D.A.V.E : A Prototype for Automatic Environment Decoration

Callum James Glover Eike Falk Anderson
The National Centre for Computer Animation, Bournemouth University

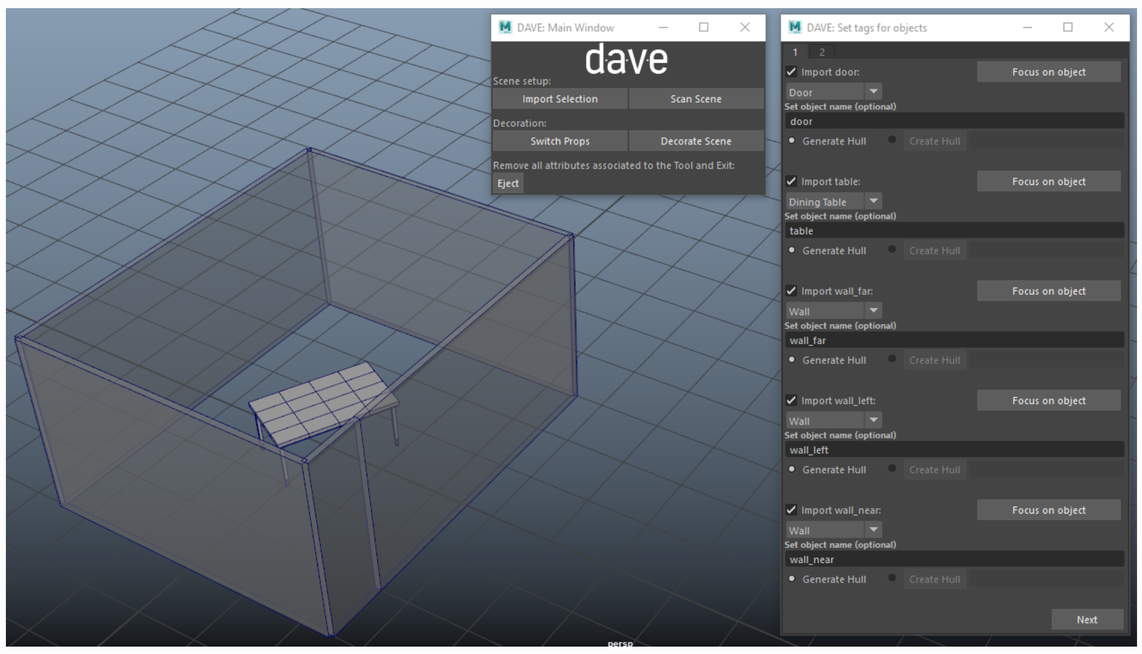
https://github.com/s4907224/DAVE | https://glovefx.com/daverepo

Introduction

Large scale environments in video games are becoming more and more common, with many buildings represented by simple facades with no interior detail. The limiting factor tends to be the cost of artists' effort and time that place a burden on the developer. Richer environments can be produced when artists focus their time on important elements of the environment, with procedural generators automating some of the artists' tasks. To this end we have developed an artist's tool to undertake much of the generic work necessary to populate a scene with objects, acting as a refined canvas for the artist to work on.

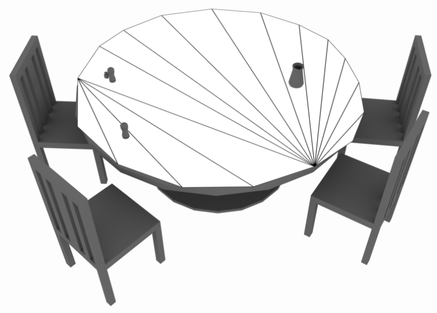
Semantic Annotation

Our prototype uses a set of UI elements to allow users to tag objects and props in the scene, employing Maya's attribute system to expose elements to the user. Our prototype will use this semantic information to automatically fit appropriate non-wall objects into each room. The prototype will deduce the room and building in which an object exists. Edges on the floor plan that correspond to doors of the room are identified and 'locked off' to prevent objects being placed across them.

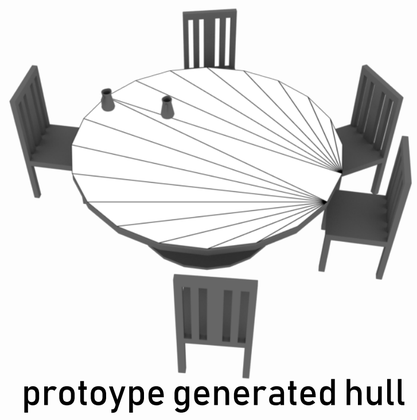


Identifying Object Shapes

Based on user choice, either a convex hull is generated by employing Graham's scan, or a user-created surface acting as the hull is used (in which case all vertices must be numbered successively and lie on a single edge loop). The resulting mesh is then triangulated, becoming a set of many smaller convex hulls. Our prototype processes each edge individually rather than the shape as a whole, essentially trying to emulate a human approach.



