BISTATIC EXPERIMENT WITH THE UWB-CARABAS SENSOR - FIRST RESULTS AND PROSPECTS FOR FUTURE APPLICATIONS

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ABSTRACT

Bistatic SAR experiments are in focus in recent years. We will present first results of an airborne bistatic experiment with the Swedish ultra-wideband sensor CARABAS, operating in 28-73 MHz. The campaign was conducted in cooperation with the Swedish Defence Research Agency FOI in Spiez, Switzerland in September 2007. It is the first large-scaled bistatic experiment with the CARABAS-sensor. The acquired bistatic data include HH and HV polarization with bistatic elevation angles of 4°, 10° and 20° for linear and circular transmitter flight tracks and fixed receiving antennas installed on a mountain. Unfortunately, during the campaign interferences with TV channels occurred and thus the resolution of the data is reduced since the bands from 40MHz to 60MHz are oversaturated and not of use for the processing. In [1] the main emphasis was placed on planning and realization of the bistatic CARABAS campaign. In [1, 2] results only for an HH linear bistatic case were presented. Now, all data – including HV channel and circular flight tracks – were generated by a time-domain global backprojection processor. Examples are illustrated in Fig. 1. and their quality is evaluated. Furthermore, in this paper we will give an in-depth prospect of potential future applications that become feasible by one of the most comprehensive bistatic low-frequency UWB datasets and are part of our ongoing research.

Fig. 1 shows a test area in Switzerland. The monostatic case is presented as well for reference (left, top). The HH linear case is illustrated for all bistatic elevation angles (4°, 10°, 20°) in a zoomed version (right, top). Furthermore, one circular track (left, bottom) and the HV linear case for all bistatic elevation angles (right, bottom) are presented. Quality measurements were introduced, evaluated and compared to simulated data. The resolution is – under consideration of the restrictions in the bandwidth – close to the theoretical optimum and the signal-to-noise ratio is within the boundaries that were derived from simulated data.

The potential of bistatic data for future applications is extensive and ranges from improving signal-to-clutter ratio for vehicle detection in forested areas and extending 3D-SAR applications to classification of natural versus artificial objects and air moving target detection. The improvement of signal-to-clutter ratio for a more robust (change) detection algorithm was already discussed in [2]. For 3D-SAR we developed a multi flight track algorithm to reconstruct height profiles from CARABAS monostatic data which is especially interesting for glaciers (foliage penetration of low-frequency electromagnetic waves into ice). These results can also be realized by a bistatic configuration with the advantage of cost savings and simultaneous data recording. More complex problems include object classification and air moving target detection. The comprehensive dataset with polarimetric, multi-angle, mono- and bistatic data enables one to perform an extensive feature extraction since they provide a rough approximation of a Bidirectional Reflectance Distribution Function (BRDF) for each (pixel-)object. These features seem to be an important input for distinguishing natural and artificial targets.

E.g. in Fig. 1 (top), a forested area, the corner reflector and a vehicle are labeled. One can see that with increasing bistatic angle the intensity of the backscattered radar energy for the vehicle and the corner reflector (artificial objects) remains almost unchanged while for the forest (natural objects in the marked rectangular) the energy and hence the contrast significantly decreases. Sophisticated classification methods are promising for an automatic identification of natural and artificial objects. Additionally, a forest model was developed at RSL and polarimetric, low-frequency simulations were conducted. First experiments with simulated data provide promising characteristics for a successful classification of natural and artificial targets.

Concluding, the paper handles the problem of SAR processing of real data experiments with a dual-pol bistatic configuration, i.e. an arbitrary flight geometry for the transmitter and a fixed receiving antenna. Furthermore, it gives an overview of ongoing projects that are concentrating on some of the applications made possible by this unique low-frequency dataset.

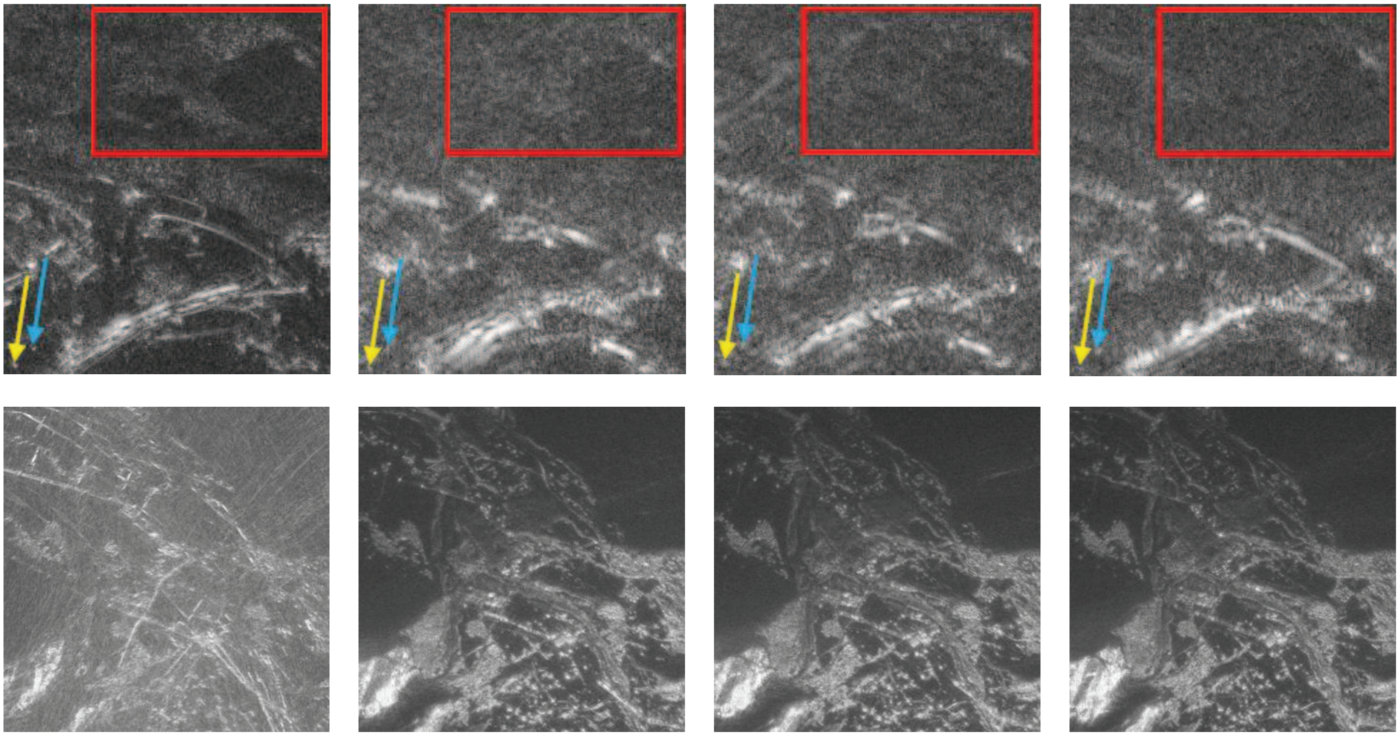

Fig. 1: Top (left to right): Monostatic and bistatic (4°, 10°, 20° bistatic angle) SLCs of a zoomed area in Spiez. The rectangle (red) marks a forest area (natural object) while the arrows (yellow, blue) label the corner reflector and a vehicle respectively. Bottom: 5x5km² area of Spiez with bistatic circular flight track (left) and bistatic linear (4°, 10°, 20°, from left to right) track with HV polarization.

REFERENCES

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