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A novel fiber-optic sensing system for monitoring debris flows

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The gradual increase in over-cultivation in mountainous regions worldwide has led to frequent landslides and debris flows. Landslides and debris flows usually produce ground vibrations and loud noises. Monitoring ground vibrations is accepted as a reliable way to detect the occurrence of such natural hazards. Various sensors have been utilized to record ground vibrations generated by debris flows. These sensors include the seismometer, geophone, microphone, accelerometer, and hydrophone. Among these sensors, geophones are most widely installed in systems monitoring debris flows. However, ground tremors generated by debris flows are significantly smaller than ground vibrations caused by earthquakes, and have a higher frequency range. Consequently, debris flow tremors can only be detected within a relatively short distance. Although this shortcoming can be overcome by installing sensors close to the origins of debris flows, deploying long cables results in high signal attenuation and transmission uncertainty in mountainous regions. Fiber optic sensors have recently been devised to detect various physical signals. Thanks to their light weight, immunity to electromagnetic interference, high sensitivity and very low optical loss, fiber-optic sensors can be potentially utilized to monitor debris flows or similar natural disasters, which usually occur in mountainous regions far from available electricity.

This study presents a novel fiber-optic sensing system for monitoring debris flows. The ground vibrations due to debris flows were sensed by a FBG Accelerometer (Gavea Sensor GS 6500) and the associated light source, data logger and photo detector are provided by a Braggscope (Fiber Sensing FS 5500). Four FBG Accelerometers were deployed along the Ai-Yu-Zi Creek, Nantou County, Taiwan, and the Braggscope was located at the front data-receiving center, a small house built near the place where electric power supply is available. After the setup of the system, artificial seismic sources were produced near each sensor either separately or simultaneously, to test the sensitivity of the sensors and the functioning of the system. The received data were also analyzed to show that the received signals own the correct frequency character and thus confirm the applicability of the monitoring system.