

Drone-Borne GPR Innovations for Soil Moisture Monitoring

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Abstract:

The accurate understanding of root-zone soil moisture and its spatiotemporal dynamics is essential for optimizing irrigation within precision agriculture. In the DuraTechFarm project, we have monitored the root-zone soil moisture of a spinach field across its growing season employing gprSense, an innovative drone-borne Ground Penetrating Radar (GPR) system. Developed by Sensar Consulting in Belgium under the EU agROBOfood MIRAGE project, gprSense integrates a specially designed frequency-domain radar instrument with full-wave inversion. This state-of-the-art combination not only refines the determination of soil dielectric properties but also facilitates automated, real-time data acquisition and processing. Its user-friendly interface enables both scientists and non-specialists, such as farmers, to conduct advanced radar data analyses, thereby enhancing its applicability in real-world scenarios.

Initially deployed on the irrigation robot 'Oscar' with Osiris Agriculture (France), gprSense represents a significant leap forward in effective water management and the promotion of sustainable agricultural practices. Throughout the growing season, we generated eight distinct soil moisture maps that revealed spatial correlations with field topography, soil electrical conductivity, and pedological data. Validated by traditional moisture sensing techniques, such as time-domain reflectometry, these maps consistently aligned with precipitation and irrigation events, thereby confirming the reliability of this method in accurately capturing the spatial patterns and temporal fluctuations of soil moisture in response to water inputs. Additionally, the results supported the estimated characterization depth of 30-40 cm for the 110-120 MHz frequency range used in this study.

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