SEPARATION OF RESIDUAL MOTION ERRORS USING A STACK OF INTERFEROMETRIC AIRBORNE SAR IMAGES

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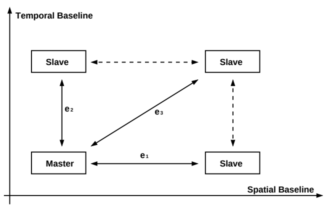
1. INTRODUCTION

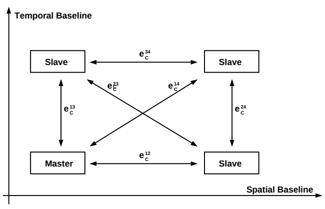
Residual motion error estimation using the multisquint method [1] is established as a robust technique to determine the track deviations beyond the accuracy of state of the art navigation systems in airborne SAR interferometry. But for stacks of interferograms the method can be problematic because only the differences between two tracks can be estimated, not the deviation of the track itself. This paper presents a method to overcome this problem, making airborne processing of interferometric image stacks as reliable as in the spaceborne case.

2. ESTIMATION OF MOTION ERRORS FOR IMAGE STACKS

In conventional interferometric data processing, each track is coregistered to one master track. Also the residual motion errors are estimated to the master track. This can be a drawback when dealing with large temporal baselines, because the accuracy of the estimation depends on the coherence between the tracks. The limited accuracy for low coherent interferograms causes remaining residual motion errors after the estimation in some of the possible interferometric combinations, shown in Figure 1(a) as dashed arrows.



(a) Conventional Processing



(b) Enhanced Processing

Fig. 1. Residual motion error estimation strategy using four tracks

A better solution could be obtained, if all interferometric combinations are taken into account for residual motion error estimation as shown in Figure 1(b). The maximum number of combinations N_c from N tracks is the binominal coefficient of all tracks over two, used for the estimation. Each combination of the tracks allows to estimate the residual motion error between the two combined tracks. This leads to an overdetermined system of equations, which allows to separate the interferometric estimations to the platform deviations of each track.

3. SEPARATION OF THE ESTIMATIONS TO THE TRACKS

One interferometric estimation contains the track deviations of the two involved tracks as

$$e_c^{mn} = e_t^m - e_t^n \tag{1}$$

where e_c^{mn} denotes the estimated deviation from the tracks e_t^m and e_t^n. So the linear system of equations derived from all track combinations can be written as:

$$\vec{e_c} = M_c \vec{e_t} \tag{2}$$

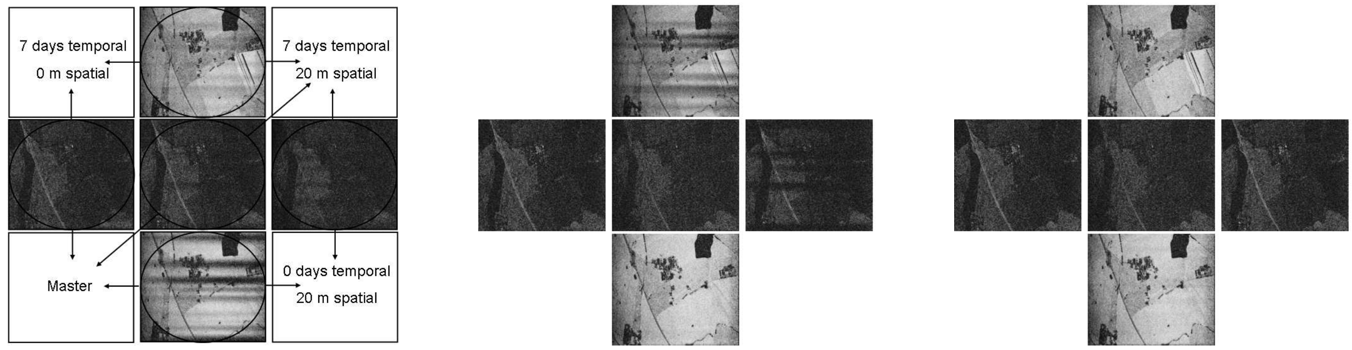
with M_c representing the track combinations. The possible track combinations from Figure 1(b) can be represented using the matrix M_c and a corresponding weight vector W containing the standard deviations of the interferometric estimations σ_c. Unfortunately the Matrix M_c is singular, independent from the number of tracks used, so there is no analytical solution possible. Nevertheless the local minimum can be found according to Equation 3.

