Ph.D. in Information Technology:

Banda, Gola and Recchia Final Dissertations

DEIB Seminar Room

January 29th, 2016

2.30 pm

First Ph.D. presentation and discussion:

Francesco BANDA – XXVII Cycle

"3D SAR Imaging of Land Ice Structure: Methods & Processing"

Supervisor: Prof. **Stefano Tebaldini**

Abstract:

In this thesis, a novel research about the use of Synthetic Aperture Radar Tomography (TomoSAR) to characterize the 3D structure of ice sheets and glaciers is discussed.

TomoSAR is a 3D imaging tool which is now used in the radar remote sensing community, due to its potential of inferring information about complex natural scenarios on a large scale in 3D. The forthcoming European Space Agency (ESA) BIOMASS mission will have TomoSAR capabilities for the study of vegetated areas and land ice.

In this thesis, the new methodologies and the processing aimed at obtaining information about the 3D structure of land ice with TomoSAR are discussed. Results from the experimental data of the ESA IceSAR 2012 campaign are presented. It is proved that TomoSAR can effectively retrieve information about subsurface ice structures, as long as the scene is not affected by temporal decorrelation phenomena.

Second Ph.D. presentation and discussion:

Dr. Andrea GOLA – XXVII Cycle

Practical aspects of marine Controlled Source Electromagnetic Method Data Processing and Imaging

Supervisor: Prof. **Giancarlo Bernasconi**

Abstract:

Geophysical EM methods are widely known and widely applied for near surface applications. Technology innovation permits today to extend EM imaging to deep exploration. The study is focused on mCSEM (marine Controlled Source Electromagnetic Method), used in offshore scenarios for large scale investigation, with the aim of recovering a subsurface electrical resistivity model, to complement other kinds of data, seismic images in first place. The main features on the estimated resistivity distribution contribute to identify either hydrocarbon accumulations or particular resistive lithologies. Being a relatively new method exploited by the industry, mCSEM has great potential but also presents some peculiar characteristics that must be taken in account, namely the inherent coarse spatial resolution and highly non-linear sensitivity to the resistive anomalies.

I investigate different aspects of mCSEM data analysis, imaging and interpretation. First I show a numerical sensitivity study on a synthetic 2.5D scenario. The data is computed with an accurate Finite Element Method simulator. The main results are that data is primarily sensitive to lateral resistivity discontinuities, exhibits rapid degradation with respect to depth and lower sensitivity to thickness of anomalies, as well as highly non-linear relation with resistivity, that as known from the theory of the method, leads to some ambiguities in data interpretation. Sensitivity also vary with frequency, as well as the depth of investigation.

Then I address the topic of performing a quick qualitative interpretation of the resistivity model. The method relies on the knowledge of the acquisition geometry and on the hypothesis of anomalies embedded in a homogeneous resistivity background. The resulting indicator is called pseudo-image and it allows a first detection and localization of anomalies and of their lateral discontinuities. Pseudo-images variations with frequency make it possible to formulate some hypothesis also on the depth of the anomalies.

Finally I investigate a CSEM migration imaging technique inspired by known algorithms in reflection seismic, with examples on synthetic and real data. The method recovers the position of the resistivity anomalies, so producing a reliable a priori model for more complex inversion procedures.

The information extracted from mCSEM data has been proven to be very useful in the framework of a multi-physics integration of different geophysical domains, that allow a better interpretation of subsurface physical properties.

Third Ph.D. presentation and discussion:

Dr. Andrea RECCHIA – XXVIII Cycle

"GeoSTARe: Geosynchronous SAR for Terrain and Atmosphere observation with high Revisit"

Supervisor: Prof. **Andrea Monti Guarnieri**

Abstract:

Synthetic Aperture Radar imaging from geosynchronous orbit (GEOSAR) has significant potential advantages over conventional Low-Earth Orbit systems (LEOSAR), but also challenges to overcome. The main problem for a GEOSAR system is the extremely weak signal power available at the receiver due to the propagation losses. The issue can be overcome either increasing transmitted power and antenna size, making the system realization technologically challenging and very expensive, or increasing the observation time of the scene, introducing the signal decorrelation problem.

The PhD work has been aimed at studying the feasibility of a low cost long observation time (from several minutes to hours) GEOSAR system, focusing on both the system performances assessment and the development of accurate and efficient techniques for the processing of the acquired data. The research activities have analyzed the main decorrelation sources, such atmosphere and natural targets, to derive theoretical performance models for the design of future GEOSAR missions.

The obtained performance models have been finally exploited to generate the first demonstrative GEOSAR products. The demo products provide to the potential data users a first glimpse of the appealing GEOSAR applications including the near real time monitoring of earth deformation phenomena like volcanoes, glaciers, landslides and building deformation in urban areas.