Passive RFID, a new technology for dense and long-term monitoring of unstable structures.

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Passive RFID technologies in earth science today

**f = 125 kHz**

- Near-field magnetic coupling
- Tag-reader distance < 0.5 m
- Typical applications: contactless payment, personal identification, animal identification
- Used to monitor riverine bedload

**f = 866 MHz**

- Far-field backscattering
- Tag-reader distance 0 to > 10 m
- Typical applications: tracking goods for logistics, transportation and retail
- Used to monitor landslide displacements

Why passive RFID tags to monitor the earth surface?

=> Deploy hundreds of low-cost wireless sensors for years

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Bedload monitoring (125kHz tags)

Tags inserted in pebbles and manually tracked with a mobile reader.

Mature method, used in 50+ studies. Advantages:
- High recovery rate (vs. paint)
- Identification (vs. magnetic & radioactive tracers)
- Small, cheap, and no battery (vs. radio emitters)

Monitors the riverine bedload of hundreds of pebbles during years (here 833 tags for 3 years). (Bradley and Tucker, 2012)
Application to debris flow study (125 kHz tags)

(A) Position of tracked pebbles after being moved by (B) a debris flow in 2015. Each color represents a position where pebbles were initially inserted.

Graff et al., 2018

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Accurate displacement monitoring using the phase difference (868 MHz tags)

Tags displacement measured by phase variations, with 868 MHz tags

\[ \phi_2 - \phi_1 = -\frac{4\pi}{\lambda} \delta r \]

Nikitin et al., 2000

Phase ↔ Displacement
Application of RFID phase-based ranging on a landslide (Pont-Bourquin)

Le Breton et al., 2019
Does it work?

RFID technique validated + More stable than wire extensometer under rain and snow

Le Breton et al. 2019

20-m long extensometer and tag-reader distance here:

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Cloud software for processing and visualization

Available today:

- Automatic RFID processing
- Interactive visualization
- Detailed data for each tag
- SMS/email alert on threshold

Operational on 3 landslides:

- Pont-Bourquin
- Harmalière
- Valloire

Ask me for a demo access:
> mathieu.lebreton@geolithe.com
Passive radio-frequency identification ranging, a dense and weather-robust technique for landslide displacement monitoring

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Abstract

Ground deformation monitoring at a local scale requires accuracy, along with dense spatio-temporal resolution. Radio-Frequency Identification (RFID) technology is proposed as an alternative to classical geodetic methods for monitoring displacements of a landslide. Passive RFID tags allow for a very dense resolution, both in time and space, at the scale of a 100-m-long surface. By deploying 19 passive RFID tags on a landslide for 5 months, this study validates the technique by comparison with laser total station and wire extensometer data. The accuracy of the RFID technique was 1 cm during normal weather and up to 8 cm during snow events. The results demonstrate that RFID tag tracking can monitor landslide displacements with multiple sensors at low cost, providing dense spatio-temporal data. This technique could potentially be used for other applications such as monitoring volcanic activity, buildings, unstable rocks or snow cover.


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