PROJECT RING

3D Radar Imaging for Non-Cooperative Target Recognition

RING aims at developing a new system for Non-Cooperative Target Recognition (NCTR) based on 3D radar imaging. The core of this project is the development of a system for 3D radar image formation based on the use of a dual orthogonal baseline interferometric radar and the associated target recognition architecture and algorithms. The operative needs that have led to this proposal concern both tactical and strategic operations where target identification is a required capability. Use of this technology has also been considered in scenarios of civil/homeland security.

State-of-the-art radar systems employ a basic target recognition system, which is based on an identification friend of foe (IFF) approach. This technology, though, is based on target's cooperation. Some modern systems employ noncooperative target recognition systems that are based on the use of 2D radar images, mainly Inverse Synthetic Aperture Radar (ISAR). 2D ISAR images, unfortunately, suffer of several issues, which may be overcome by employing 3D radar imaging technology. 3D information of a target, in fact, leads to a more refined target identification and prioritization for operational and tactical purposes. The precise target identification can be used for recognizing and prioritizing detected target. For example, the developed technology will provide vital information, including cases where it must be decided whether a detected target can be treated as an attacking plane, or whether it is fighter or bomber (with precise brand assignment), if it is armed (in case of externally attached missiles or bombs), and so on so forth. This project aims at developing and validating such technology to make it available to future radar systems.

The proposed technology could also be used in homeland security scenarios, in order to enhance maritime and border surveillance where it is important to recognize and classify detected targets. Examples are the protection of ports, airports, ships, critical infrastructures, coastal control, immigration monitoring and prevention, including maritime, air and space surveillance from different types of platforms (ground, naval, air and space). In all aforementioned applications, there is the need to recognize a threat produced by a non-cooperative target, which can be significantly enhanced by using recognition techniques based on a novel 3D radar imaging technology.

The project partners will develop three different demonstrator that will be tested during the third year of the project:

- A ground based interferometric radar system
- A Ship borne interferometric radar system
- A drone based interferometric radar system using 4 drones flying in formation.

During the second year of the RING project, we have realised the three technological demonstrators and developed algorithms for the recognition of non-cooperative targets that are based on 3D radar images. More specifically, two database-free approaches have been proposed that compare the 3D target reconstruction with the "reference" target saved in the system database. The first one directly compares the 3D target reconstruction with a target CAD model. The second one compares specific 2D views obtained from both the reference geometrical target model and the 3D target reconstruction.

Figure (b) shows an example of 3D InISAR reconstruction obtained by using a ground-based system previously developed by RaSS (2016).

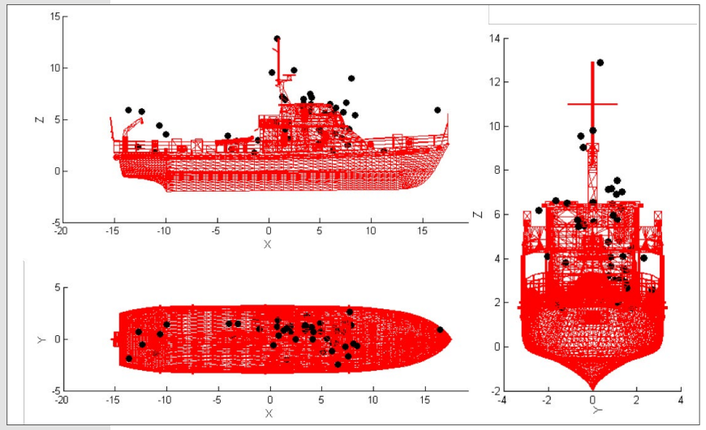
Figures (c,d,e) illustrate the drone-based demonstrator main components.

Figures (f,g,h) show an example of database-free classification

Technical Sheet

Funding institution:
MoD (IT)
Project partners
GEM, ECHOES, WUT, PIT-RADWAR
Project duration
January 2020 - October 2023
Involved countries
Italy, Poland

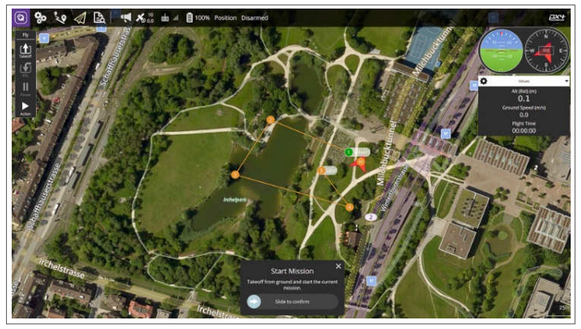
(a)The first ground based interferometric radar system developed at the RaSS laboratory in 2016 - PIRAD demonstrator



(b) An example of 3D InISAR results using real data acquired using PIRAD system. the results of the 3D InISAR is a cloud of points in the 3D space and is compared in this figure with the target CAD model

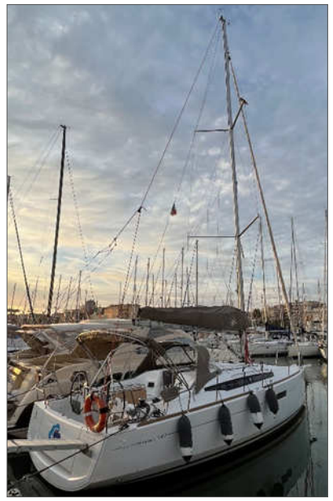
(c) Drone selected for the drone-based demonstrator

(d) Drone Futaba T10J radio controller;



(e) Drone Qground control software

(f) Radar antenna - 20dBi gain



(g) A picture of the measurements

(h) A picture of the cooperative target used in the measurements.