Constructing 3D Models of Urban Environments

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Creating the model geometry

Working with 3D modeling and image-editing tools, we use data such as site photographs, maps, and elevations to make a basic 3D mesh with correct proportions and scale. In some cases, our task is to create generic structures that are appropriate for the virtual site or context in which the model will reside. In other cases, our task is to replicate real world structures using photographs of the actual given buildings as the model textures. The image below and to the left is one of many site-specific photographs we used to create models for a given terrain database. The image to its right is a blueprint of the entire site, which we used as a guide to placing completed models in context on the terrain and to confirm the footprint of the 3D models.

After constructing the 3D mesh of the building, we add internal walls and the floor and then cut out openings for doors and windows. At this point we can overlay reference imagery on the 3D model, making any necessary adjustments to refine this base model.

When the base model is finished, we create final geometry details such as stairs, down pipes, and gutters.

Adding MetaVR HPX format features

VRSG supports features in the MetaVR's HPX 3D file format. These features enhance the model's realism in a real-time context, for example:

- Switch states toggle between open and closed doors and windows.
- Level of detail (LOD) switches swap in a less detailed version of a model at a distance to improve performance.
- Animation nodes add a looping sequence to models requiring movement (such as flags and vehicle wheels).

HPX material assignments determine how the surfaces of a model respond to lighting.

Photographing buildings for modeling

Textures for 3D models depend heavily upon the original photographs from which they derived. Such photographs should to be taken in a perspectiveless manner, ideally with a digital camera of at least 6 megapixels at full resolution. Perspectiveless means that you take the photograph fully perpendicular to the subject. For efficient modeling, textures should be perspectiveless when we apply them to a model. Otherwise, removing perspective from a photograph is a labor intensive image-editing effort. Good and even lighting is also important; shadows as well as snow and dirt are aspects that obscure the normal state of the building to be modeled. (We add these environmental details after the model is built.)

Below is an example of a perspectiveless photograph; we used this one in modeling the building shown on the next page:
Texturing the model
To make textures for our models, we edit the photographs, by adjusting the color and removing any unwanted interference and camera distortion. Shadows can be baked into parts of the texture to simulate soft lighting.

We place all the textures for the model into one larger composite texture in 512 x 512 pixel allotments for efficient texture paging within VRSG.

Images of bricks and concrete are edited to become tiling textures that repeat seamlessly across a large area, such as a wall. The following images are examples of a composite texture and a tiling texture:

Texture elements are tiled, or repeated, whenever possible to reduce the memory requirements for rendering the model. Such textures are useful in terms of marginal utility in that their visual content is generic; some texture elements contribute more to the model fidelity than others. We model textures that contain unique architectural information, such as the facade of a building, as photo-specific. This means that there is a one-to-one mapping of the photographic element to the model’s geometry.

Next, we apply the photographic textures to the mesh so we can see what the output will look like in VRSG. Mapping the textures onto the 3D mesh is the most complex task in creating the model because each face on the mesh must be assigned to a part of the texture. Any mismatch in scale, alignment, or tone is easily visible.

Inspecting the final model
When the model is complete, we export it to a MetaVR HPX file and view it in the ModelViewer or render it in VRSG. We inspect the model’s switch states, material settings and artifacts in the geometry and make any needed corrections.

Finally, the model is reviewed by other members of MetaVR, and any necessary corrections or refinements are made.

Below is one of the photographs of the original building on which the model shown above is based:

Next is a VRSG screen capture of the model in its analogous context in the virtual world. (See more comparisons on the next page.)
Case study: actual and simulated views of MetaVR’s virtual Leschi Town MOUT site

In the following set of images you can compare photographs of the Ft. Lewis, WA, Leschi Town MOUT site on the left with the VRSG screen captures of the simulated view of the MOUT site within MetaVR’s Ft. Lewis terrain database on the right. The models of buildings and other structures are photorealistic; we created the models from a set of approximately 200 photographs of the Leschi Town area.

For more product information, pricing, and ordering, see MetaVR’s Web site at www.metavr.com or send email to inquiries@metavr.com.