# Geometric and Photometric Constraints: Motion and Structure from Three Views

by

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Submitted to the
Department of Electrical Engineering and Computer Science
on February 27,1998, in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

## Abstract

This thesis addresses the problem of recovering both the camera motion and scene structure given a sequence of images obtained from a camera moving through a rigid environment. The core of the thesis is the *model-based brightness constraint*, a new method for computing the camera motion and dense scene structure from three views. We combine photometric constraints together with geometric constraints to directly compute the camera motion from the image brightness derivatives (spatial and temporal). This type of method is dubbed a *direct method* because it does not require prior computation of optical flow or point correspondences. We describe the advantages and limitations of this method and present results with real images.

We apply the same framework to the analysis of image sequences obtained from a moving stereo rig. We show that the motion of the stereo rig can be computed directly from the image derivatives using linear equations. Correspondences are not required. The motion estimates between stereo pairs enable us to combine depth maps from all the pairs in the sequence to form an extended scene reconstruction and we show results from a real image sequence.

The tensor brightness constraint is intimately connected to 3D reconstruction from line correspondences. For line correspondences, the linear solution is degenerate when all the lines come from a Linear Line Complex (i.e. when all the lines intersect a single line in space). This configuration is quite common in practice and in particular, it arises in the context of the model-based brightness constraint. We show a method for overcoming the degeneracy of the general case and show some experimental results.

To accurately disambiguate between camera translation and rotation a wide field-of-view is required. For wide angle lenses, non-linear lens distortion can be a significant factor and affect the accuracy of motion and structure estimates. We present a new method for determining the lens distortion parameters using geometric constraints on a set of point correspondences in multiple views. There is no need to know the 3D location of the points.

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