PROJECT 3D-ISAR

ATR by means of Polarimetric ISAR Images and multi-view 3D InISAR

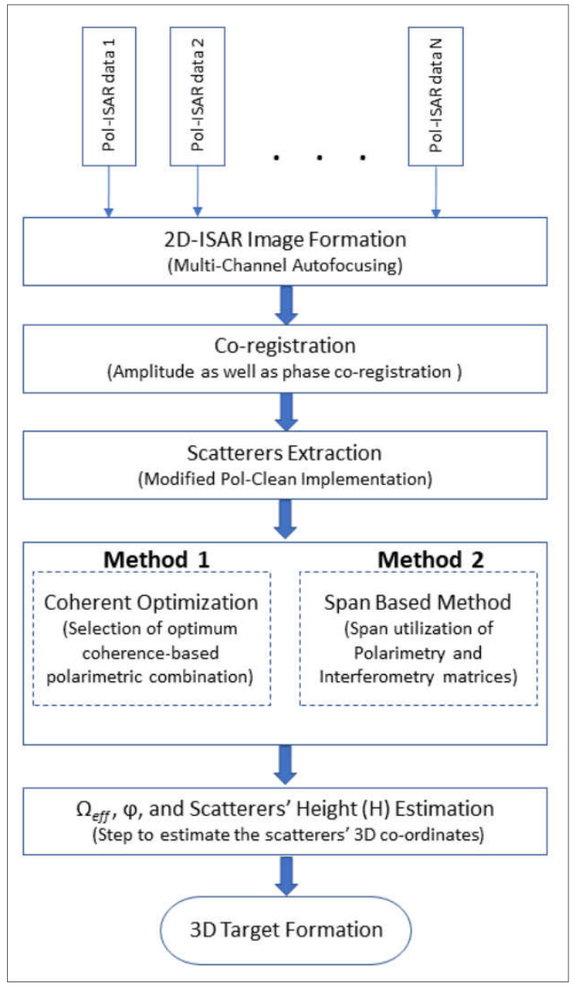
Technical Sheet
Funding institution:
ONR GLOBAL
Project partners
CNIT RaSS
Project duration
September 2020 - September 2023
Involved countries
Italy

Both homeland security and asset protection in military scenarios require high performing modern surveillance systems in terms of accuracy and response times. Examples are the protection of ports, airports, critical infrastructures, immigration monitoring and prevention, maritime and air surveillance from various types of platforms (land, sea, air and space). In this variety of applications there is the need to have a support for the recognition of the threat produced by an approaching target.
The aim of the project 3D-ISAR is twofold:

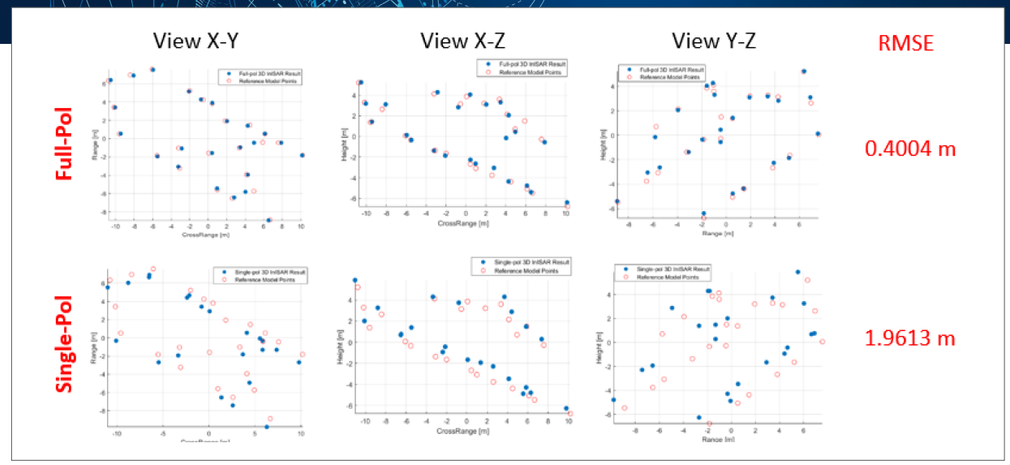
- Demonstrate that the use of polarimetry may enhance the performance of 3D Interferometric ISAR imaging systems. 3D InISAR has been proven effective to generate a 3D point target model of non-cooperative moving targets. To further enhance its performance, a fully polarimetry 3D InISAR algorithm is under development that will be able to combine the advantages of fully polarimetry radar over single polarisation radar and those of 3D InISAR over 2D ISAR imaging.
- Develop a non-cooperative target recognition algorithm that exploits fully polarimetric 3D InISAR results.
  The use of 3D target reconstruction instead of 2D ISAR images may overcome the problem of creating large and costly databases as 3D reconstructed images can be compared directly to geometrical target CAD models or simulated 3D e.m. CAD models. Moreover, the use of machine learning will be also investigated in this work for the implementation of NCTR algorithms.

