from the acquired measurements and provide accurate information to the end-users/stakeholders. Furthermore, the service can be exploited for commercial use either to be sold partially or entirely as a service, including technical support and training. Moreover, the project’s technical equipment parts are also available to the stakeholders.

3. Outlook for the future

“PROION” project is in an early stage, in which instrumental and remote sensing measurements are collected and processed. Meanwhile, suitable soft computing algorithms are being developed and the web platform is being designed, towards the generation of an innovative decision-making and decision-support tool.

4. Acknowledgements

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