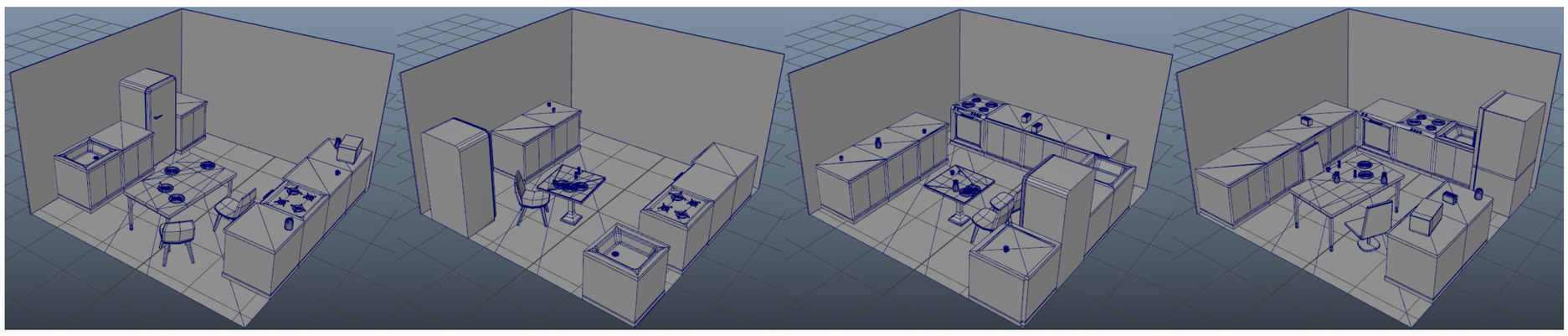
user defined hull



protoype generated hull

Decorating Kitchens

Rule sets for different types of rooms (here: kitchen) use the pre-processed rooms and objects and methodically place props.
If the kitchen is large enough, a dining table will be placed and decorated in its centre. Randomly spaced runs of counter-tops and appliances are placed with simple constraints, e.g. preventing a gas hob to be placed if an oven with a gas hob already exists. Edges are randomly skipped as a simple method to attain variation. Counter-tops are decorated by placing up to two objects from a set of toasters, kettles, microwaves etc.



Results

Our proof-of-concept prototype tool generates scenes that appear natural with somewhat human-like object placement, which we hope to verify with a future user study. We believe our approach is as effective as existing methods, yet simpler and computationally less expensive. Our prototype provides a framework for a more comprehensive tool - with infrastructure for hull generation, room determination, and interactive semantic annotation by the user - and can potentially process thousands of rooms, the bottleneck being user input (setting up three buildings with six rooms takes approximately 4 minutes by the user, whereas the processing takes less than a second). Further automation could improve this (procedural buildings with automatic semantic annotation) and in the future we also plan to extend the system with more complex rule-sets and room descriptions.

References
BRADLEY B.: Towards the Procedural Generation of Urban Building Interiors. Master's thesis, The University of Hull, 2005.
ELINDER T.: General Methods for the Generation of Seamless Procedural Cities. Master's thesis, Lund University, 2017.
GRAHAM R. L.: An efficient algorith for determining the convex hull of a finite planar set. Information Processing Letters 1 (1972), 132– 133.
KÁN P., KAUFMANN H.: Automatic furniture arrangement using greedy cost minimization. In 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR) (2018), pp. 491–498.
LOPES R., TUTENEL T., SMELIK R. M., DE KRAKER K. J., BIDARRA R.: A constrained growth method for procedural floor plan generation. In Proceedings of GAME-ON 2010: the 11th International Conference on Intelligent Games and Simulation (2010).
MERRELL P., SCHKUFZA E., LI Z., AGRAWALA M., KOLTUN V.: Interactive furniture layout using interior design guidelines. In ACM SIGGRAPH 2011 Papers (2011), pp. 87:1–87:10.
TUTENEL T., BIDARRA R., SMELIK R. M., DE KRAKER K. J.: Rule-based layout solving and its application to procedural interior generation. In Proceedings of the CASA'09 Workshop on 3D Advanced Media in Gaming and Simulation (3AMIGAS) (2009), pp. 15–24.
XU K., STEWART J., FIUME E.: Constraint-based automatic placement for scene composition. In Proceedings of the Graphics Interface 2002 Conference (2002), pp. 25–34.