$$\sum_{i=0}^{N_c} \left| M_c\left(i\right) e_t - e_c\left(i\right) \right| W\left(i\right) = 0 \tag{3}$$

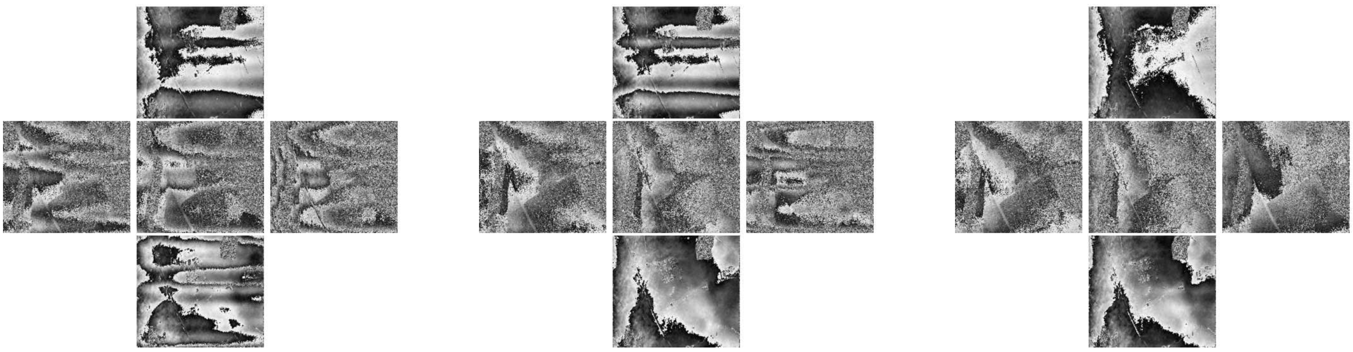
This allows the separation of the interferometric estimates, if four or more tracks are available. It should be noted that the track deviation acquired, is not necessarily the “true” one, since more than one local minimum could be present. The minimization process just tries to find a solution capable to compensate the estimated phase errors.

4. EXPERIMENTAL RESULTS

To verify the performance of the proposed method, an interferometric configuration as shown in Figure 1 was chosen from the AGRISAR Campaign over Goermin, Germany. Figure 2(a) shows the interferometric phase and coherence after topography adaptive motion compensation [2], but without any residual motion error estimation at all. Figure 2(b) shows the results of the conventional processing strategy shown in Figure 1(a). Figure 2(c) shows the results of the proposed method in Figure 1(b).



(a) Coherence without estimating RME (b) Coherence from conventional processing (c) Coherence from enhanced processing



(a) Phase without estimating RME (b) Phase from conventional processing (c) Phase from enhanced processing

Fig. 2. Experimental results of a C-Band time series acquired over Goermin, Germany

5. REFERENCES

[1] Pau Prats, Andreas Reigber, and Jordi J. Mallorqui, “Interpolation-free coregistration and phase-correction of airborne sar interferograms.,” in *Geoscience and Remote Sensing Letters*. IEEE, 2004, vol. 1(3), pp. 188–191.

[2] Pau Prats, Andreas Reigber, and Jordi J. Mallorqui, “Topography accomodation during motion compensation in interferometric repeat pass sar images,” in *International Geoscience and Remote Sensing Symposium*. IEEE, 2005, vol. 1.