The LORAM experiment: an overview

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Advances in sensor and information technology will significantly improve future intelligence, surveillance and reconnaissance (ISR) systems. In particular, performance will be greatly enhanced by utilising a wider portion of the electromagnetic spectrum. One of the main reasons for this is that it becomes increasingly difficult to enable counter-measures (low signatures, concealment, camouflage, jamming, etc) over a very wide bandwidth. ISR systems at large stand-off distances operate in the radio- or microwave bands due to their capability of penetrating clouds, fog, rain etc. Active and passive sensor technologies, i.e. radar and electronic support measures (ESM), complement each other. The latter are effective against emitting targets but suffer from poor angular resolution and the prerequisite that a target must emit electromagnetic energy. Radar systems, on the other hand, are effective also against targets without self-emission. The geometrical resolution and sensitivity of radars are significantly improved using advanced signal processing techniques. Examples of the latter are synthetic-aperture radar (SAR) and ground moving target indication (GMTI) which enables both stationary and moving targets to be detected, positioned and classified at large stand-off distances. Future military defence systems will include network-centric capabilities such as a common ground picture with situational information on targets and the surrounding terrain. The generation of a wide-area ground picture is, however, a very difficult problem because of the large number of targets involved and the variability found in both targets and background. The ground situation also provides a lot of opportunities for hiding, camouflage and deception.

There is currently a significant effort to develop new sensor technologies for the difficult case of detecting lowsignature and concealed ground targets. Foliage is here an effective means of concealment available to military forces and recent conflicts have demonstrated the shortcomings of current ISR systems in this respect. The SAR experiment LORAM was conducted in southern Sweden during a period in September-October of year 2004. The radar campaign is part of a joint research effort between France and Sweden in support to studies on how various ISR assets should be combined to create a common and complete ground picture. The LORAM 2004 program focused on some of the above-mentioned research topics by collecting airborne SAR and GMTI data over documented ground target deployments and clutter areas. The experiment layout will allow the target detection performance to be evaluated for different operating conditions. The airborne campaign included the French airborne multifrequency radar testbed RAMSES operated by ONERA, and the Swedish airborne radars CARABAS-II and LORA operated by FOI:
• RAMSES was configured with two different radar installations with SAR and GMTI during the period: one operating in P/L band and one operating in P/X band. • The CARABAS-II SAR system operated in the frequency band 25-85 MHz. • The LORA sensor occupied various portions in the interval 200-800 MHz in SAR and GMTI modes. The overall objective of the research work is to provide a basis for specification of future operational airborne radars fielded with SAR and GMTI modes for foliage penetration applications. The available radar sensors in the campaign make it possible to compare performance across frequency bands in the interval of about 20 MHz to 10 GHz. Figures of merit to consider concern detection, positioning, tracking, classification, and identification of stationary and moving vehicles. Understanding of the electromagnetic propagation and image formation properties of each frequency band is recognized to be of fundamental importance to the successful outcome of the research. The main objectives to address in the planning process of the LORAM 2004 experiment layout were:

• Collect radar data in the frequency range from about 20 MHz to 10 GHz under controlled ground target scenarios for evaluation of detection performance in different operating conditions.

• Enable evaluation of detection performance based on both exhaustive target/clutter statistics as well as example target groupings. The former will be used to derive “ROC” (Receiver-operator-characteristics) curves which give technical detection performance, whereas the latter provides illustrative examples for specific application scenarios.

• Conduct airborne data collections with RAMSES, CARABAS-II and LORA over common target deployments. RAMSES will operate both SAR and GMTI modes in P- (400-470 MHz), L- (1.2–1.4 GHz) and X- (9.31-9.61 GHz) bands, CARABAS SAR will operate in the 25-85 MHz band, and LORA will operate both SAR and GMTI modes in the 200-800 MHz band.

• Collect radar, target and environment data across the following operating conditions: 1) Radar mode, frequency, polarization, incidence angle and aspect angle; 2) Target type, degree of foliage concealment, orientation and movement; 3) Clutter type, radio-frequency interference environment, and right-left ambiguity.

The main part of the SAR imaging took place over a restricted area used by the Swedish Army for training purposes and located in southern part of Sweden. About 30 targets of a few different classes were used and deployed in a number of configurations on ground, with the majority of the vehicles obscured by foliage. Additional forest clutter statistics were collected to enable investigations under controlled conditions by imaging a forestry park located about 100 km southwest of the main test site. Operated by the Swedish University of Agricultural Sciences, detailed ground truth information about the different forest stands are available for this location.

This presentation will summarize the SAR experiment LORAM 2004. The participating SAR sensors will be described and details on the experiment layout will be given. Examples of SAR images acquired at different radar frequencies over the same ground target deployment will be shown. Some example of target detections will be found.