
*The technology*

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WORKSHOP
Monitorització del terreny com a eina de gestió del risc
i presentació del Projecte Europeu Wi-GIM
Institut Cartogràfic i Geològic de Catalunya
Barcelona, 27 January 2017
WI-GIM Life Project (LIFE12/ENV/IT001033)

- Wireless Sensor Network for Ground Instability Monitoring
  - Beginning date: 01/01/2014
  - End date: 31/03/2017
  - Total Budget of the project: € 1.043.090 (EU Contribution 49%)

- Coordinating Beneficiary:
  - International Consortium on Advanced Design (ICAD) - Italy

- Associated Beneficiary:
  - Earth Science Department – University of Florence (DST) - Italy
  - Institut Cartografic i Geològic de Catalunya (ICGC) - Spain
  - Istituto Nazionale di Geofisica e Vulcanologia – Sez. Pisa (INGV) - Italy
  - Regione Emilia-Romagna (RER) - Italy
Landslide monitoring technology

SURFACE CONTACT TECHNOLOGY
- Extensometer
- Inclinometer

REMOTE SENSING TECHNOLOGY
- SAR Systems

Disadvantage:
INSTALLATION

WSN
Wireless Sensor Network

Cost effective node
Easy and quick installation
Good Accuracy (it depends from technology)

Disadvantage:
COSTS INSTALLATION

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WSN + RANGING RADIO

Wireless Sensor Network benefits
+
Sensor node distance measurement with radio frequency technology
WI-GIM Life: Ranging technology

**HYBRID SOLUTION**

**WI-Gim Node**

- **Ultra Wide Band**
- **FMCW Radar**
- **GPS**
- **GSM**

- Ranging + Data Nodes communication
- Hi Precision Ranging
- Absolute position
- Data web access

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Ultra Wide Band

LAB TEST RESULTS

Accuracy: ±8 cm

Coverage: 150 m (LOS)

Ranging + Communication
Ultra Wide Band

\[
\text{range} = \frac{t_{\text{round-trip}} - t_{\text{turn-around}}}{2}
\]

line of sight

1st reflection

2nd reflection

Received signal

Delay (ns)
LAB TEST RESULTS

Accuracy: ≈ 8 mm

Coverage: ≈ 70 m

(LOS) It depends on the target surface area
FMCW Radar

\[
\frac{t_d}{T_s} = \frac{f_b}{B_{\text{sweep}}}
\]

\[
R = \frac{cT_s f_b}{2B_{\text{sweep}}}
\]

frequency excursion, sweep bandwidth \( B_{\text{sweep}} \)

beat frequency \( f_b \)

sweep time \( T_s \)

range \( R \)

receiver output

Fourier transformation

modulus of the spectrum
WI-GIM Life: General architecture
WI-GIM Life: Benefits of ad hoc networks

The architecture has been designed as an ad-hoc sensors network

- Cluster-based
  - Independent clusters
  - Non-contiguous areas can be monitored at the same time
  - More flexibility
  - More scalability
  - More adapt to future upgrades

- No need for a “stable” area
- User-friendly configuration wizard
- Remote alarms
- Remote periodical report
WI-GIM Life: Project Idea
WI-GIM Life: Project Idea

Quick Installation
Low Cost
Flexibility
Real-Time
Modularity
Low vulnerability
Limited Environmental Impact
WI-GIM Life: Prototype Development

Master:
- Radar
- Decawave
- Master Node
- Battery (3 kg)

Slave:
- Slaves Node
- Battery (3 kg)
- Decawave

Measurements:
- 170 cm
- 200 cm
- 80 cm
- 90 cm
- 180 cm

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WI-GIM Life: Prototype Testing
WI-GIM Life: Roncovetro Experimental Site
WI-GIM Life: Sallent Experimental Site

Master Node UWB

Master Node Radar
System Offsets
- Compensation of Sensitivity of Decawave UWB algorithm

Outliers
- Algorithms for identification and compensation of outliers have been developed

Electronic noise depends on temperature
- It has been compensated with data post-elaboration

Compact and resistant chassis
- Atmospheric agent resistant (snow, rain, humidity)

System Power Consumption
- Event-driven wake-up firmware algorithms have been developed to perform energy saving on battery
- Solar Cell add-on available
ACCURACY OF RAW-DATA HIGHER THAN EXPECTED

THE SYSTEM WORKED WELL IN EXPERIMENTAL SITE
- Early warning possible device for fast landslides (type 3-7)

WEB DATA POST-PROCESSING CAN FURTHER REDUCE THE ERRORS

HIGH POTENTIAL OF INDUSTRIALIZATION
- Device can be much smaller in the final version
- Energy consumption can be much less with further hardware and software optimization
THANK YOU FOR YOUR ATTENTION

http://www.life-wigim.eu
WI-GIM Life EU Project
WI-GIM Channel

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