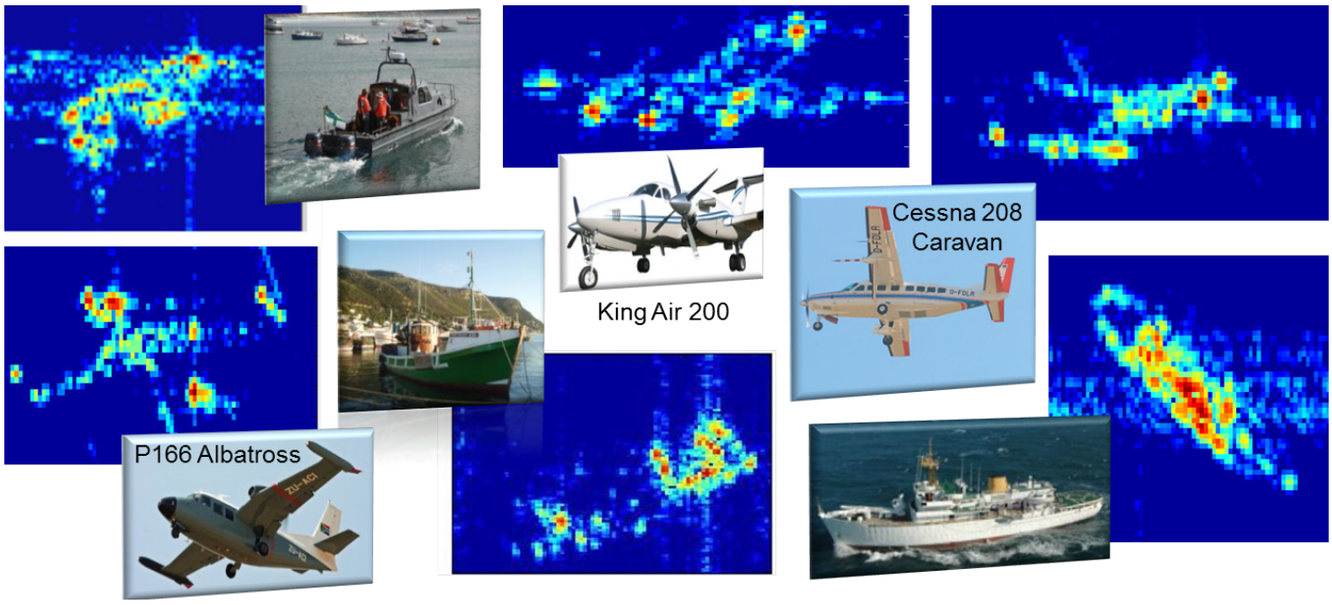
Focus on CSIR

Radar Non-Cooperative Target Recognition

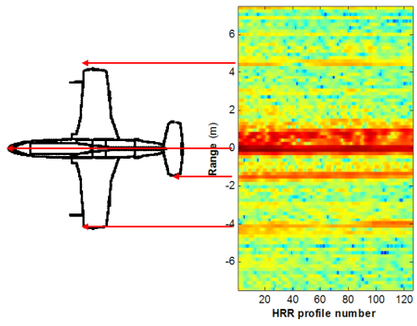
Preparing for the Next Generation of Modern Radar Systems



ISAR images of maritime vessels and aircraft

The reliable and early identification of objects is a determining factor in the ability of law enforcement agencies and the military to initiate appropriate responses. Potential benefits of having this information include:

- Making full use of the capabilities provided by modern long range weapons systems
- Decreasing the possibility of fratricide
- Improving efficiency in the policing of economic exclusion zones and environments where piracy and poaching are likely to occur
- Improving situational awareness in anti-terrorism and asymmetric warfare scenarios
- Improving radar (and other sensor) performance by optimising operational modes for specific target types



High range resolution profiles of an L29 jet

With the aim of seeing these benefits realised, the CSIR has had an engineering team focused on R&D in the field of radar Non-Cooperative Target Recognition (NCTR) for over more than a decade. The capability established has grown from a small base in 2004 to being one of the well recognised groups in target recognition worldwide as evidenced by invited participation in NATO workgroups, tutorial presentations on the topic of NCTR at IEEE conferences, several cited publications in the field and an award at an international conference. Since 2011 this has led to collaborative R&D projects in the field with both local and international radar industries.

