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Master Thesis: Tree Height Estimation Using Frequency Domain Coherence - Towards In-SAR Phase Unwrapping

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Abstract: Due to their crucial role in Earth's carbon cycle, it is important to monitor forests for detection of deforestation and for a better understanding of changing processes within them. A possible solution for this purpose is the TanDEM-X/TerraSAR-X constellation, which allows the acquisition of two spaceborne synthetic aperture radar images simultaneously. This single-pass interferometry offers the opportunity to generate global digital surface models from the interferometric phase even for areas covered with dense vegetation. However, the main drawback of radar interferometry is the phase ambiguity that has to be resolved by phase unwrapping. Sudden jumps between tree crowns and the ground terrain challenge conventional phase unwrapping techniques. Therefore, in this study, the subtraction of an estimate tree height based on coherence is performed, to create a slowly changing residual phase. This residual phase can be unwrapped with conventional phase unwrapping algorithms. After unwrapping, the estimated tree heights can be added and the final digital surface model is obtained. Further, to resolve coherence estimation issues due to topographic variations and to avoid blurring at edges, a new coherence estimation in the frequency domain using subbands is presented. Frequency domain coherence is affected by a linear residual topographic phase due to a different center frequency for each subband. The theoretical impact of this residual ramp is shown and the frequency coherence is processed for the available dataset. A comparison with spatial coherence yields promising results. Using this new coherence method, a tree height estimation based on an ground phase approximation is performed with the Random Volume over Ground (RVoG) model. This ground phase is approximated by using multiple radar images. Resulting height estimations are presented.

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