REGULARIZED RECONSTRUCTION OF M-REP SHAPES WITH STATISTICAL A PRIORI KNOWLEDGE

MATTHIAS FUCHS AND OTMAR SCHERZER

The reconstruction of geometry or, in particular, the shape of objects is a common issue in image analysis. Starting from a variational formulation of such a problem on a shape manifold we introduce a regularization technique incorporating statistical shape knowledge. The key idea is to consider a Riemannian metric on the shape manifold which reflects the statistics of a given training set.

We expect the surface to be reconstructed the minimizing argument of an energy functional: In case of image segmentation we use for instance the Mumford-Shah functional [3] or the “Snakes” energy [2]. These energies incorporate some kind of regularization to ensure the well-posedness of the corresponding variational problems.

A second basic problem in shape analysis and recovery is the right representation of the hypersurface in implementations. There exists no canonical approach to model such objects, but the right choice depends on the expected topology and regularity of the solution.

We propose the use of *intelligent* shape models to represent the geometry we want to detect and to regularize the underlying detection problem. These shape models share the following two characteristics:

- A shape model is associated with a finite dimensional parameter manifold. An element of this manifold corresponds to an instance of the shape model.
- A shape model can be associated with statistical data which describes how frequently individual instances of the shape model occur.

We employ the two properties above to define a regularization technique which takes into account a priori information on the expected solution. As illustrated by some examples this enables us to detect geometries even if the original data is perturbed (e.g. some parts of it are missing or occluded), or allows us to significantly reduce the complexity of reconstruction methods.

In our work we combine the idea of adding a statistically motivated regularization term to a variational problem with the use of advanced shape models on manifolds. In particular, it provides a framework to use M-Reps [4] as a starting point for a Mahalanobis regularization of variational segmentation problems. To our knowledge this ([1]) is the first paper which combines the idea of M-Reps with statistical segmentation functionals. An extension of M-Reps to a shape space with a purely *geometric* metric is also discussed.

This work summarizes results from [1].

References

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University of Innsbruck
E-mail address: `matz.fuchs@uibk.ac.at`

University of Vienna
E-mail address: `otmar.scherzer@univie.ac.at`