Figure 1 shows the proposed 3D-InISAR imaging algorithm. Specifically we have implemented and tested two different approaches, the coherent optimization and the span based methods.
Figure 2 shows an example of results using simulated data, in which the advantage of using fully polarimetric information can be appreciated either visually as well as numerically. In fact the RMSE calculated between the coordinates (true and estimated) of each scatterer is provided to be much lower when using polarimetry.
Figure 3 shows results obtained by using multiple views (both in elevation and azimuth) of the same target superimposed to the target CAD model. The same figure also reports the estimated target size and size ratios to show that the use of polarimetry permits obtaining a better estimate of the target size and preserve the target shape more faithfully.

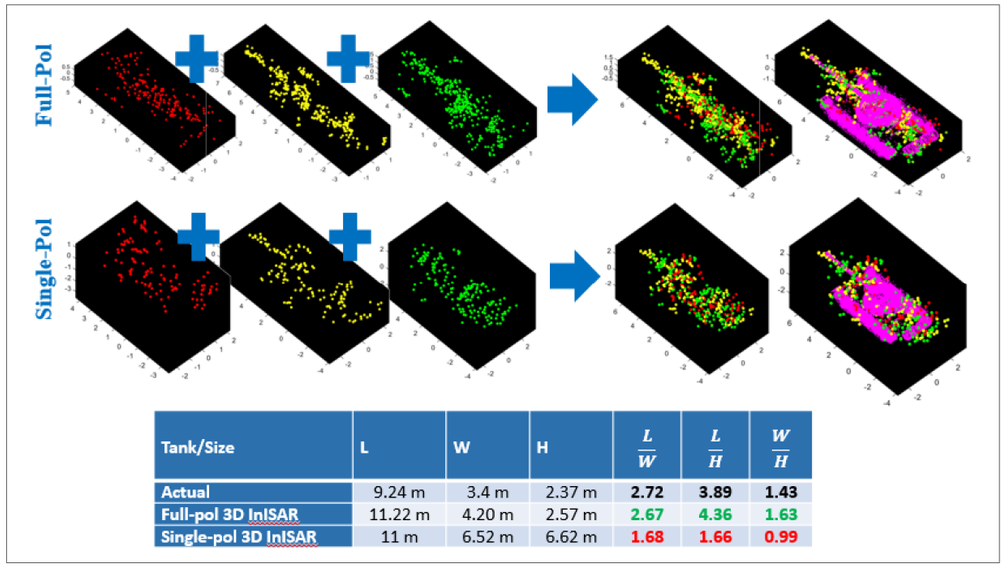
[2] E. Giusti, A. Kumar, F. Mancuso, S. Ghio and M. Martorella, "Fully polarimetric multi-aspect 3D InISAR," 2022 23rd International Radar Symposium (IRS), 2022, pp. 184-189, doi: 10.23919/IRS54158.2022.9905018



(a) 3D-InISAR imaging algorithm

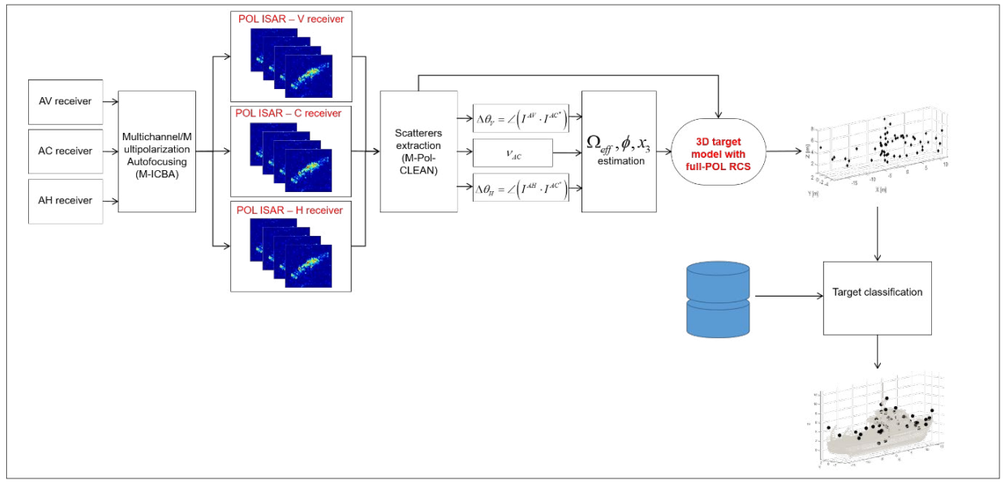


(b) An example of 3D InISAR image reconstruction obtained by processing simulated data and either fully polarimetric and single polarimetric data



Tank/Size	L	W	H	$\frac{L}{W}$	$\frac{L}{H}$	$\frac{W}{H}$
Actual	9.24 m	3.4 m	2.37 m	2.72	3.89	1.43
Full-pol 3D InISAR	11.22 m	4.20 m	2.57 m	2.67	4.36	1.63
Single-pol 3D InISAR	11 m	6.52 m	6.62 m	1.68	1.66	0.99

(c) 3D target reconstruction using fully polarimetric radar data of a tank [2]



(d) A high level block diagram of the software algorithm that we implemented.
The project activities will focus on the development of the multichannel/multipolarization CLEAN algorithm and on the development of a target classifier