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Automatic Photomonitoring Analyses for Rockfall Detection and Mapping at the Poggio Baldi Landslide, Italy

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In recent years, the monitoring of natural phenomena has become increasingly essential, with scientific innovations continuously enhancing its quality through more effective tools and efficient techniques. This study focuses on the synergistic utilization of two complementary monitoring techniques employed at the Poggio Baldi natural laboratory to monitor the active rock scarp: photomonitoring and laser surveys.

The Poggio Baldi landslide is one of the largest rock and debris landslide phenomena in the Emilia-Romagna Apennines, with an estimated volume of approximately 4 million cubic meters. Two documented episodes of activation occurred on March 25, 1914, and March 18, 2010, with ongoing rockfall phenomena on the scarp. To monitor the current rockfall phenomena on the landslide slope in 2021, the University La Sapienza inaugurated the Poggio Baldi natural laboratory. Over the past three years, a combination of monitoring techniques for rockfall has been employed at this site.

Utilizing affordable sensors such as optical cameras enable the daily monitoring of slopes. Through the implementation of automated acquisitions, images can be captured at an hourly frequency or even more frequently. This approach provides detailed information on rockfall occurrences, including their specific locations, affected surface areas, and the frequency magnitude relationships. To further validate rockfall occurrences, additional instruments like microphones and seismic devices can be integrated. The acquired images possess a lightweight quality, making photomonitoring a practical and cost-effective option for continuous surveillance. These images facilitate change detection analyses, allowing for the assessment of any alterations between successive images. The analytical process has been seamlessly automated to enhance efficiency.

The combined use of laser scanners and photomonitoring creates a comprehensive monitoring strategy. While laser scanners provide detailed volumetric data, photomonitoring enhances the understanding of individual events' frequency, size, and location. This combined approach leverages the strengths of each technique, mitigating the limitations of the individual methods. Relying only on periodic LiDAR acquisitions wouldn't enable us to assess whether portions of the landslide slope collapsed in a single event or multiple events, and if smaller rockfalls could be

precursors to larger magnitude events. Moreover, employing this combination of permanently installing an optical instrument and conducting periodic LiDAR surveys proves advantageous both economically and in managing the volume of data.

The advantage of this combined method lies in its ability to provide both detailed, high-resolution data from laser surveys and near real-time information from photomonitoring. This approach allows for a better understanding of the ongoing dynamics of the landslide at Poggio Baldi, contributing valuable insights for hazard assessment and facilitating the development of more effective risk mitigation strategies.