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UAV-RFID landslide monitoring : centimetric precision with flying antennas

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Radio-Frequency Identification (RFID) shows great potential for earth-sciences applications [1], notably for landslide surface monitoring at a high spatio-temporal resolution with long-term robustness to meteorological events (rain, fog, snow) [1,2]. The ability to localize RFID tags using Unmanned Aerial Vehicles (UAV) in a Synthetic Aperture Radar (SAR) approach, would offer new possibilites for monitoring inaccessible terrain, even under vegetation and snow [3].

To that end, an onboard measurement system was built that allows Global Positionning (GPS) tracking of an RFID reader antenna, in order to perform real-time SAR measurement acquisition. Three antenna tracking methods were compared.

In addition, Markov-Chain Monte-Carlo (MCMC) optimization was used to estimate tag position and characterize the solution, even in non-convex cost function scenarios. Two cost functions were compared, based on different RFID-phase processing approaches.

Real-time SAR-RFID localization yielded a centimeter accuracy in the horizontal plane, with lower resolution in the vertical direction. The Post-Processed Kinematics algorithm proved to best fit antenna tracking. The unwrapped-phase cost function provided more convex solutions, at the cost of a lower accuracy compared to the complex-phase cost function. MCMC is computationally efficient in SAR-RFID optimization, with enhanced results concerning the shape and orientation of the main localization errors.

[1] Le Breton, Mathieu, et al. "Passive radio-frequency identification ranging, a dense and weather-robust technique for landslide displacement monitoring." Engineering geology 250 (2019): 1-10.

[2] Charléty, Arthur, et al. "2D Phase-based RFID localization for on-site landslide monitoring." Remote Sensing 14.15 (2022): 3577.

[3] Charléty, Arthur, et al. Towards centimeter precision UAV-RFID localization, in preparation.