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Promotionsthema:

Data fusion for automatic road extraction from multi-aspect SAR data

The recent development of new high resolution SAR-systems offers new potential for automatic road extraction. However, automatic road extraction in SAR imagery does not necessarily become easier with the improved resolution, yet it faces new challenges. Especially in urban regions, the complexity arises through dominant scattering caused by building structures, traffic signs and metallic objects in cities. The inevitable consequences of the side-looking geometry of SAR, occlusions caused by shadow- and layover effects, is still present in forestry areas as well as in built-up areas. A combination of SAR images illuminated from different directions (i.e. multi-aspect images) reduces these negative imaging effects. Preliminary work has shown that the usage of multi-aspect SAR images improves the road extraction results. Multi-aspect images supply the interpreter with both complementary and redundant information. But due to the complexity of the SAR images the information is often contradicting as well. A correct fusion step has the ability to combine information from different sensors, which in the end is more accurate and better than the information acquired from one sensor alone.

At the Technische Universität München, an automatic road extraction system for both optical and SAR data has already been developed. In this work, the road extraction system shall be extended with a fusion module for multi-aspect SAR data. The concept is that the fusion module shall make use of both sensor geometry information as well as context information. For instance, exploiting sensor geometry information relates to the observation that roads in range direction are less affected by shadows or layover of neighboring elevated objects and should therefore be better evaluated than roads in azimuth direction.

The underlying theory of the approach originates from Bayesian probability theory. First, a line extraction is carried out in each image, followed by an extraction of attributes describing geometrical and radiometric properties of the line segments (i.e. length, curvature, etc.). Based on these attributes each line segment becomes an uncertainty assessment that the line segment belongs to one of the predefined classes (i.e. roads, shadow, etc.). Likelihood functions were learned from training data, by fitting probability density functions to histograms. Afterwards the line segments are fused iteratively. In this part, the fusion has to deal with the fact that line primitives were extracted in only one image. The ability to successfully extract a road is highly dependent on the context region and the sensor geometry. Based on this information, the fusion module shall support or reject line primitives with a high certainty of being roads. This assessment is the input to the last step of the road extraction system, the road network generation.