Retargeting 3D Objects and Scenes

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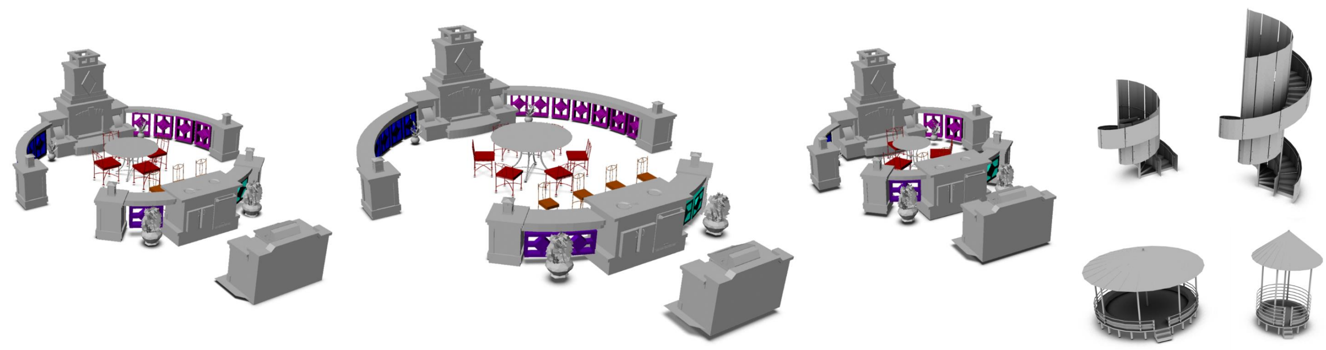

(a) (b) (c) (d)

Figure 1: *Given an input 3D scene (a), the proposed method generates adaptive retargeting results (b) and (c) which respect the original spatial arrangement by exploiting structural regularities. The color-coded parts are the detected regular patterns representing the semantic groupings of the 3D objects in the scene. The proposed method also generates object-level results (d) which contained spiral or rotational structures.*

1 Introduction

We introduce an interactive method suitable for retargeting both 3D objects and scenes under a general framework. Initially, an input object or scene is decomposed into a collection of constituent components embraced by corresponding *control bounding volumes* which capture the intra-structures of the object or the semantic groupings of the objects in the scene. The overall retargeting is accomplished through a constrained optimization by manipulating the *control bounding volumes*. Without inferring the intricate dependencies between the components, we define a minimal set of constraints that maintain the spatial arrangement and connectivity between the components to regularize valid retargeting results. The default retargeting behavior can then be easily altered by additional semantic constraints imposed by users. This strategy makes the proposed method highly flexible to a wide variety of 3D inputs and achieves structure-preserving pattern synthesis in both object- and scene-levels.

2 3D Object and Scene Retargeting

The input of our system is a polygonal mesh $\mathcal{M} \in \mathbb{R}^3$ representing the geometry of a source *object* or *scene*. For the case of a 3D scene, $\mathcal{M}$ can be further divided into n objects $\mathcal{M}_i \in \mathcal{M},\ i = 1 \ldots n$. Our goal is thus to retarget $\mathcal{M}$ into $\mathcal{M}'$ in a way such that $\mathcal{M}'$ preserves the original structure of $\mathcal{M}$ or spatial layout of $\mathcal{M}_i$ in $\mathcal{M}$. The proposed method is composed of two main stages: *scene analysis* and *scene retargeting*.

Scene Decomposition and Analysis. Inspired by [**?**], scene analysis is to detect the regular patterns from all $\mathcal{M}_i \in \mathcal{M}$. Based on the detected structural regularity, we decompose $\mathcal{M}$ into a collection of constituent components, and encapsulate them into a set of *control bounding volumes* $\mathcal{V}_j \in \mathcal{V}$. Note that a global bounding volume $\hat{\mathcal{V}}$ enclosing all $\mathcal{V}_j$ is also included into $\mathcal{V}$ to enable easy editing of the whole scene. The mesh vertices $\mathbf{x}_k$ within each $\mathcal{V}_j$ are represented as the parametric form: $\mathbf{p}_k = (u_k,\ v_k,\ \omega_k)$, where $(u_k, v_k, \omega_k) \in [0,\ 1]$ is the local coordinate system of $\mathcal{V}_j$ spanned by its three axes. The 3D position of $\mathbf{x}_k$ can then be represented as $\mathbf{x}_k = f_j(\mathbf{p}_k) = \mathbf{o}_j + (u_k w_j,\ v_k h_j,\ \omega_k d_j)$, where $\mathbf{o}_j$ is the origin of $\mathcal{V}_j$, and w_j, h_j, and d_j indicate the lengths of width, height, and depth of $\mathcal{V}_j$, respectively.

Interactive Scene Retargeting. In our system, the retargeting results can be obtained by directly manipulating on $\mathcal{V}_j$. For example, users may *stretch* or *displace* $\mathcal{V}_j$ and the system automatically updates the 3D geometry according to the results of structural analysis. To achieve this goal, the unknown parameters $(\mathbf{o}'_j, w'_j, h'_j, d'_j)$ associated with a modified $\mathcal{V}'_j$ need to be determined, which is formulated as a least square optimization problem. In a nutshell, since we expect the parametric form $\mathbf{p}_k$ of each $\mathbf{x}_k$ remains unchanged after manipulation, we may impose a set of linear constraints by requiring a number of control points to *adhere* to specifc locations. For example, to obtain visually plausible retargeting results, *anchor* and *positional* constraints are exploited to enforce physical connectivity and maintain the spatial arrangement. The control points of anchor constraints are selected as the common vertices between two adjacent bounding volumes $\mathcal{V}_i$ and $\mathcal{V}_j$ while those of positional constraints are the centers of $\mathcal{V}_j$ and the corresponding parametric forms in $\hat{\mathcal{V}}$. Anchor constraints thus enforce the new $\mathcal{V}'_i$ and $\mathcal{V}'_j$ to be connected by requiring the control points to be equivalent after updating their parameters. On the other hand, positional constraints encourages $\mathcal{V}'_j$ to adhere to the same relative position with respect to $\hat{\mathcal{V}}$ after retargeting. After updating the parameters of each $\mathcal{V}_j$, the overall retargeting result is obtained by deriving the new 3D geometry according to the new parameters.

References

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