EXPERIENCE WITH BAYESIAN IMAGE BASED SURFACE MODELING

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Abstract

Traditional image based surface modeling uses either geometric or photometric considerations, to respectively constrain surface point locations or slopes, and continuity to recover the fullsurface. Point density is limited by the image pixilation, and point estimates by failure of the underlying assumptions. Both problems are exacerbated by working directly from the images.

This paper describes an alternate approach, in which both the surface and the observation process are modeled, and Bayesian inference is used to estimate the joint model parameters most likely to have generated the observed images. This observation model ideally describes the surface lighting, atmospheric effects, camera pose, camera optics, sensor response, and data processing, that affect image generation. Any or all of the observation model parameters may need to be estimated for each image. Thus this is a much more complex problem than direct surface estimation. But it has the countervailing advantage of being able to work with any number of images, taken under quite different conditions, and thus providing independent and often complementary information.

I describe an implemented system, with a brief introduction to the underlying mathematical models and the compromises made for computational efficiency. I describe successes and failures achieved on actual imagery, where we went wrong and what we did right, and how our approach could be improved. Lastly I discuss how the same approach can be extended to distinct types of instruments, to achieve true sensor fusion.

Joint work with Peter Cheeseman, Frank Kuehnel, Andre Jalobeanu, Esfandiar Bandari, Doran Tal, Eudo von Toussaint, Robin Morris, Vadim Smelyanskiy, and David Maluf.

Key Words: Modeling, Remote Sensing, Data Fusion