Frontier of Statistical Physics and Information Processing 2013

Thermodynamics-inspired Phase Unwrapping in Remote Sensing using SAR Interferometry

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On the basis of analogy between Bayesian inference and statistical mechanics, one of the present authors (Y.S.) has investigated phase retrieval [1] under a restricted condition. So, in this study, in order to generalize the previous method, we construct a method of wave-front reconstruction in remote sensing using the synthetic aperture radar (SAR) interferometry [2]. Here, we use the maximizer of the posterior marginal (MPM) estimate for phase unwrapping and maximum entropy for noise reduction from unwrapped wave-fronts. Next, we investigate static property of the MPM estimate from a phase diagram described by using Monte Carlo simulation for a wave-front in remote sensing using the SAR interferometry. The phase diagram clarifies that phase unwrapping is accurately realized by the MPM estimate under the constraint of surface-consistency condition using the appropriate model prior, and that the MPM estimate smoothly carries out phase unwrapping utilizing fluctuations around the MAP solution. Also, using the Monte Carlo simulations, we clarify that the method of maximum entropy using an appropriate model prior succeeds in reducing noises from the unwrapped wave-front obtained by the MPM estimate.

[1] Yohei Saika and Hidetoshi Nishimori, Progress of Theoretical Physics Supplement, Vol. 157, pp. 292-295, 2005.
[2] Yohei Saika and Tatsuya Uezu, Interdisciplinary Information Sciences, accepted.