**Abstract**

Texture information is a descriptor of the scene structures and objects. Texture parameters are important information for the recognition of HR SAR images: for classification as separation of different textures and for object recognition as fingerprint and local characterization. On the other hand the phase of HR images show patterns and structures. We propose a new Gauss-Markov Random Fields (GMRF) for direct model SLC data. The information delivered from the phase is visible in the second order statistics and it is important for texture characterization. The circular complex Gaussian likelihood of the data is suitable to be modeled by GMRF. An efficient parameter extraction for texture characterization is important in order to create an alphabet of plausible primitive feature for image labeling. A Bayesian parameters estimation and model selection is implemented and compared with Evidence Maximization (EM) information extraction [1]. The results are demonstrated on E-SAR SLC image of Dresden, Germany.

**Implementation Aspects**

- **GMRF Model:**
  \[ p(x_i | \theta, \mathbb{N}) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp \left\{ \frac{1}{2\sigma^2} \left[ x_i - \sum_{j\in\mathbb{N}} \theta_{ij}(x_j + x'_{ij}) \right]^2 \right\} \]

- **LSE:**
  \[ \hat{\theta} = (G\theta | G)^{-1}G\theta \]
  (G) clique system matrix.

- **Model Evidence:**
  \[ p(x_i | \theta_{\text{GMRF}}) = \frac{1}{4\pi\sigma^2 \theta_{\text{GMRF}}} \exp \left\{ \frac{1}{2\sigma^2} \left[ x_i - e^\theta - e^\theta \right] \right\} \]

**Method and Discussion**

The Complex-GMRF algorithm:

- Is based on a simpler model: circular complex Gaussian instead of Gamma distributed data;
- Is faster due to linear complexity (~10 times faster);
- Working directly on SLC images is able to capture correlated phase pattern.

For classification maps the obtained results are better than one obtained through EM. The assessment of the phase pattern effects on primitive feature extraction by investigation and comparison of several model to find out the best data fitting. The major problem of this task is to understand how the second order statistic of the phase characterize the scene. Moreover could be done a distinction in between the pattern due to scene behavior and the structures created by system impulse response.


**Classification map based on features extracted by Complex-GMRF.** 5 classes: river and non-built area (black), vegetation and small buildings (blue), medium buildings (green), big buildings (red), very strong scatterers (yellow).

HR image over urban and natural scene containing a variety of structures which are reflected in texture signatures: vegetation, water river, residential areas, small building, higher buildings, strong scatterer patterns.

Over 10 meters resolution SAR images generally show uniform and uncorrelated phase. For meter resolution the phase brings information in form of correlated patterns. This information must be exploited for further scene understanding.