

UAV-Based Synthetic Aperture Ground Penetrating Radar

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A novel approach for antipersonnel landmine detection using a UAV in combination with a Synthetic Aperture Ground Penetrating Radar (SAGPR) is presented. The objective of the system is to achieve a significant progress in humanitarian demining. To accelerate the process of land release, the focus is on the technical survey. The presence and approximate location of suspicious objects shall be detected by the radar and marked for further investigations using different sensor modules.

For a reliable mine detection it is beneficial if different sensor principles are used. Since the payload of a UAV is limited the overall system is separated into a carrier platform and independently operating sensor modules. The interface between the carrier platform and the sensor module is mechanical only.

As carrier platform, a 5 kg-payload octocopter in conjunction with a Pixhawk PX4 flight controller was chosen. The SAGPR module consists of a 1 GHz to 4 GHz side-looking FMCW radar, a single-board computer for data logging and a RTK GNSS for localization. The radar is a SISO system in a bistatic configuration.

The image processing is done offline using a backprojection algorithm. This SAR algorithm can handle low frequency UWB FMCW radar data obtained from a non-linear flight path in the near and far field of a wide-beamwidth antenna and thus meets all requirements.

As introduction, the fundamental system concept and the challenges of this approach with respect to the SAGPR module are presented. To verify the functionality, UAV-based Stripmap SAR measurements and linear rail based GPR measurements

are shown in the experimental part of this presentation. Thereby, the challenges of Stripmap SAR in conjunction with a SISO radar system are discussed.

These results motivate an innovative method – Spotlight SAR – for UAV-based mine detection, which is presented in the following theoretical part of this presentation. Finally, a short conclusion is given.