Modelling Man Made Environments: Geometric and Appearance Based Techniques

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Abstract

Man made indoors and outdoors environments posses a lot of regularities which can be efficiently exploited in a model acquisition by means of visual sensing. We are interested in these modelling issues in the context of navigation and exploration of mobile robots equipped with visual sensing and their interaction with humans. The presented techniques exploit the observations that in man made environments the majority of lines and planes is aligned with the principal directions of the world coordinate frame. This substantially simplifies all stages of the model acquisition pipeline. By combining the observations about environment's geometry and topology we will demonstrate an interactive technique for acquisition of the metric model of the environment from a sparse set of views.

Geometric Models. Recently developed insights into relationships and constraints between multiple views of different geometric features have shown that all the incidence relationships can be encoded in terms of the rank condition of the so-called *universal multi-view matrix* M. This approach gives rise to new factorisation based algorithms which enable truly global analysis of the observed image data and incorporate multiple features. An example of 3D structure and camera pose recovery in an uncalibrated setting, exploiting the incidence relationships between points and lines, is in Figure 1.

Topological models. The task of imposing a discrete structure on a quasi-continuous space of visual observations requires a definition of a distance measure between image appearances. We choose to use the information provided by image gradient orientation as the basis for the distance measure computation. The temporal and pairwise comparison of the neighbouring views based on the defined distance measure in Figure 2 clearly reveal the structure corresponding to different locations of the environment. More recent extensions are currently being developed towards automated acquisition of the topological model. Related publications can be found on author's web-site. [1]

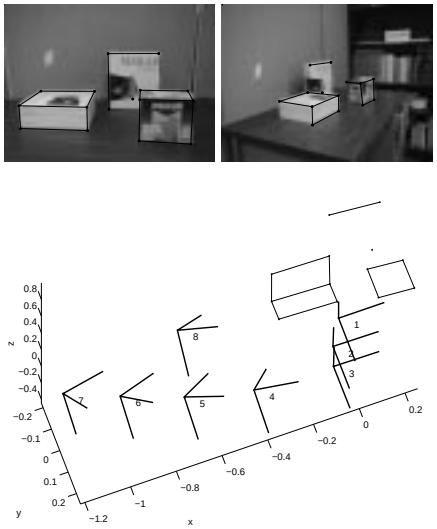

Figure 1: Two sample views of the scene and recovered 3D structure of the scene and camera motion.

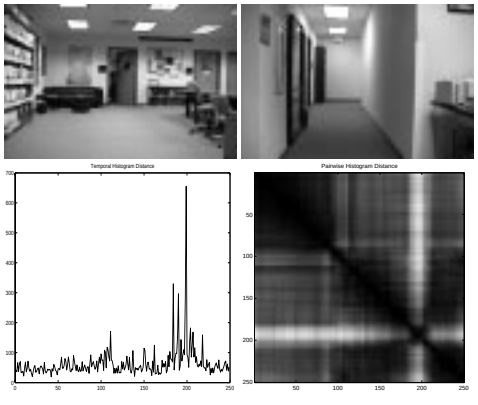

Figure 2: The temporal and pairwise comparison of images appearance.

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