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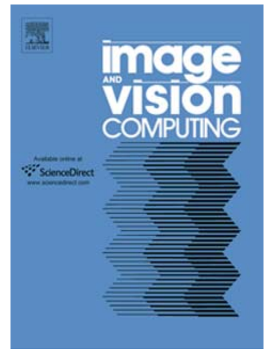


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# Compression of Probabilistic Volumetric Models Using Multi-Resolution Scene Flow

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## 1. Introduction

Progress in the accuracy and speed of 3-d reconstruction algorithms has motivated research in the construction and analysis of dynamic 3-d scenes [1, 2, 3, 4, 5, 6]. A key attribute of dynamic scenes is the instantaneous 3-d motion of surfaces in the scene. This motion field establishes correspondences between surfaces at two consecutive time steps and it is commonly referred to as *scene flow* [7].

This paper presents a new method to estimate *dense* scene flow from calibrated multi-view image sequences. The proposed method reconstructs 3-d models independently for each time step using images synchronously captured from multiple viewpoints. Then, the method computes the 3-d flow between two consecutive 3-d models. The first contribution of the paper is to formulate the scene flow problem using a volumetric and probabilistic representation of 3-d surface geometry and appearance. A typical result of the proposed algorithm is shown in Fig. 1. The 3-d models are encoded in a multi-resolution grid that stores occupancy probability in each voxel, as well as a surface appearance distribution. Here, surface appearance refers to the combination of surface reflectance and illumination giving rise to the pixel intensity or color seen in images of the surface. The second contribution of this work is presenting an improved method for scene reconstruction and its applications in compression. A desirable property of the optical flow field is a compact representation from which the inverse quantity can be derived. By modeling position and flow vectors with a gaussian mixture model (GMM), a scene can be decomposed into regions of similar motion. The flow field within each partition is assumed to be locally affine and consequently fitted to a 12-parameter transform. Using the sets of affine transformations, a receiver can then reconstruct scene instances after the first one, obviating the need to send the full model at every time step.

The choice of 3-d model representation yields several advantages in estimating scene flow. First of all, the representation encodes surface occupancy and appearance information in a dense manner, *i.e*. estimates are available everywhere in the volume. This representation yields an analogue of the image domain in 3-d. An image encodes the perspective projection of surface appearance in a 2-d regular pixel grid. This representation encodes probabilistic estimates of surface locations and their appearances in a 3-d voxel grid. This 3-d volumetric image representation enables the computation of scene flow by classical optical flow methods. In this paper, the Horn and Schunck formulation for optical flow [8] is adapted to compute dense scene flow in such 3-d models.

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