

## 3D Reconstruction from Images taken with a Coaxial Camera Rig

3D reconstruction from images taken through an endoscope or borescope has numerous medical and industrial applications, but until now has not found wide acceptance due to the lack of space available for a traditional stereo baseline. While it is possible to acquire image pairs taken along a common optical axis using a coaxial camera rig (two cameras that image along the same optical axis via a beam-splitter), performing 3D reconstruction on these images has not been possible in the center region of the images due to the very small disparity between corresponding points. This characteristic of coaxial image pairs has been called the unrecoverable point problem.

We introduce a novel method to overcome the unrecoverable point problem, using a variational methods optimization algorithm to map pairs of flow fields from different focal length cameras in a coaxial camera rig. Instead of using pixel based correspondences our method uses the ratio of the optical flow fields at each pixel location to perform 3D reconstruction. This not only results in accurate image pair alignment but also produces accurate dense depth maps throughout the field of view.

We test our method on synthetic optical flow fields and on real image sequences taken with a coaxial camera rig. We demonstrate our method's accuracy by comparing against a precision ground-truth. Accuracy is comparable to a traditional binocular stereo camera rig, but without the need for the traditional stereo baseline and with substantially smaller occlusions.