ABSTRACT

QIN Yuxiao Ph.D., Purdue University, December 2018. Sentinel-1 Wide Swath Interferometry: Processing Techniques and Applications. Major Professor: Daniele Perissin.

The Sentinel-1 (S1) mission is a part of the European Space Agency (ESA) Copernicus program. In 2014 and 2016, the mission launched the twin Synthetic Aperture Radar (SAR) satellites, Sentinel-1A (S1A) and Sentinel-1B (S1B). The S1 mission has started a new era for earth observations missions with its higher spatial resolution, shorter revisit days, more precise control of satellites orbits and the unprecedented free-to-public distribution policy. More importantly, S1 adopts a new wide swath mode, the TOPS mode as it default acquisition mode. The TOPS mode scans several different subswaths for gaining a larger coverage. Because the S1 mission is aimed at earth observation missions, for example, earthquakes, floods, ice sheets flow, etc., thus it is desired to have large monitoring areas. Although TOPS is still a relatively new idea, the high quality data and wide application scopes from S1 has earned tremendous attention in the SAR community.

The signal properties of wide swath mode such as TOPS are different from the more conventional stripmap mode, and it requires special techniques for successfully processing such data in the sense of interferometry. For the purpose of doing Interferometric SAR (InSAR), the coregistration step is of most critical because it requires a 1/1000 accuracy. In addition, processing wide swath mode requires special steps such as bursts stitching, deramping and reramping, and so on. Compared with stripmap, the processing techniques of wide swath mode are less developed. Much exploitations are still needed for how to design a generic and robust wide swath interferometric processing chain.

Driven by the application needs of S1 wide swath interferometric processing, this research studies the key methodologies, explores and implements new processing chain, designs a generic wide swath processing flow that would utilize the existing stripmap processing platform, as well as carries out preliminary applications. For studying key methods, this study carries out a quantitative analysis between two different coregistration methods, namely the cross-correlation approach and the geometrical approach. The advantages and disadvantages for each method are given by the author, and it is proposed to choose the suitable method based on one's study area. For the implementation of the new processing chain, the author proposes a user-friendly stripmap-like processing flow with all the wide swath related process done behind the scene. This approach allows people with basic knowledge in InSAR and very few knowledge in wide swath mode to be able to process and get interferometric products. For designing the generic process flow, the author applied TOPS's workflow to the other wide swath mode, ScanSAR mode and demonstrated the feasibility of processing two different wide swath mode with the same processing chain. For preliminary applications, the author shows a large number of interferometric data throughout the research and presents a case study with multi temporal time series analysis using a stack of S1 dataset.

This research is application oriented, which means the study serves for real-world applications. Up to now, the processing chain and methodologies implemented in this research has been shared by many research groups around the world and has seen a number of promising outcomes. The recognition from others is also an affirmation to the value of this research.