The main areas in which a technology base has been developed include:

- High Range Resolution Profiling
- Inverse Synthetic Aperture Imaging
- Micro-Doppler Analysis
- Track based information

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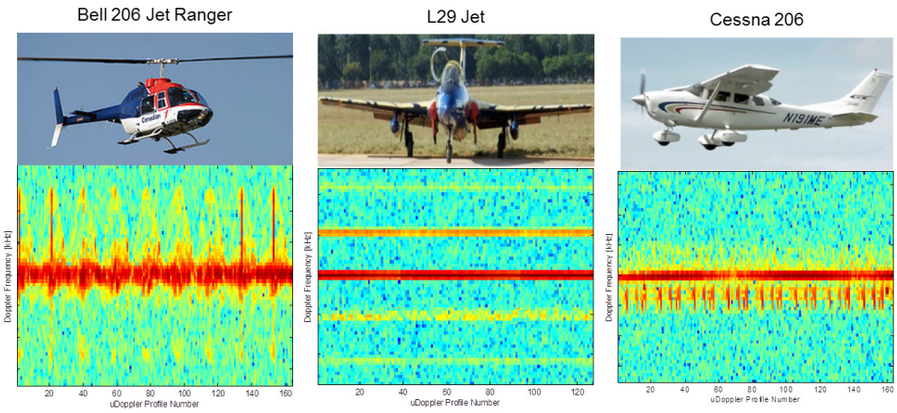
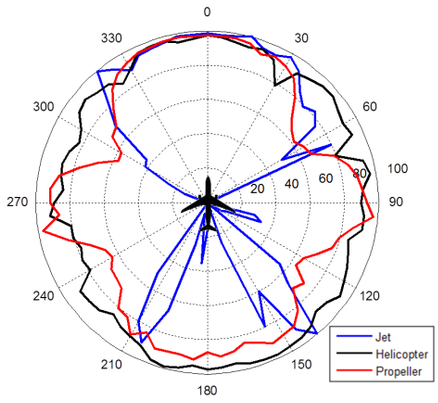


Micro-Doppler modulation from different classes of aircraft



Micro-Doppler aircraft classification accuracy versus aspect angle

High Range Resolution (HRR) Profiling

For detection and tracking applications, radars typically make use of range resolutions in which the entire target range extent is spanned by only a single or a few resolution cells. In HRR measurements the target is resolved into many range cells, allowing detailed insight into how the scattering strength varies over its range extent.

To achieve these resolutions a wide transmit bandwidth is required. The CSIR has developed a significant amount of experience in the measurement of HRR profiles using several different techniques, some of which can be retrofitted onto older radars not specifically designed for the purpose. Processes have also been developed to ensure that the measured HRR profiles are not severely compromised by high range sidelobe levels.

The HRR profiles produced can be used to infer physical characteristics of a target such as length, width and wingspan as well as in template-based classification.

Inverse Synthetic Aperture Radar (ISAR) Imaging

Target movement relative to a radar can be exploited to form two-dimensional (range and cross-range) images using ISAR techniques. ISAR imagery contains information on the physical shape and structure of a target. The CSIR has developed algorithms to produce ISAR images of both aircraft and maritime targets. Extensive research has also been conducted in the practical use of ISAR imagery including automatic image selection and the successful classification of maritime targets.

Micro-Doppler Analysis

Moving parts on a target such as propellers, rotor blades and jet engine turbines blades cause modulation of a radar echo that can be used to classify the method of propulsion. The CSIR has developed a strong capability in the analysis and use of micro-Doppler modulation. An automatic classification process has been developed for aircraft that correctly discerns between helicopters, propeller aircraft and jets with accuracy of around 90%. The process has been shown to work successfully on search and tracking radar systems that utilise different frequency bands. Micro-Doppler from helicopters has also been successfully exploited for identification (make and model) purposes. The CSIR has begun research in the use of micro-Doppler for land target classification which has application in border patrolling and poaching.

NCTR mode in MecORT

The CSIR has developed an NCTR software-based processor for use in the MecORT radar measurement facility. The processor contains many of the algorithms produced during research efforts, together with the necessary interfacing and management functions. Operator interfaces for controlling the target classification process and performing operator-based classification have also been developed.

Future Prospects

Based on the recent trends in the field of machine learning, radar classification related technology is set to play an increasingly significant and important role in future radar systems. The CSIR, on the back of over a decade of experience in this field, is well positioned to support stakeholders and clients in the security and defence markets to harness NCTR technology in their future radar systems.

Contact details

Brian Burmeister
BBurmeister@csir.co.za
012 841 4828

www.csir.co.za

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