Master Thesis: Studying Practical Impact of Recent Network Flow Algorithms for SAR-Phase Unwrapping

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Setting

SAR (synthetic aperture radar) is a radar system used to create very high resolution images of landscapes. The SAR image is created by recording the echo of pulses of radio waves that are sent towards the object recorded [5]. These echo signals, for each pixel/measured point deliver phase-wrapped values modulo 2π, i.e., they may however have offsets that corresponds to different multiples of 2π. Reconstructing these multipliers and thus the actual elevation of each pixel can be formulated as a network flow problem, more precisely as an undirected shortest transshipment problem [2]. The process of reconstructing the multipliers is called phase unwrapping.

Recent development in algorithms for network flow problems, in theory as well as in practice, rises the question whether also the process of SAR-Phase Unwrapping can be improved. Studying this question shall be subject of this master thesis.

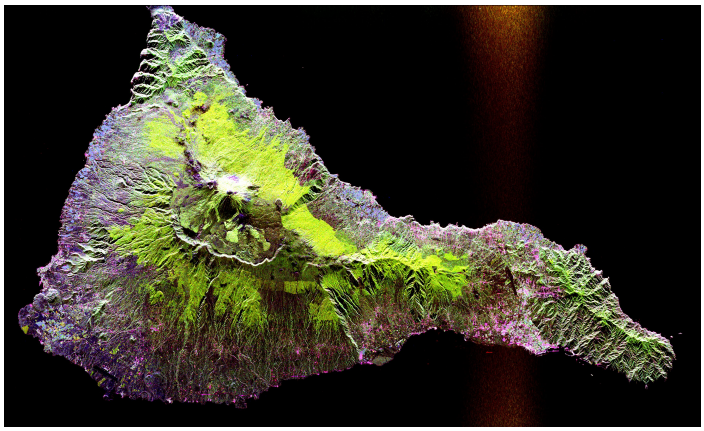

Figure 1: An example SAR-image. It pictures the Teide volcano on the island of Tenerife. Lava flows are pictured in green, brown while vegetation appears in purple, green and yellow [5].

Tasks

The rough plan for this master thesis includes the following.

1. Literature research, reading and presenting the relevant literature.
2. Acquiring data from real-world measurements and transforming them to Min-Cost Flow instances.
3. Evaluation of existing implementations of combinatorial algorithms, including [3] and [1].
4. Modification of [1] and its implementation, such that it terminates prematurely with a solution satisfying an approximation guarantee that is given as a parameter.
5. Implementation of the algorithm introduced in [4] using the modification from above as a subroutine.
6. Experimental evaluation of the implementation, including finding a suitable approximation ratio for the subroutine calls.

References

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[2] Mario Costantini. A novel phase unwrapping method based on network programming. *Geoscience and Remote Sensing, IEEE Transactions on*, 36(3):813–821, May 1998, http://dx.doi.org/10.1109/36.673674.

[3] Andrew V Goldberg. An efficient implementation of a scaling minimum-cost flow algorithm. *Journal of Algorithms*, 22(1):1 – 29, 1997, http://dx.doi.org/10.1006/jagm.1995.0805.

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