## Experimental results

**Motion Based Image Registration with Applications**

**Toward Multimodal and Coaxial Camera Rigs Guidelines for Author Response**

The method that we present in our paper uses variational methods to map pairs of 1D lines based on the optical flow (OF) along the lines. The relationship between the flow on the 1D lines comes from the camera geometries. We intentionally avoid evaluating the quality of OF algorithms. What our work demonstrates, is that given a known geometric relationship, OF along a 1D line pair from two camera positions can be mapped in such a way that depth maps can be estimated. We acknowledged in our paper that the quality of the depth map depends on how well the OF fields from the camera pairs follow the geometrical equations. One of the main advantages of our work, is that certain common OF errors (e.g. the aperture problem) will produce OF fields which are not an accurate projection of the motion field, but as long as the misrepresentation follows the geometric relationship the depth estimate is unaffected.

Since we are not trying to evaluate the quality of the OF algorithm and because we are mapping flow along 1D lines, we don't require a wide range of scenes to show the range of situations in which the method works, what we need is a wide range of 1D OF curves. For the coaxial camera rig we resample the field in 5 degree radial increments so that we have 72 radial lines being analyzed for each coaxial camera image pair. The scene we chose produces a wide variety of shapes of the 1D radial line, all with a wide range of characteristics.

We respectfully submit that there is sufficient variability in our experimental data to demonstrate that the method works on a wide variety of OF fields.

## Initialization

As mentioned in our paper, initialization works best when the OF fields being used for initialization contain only translation parallel to the image plane or only translation perpendicular to the image planes. What may not be clear in our paper is that any OF field pair can resampled in such a way as to meet this criteria.

An OF field is a superposition of the field generated by translation parallel to the image plan with the field generated by translation perpendicular to the image plane. Fortunately, these two fields can be separated along every radial line, except one radial line pair, by resampling the flow into radial flow and flow perpendicular to the radial flow. The flow perpendicular to the radial flow can be thought of as flow along concentric rings around the optical center.

Flow due to translation perpendicular to the image plane only affects the flow field along the radial lines. The flow field along the concentric rings only contains flow due to translation parallel to the image plane. It is this flow field that is used for initialization.

The one exception mentioned above is the radial line pair where translation parallel to the image plane is along the radial line. In this case there is no optical flow perpendicular to the radial line. Along this one radial line pair we estimate flow due to forward translation based on the rest of the image and remove that flow to get an estimate of the flow parallel to the image plane.

## Derivation of Equations

For space reasons we can only show the derivation for the coaxial camera rig. The stereo camera rig follows the same logic The relationship between a pixel in the front back cameras for corresponding points in the scene can be derived by solving the projection equations for the two cameras for X and then setting them equal to each other. See main paper for definitions. This results in:

(1)

which can be rewritten as

(2)

thus for corresponding points in the scene.

The relationship between the OF in back camera and that in the front camera for the same point in the scene is then:

(3)

Which can be rewritten as:

(4)

solving for we get

(5)

substituting 3 into 5 we get

(6)