Linking 2D data to a 3D Architectural model

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Abstract

In this paper we describe a method for identifying on a 3d geometry of a building, the analyses from the rendered image. The goal of this process is to link two different data types, development of a 2D analysis and link the result to the 3D model on an architectural domain.

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1. Introduction

The common process for producing a 2d image is made from pushing 3D data to the frame buffer. By doing this, the camera defined for the render will be selective and the visible data will be processed.
If on one hand, the problem of acquiring visible data is solved, on the other hand, there is no tracking of any kind of data visible or hidden on the image. Since the goal of the render is to get the image of the model, the process works one way and forward.
Performing analyses on a 3D data of an architectural model is a task that depends on the construction of the 3D model, since there are many different methods of modeling the same object, there would be a need for different analyses approaches for each model. Nevertheless, the resulting image of the model will be the same, therefore, our process focuses on the render and links the analyses of the image to the original 3D data.

2. Related Work in 3D architectural domain

Attribute retrieval in architectural domain is a rather unexplored field, though, depending on the goal of the work, some methods for analysis of 3D and 2D data, can be found.
Linking data from 2D or 3D is used on several papers with different goals.
A process for geometry construction is proposed by [MZW*06], that consists in rebuilding geometry according to an image analyses. The retrieval of windows of a building is performed by the detection of the frequency related to the window alignment on the image. A 3D model of the building is produced according to the retrieved 2d shapes.
One study describing shapes in the Architectural domain was developed [WBK08] using groups of horizontal slices of the model. These images are used to identify cells that represent rooms of an apartment or a house. The evaluation of cells of the image results in a connectivity graph.
In the Virtual Reality field, [DF08] developed a process to detect tracks for agents in 3D worlds. Horizontal 2D image slices are produced and floor information is fed to agents to move in the 3D model.
Linking data can be of great use and has a wide application on several fields. In our process linking data is performed to feed back information from 2D analyses into the 3d model.
3D Geometry has qualities compared to other multimedia files. In [VKF*06], is presented a synthesis of methods for analysing geometry and the advantages of this type of data.
Detecting characteristics on a 3D architectural model like in other models, goes beyond its morphology, since they have arbitrary topologies [VKF*06]. Therefore, standard methods for shape retrieval and analyses of 3D building models aren't efficient and methods related to architecture grammar are needed. Building an architecture grammar is possible from the analyses of the render and returning the meaning to the model. Linking back to 3D data will increase the value of the 3d architectural model in any field of work.

3. Over View

The method starts with an OBJ file format model. Its geometry is triangulated as a standard procedure for ease of conversion from any kind of format. Triangulated OBJ models are generally used for its versatility in accessing geometry description. However, this file format has a generic data structure dedicated to all kind of 3D models, therefore, the lack of meaning or semantic orientated structure, makes it similar to a polygon soup.
From the OBJ loaded model, several polygon lists and respective renders are created.

The method is developed from an original list of polygons and by refining this list into others, based on the analyses of the new rendered image. Each time a new list is refined its sent to the frame buffer. This is made in several stages until one image with architectural features is obtained.

The link is possible by performing any analyses on the final image and tracking to the respective polygon through the image with color tags.
A particular pixel position in one image has different meaning on another image but relates to the same polygon.

4. Polygon Tagging

In the beginning of this stage, we need to produce an image with visible polygons from the CamList. Before the render process, each polygon is tagged with an exclusive ID color per vertex, according o each polygon identifier. A 32-bit integer is used. All polygons will be sent to the frame buffer with their respective identifier referred previously.
Each polygon is projected according to length distance, this way, the polygons close to the camera will be the last to be sent to the buffer and will not became hidden by others.

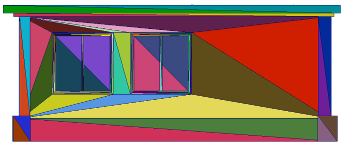

Figure 1 : Buffer image of tagged triangles (for better identification purposes, colours are simulated)

This stage results n an image with all polygon colored and without visual meaning.
A tracing algorithm identifies each colors exist in the image allowing to select the correspondent polygons from the CamList. A new list, TagList, is created for all visible triangles the first image.
This process of color tagging lets us keep the link between the two worlds, the resulting 2D image and the 3D geometry.
The TagList will be reconstructed according to depth clusters and another image is produced.

5. Cluster Creation

The Cluster creation is performed by grouping triangles of a certain type. All triangles with the same depth information are grouped under a new list and render image.
From the TagList a new list is made by placing in order of proximity all triangles. This new list, clusterList, that produces the clusterImage, gathers groups of coplanar triangles according to their depth value and colors each set of polygon face in grey scale according to de group they belong.

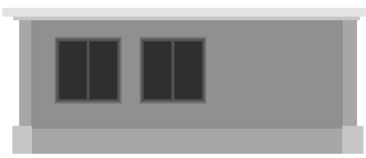

Figure 2 : Image of cluster triangles (for better identification purposes, colours are simulated)

This process revealed more efficient than others usual processes [KT03], since the groups of triangles are made from pre selected geometry and using the exclusively information from the image.

The coloring of the faces is destined to differentiate depth levels. Other processes of depth identification based on ZBuffer, are used in studies were the need for depth precision is not crucial.

6. Linking data

The clean cluster image allows performing many types of image analyses and retrieving architectural features is simplified. Acquiring areas of interest can be tracked back to the model by matching the pixels to the same ones on the TagImage. The colors from the referenced by the interest area point directly to the polygons of the model.
Clustering polygons on the model, allows restructuring the 3D architectural model.

7. Conclusion and future work

This paper presents a simple and practical method for linking 2D to 3D data. From the experimental results we can draw the conclusion that this method is reliable and useful for a wide range of analyses on 3D architectural models. The current application developed on C#, besides using OBJ files, isn’t meant for performance. However heavy loaded models are simplified at the start due to visibility selection. Complete models, with inside and outside geometry and about 250000 polygons where easily loaded and rendered. Nevertheless, the smaller polygon models can have the same performance as bigger ones since only the visible geometry is processed. In future work this method is to be extended to retrieval of architectonic attributes and restructuring of the 3D model

10. References

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