PHOTOREALISTIC PRESENTATION OF THE PALAIS GRAND DUCAL BASED ON PHOTOGRAMMETRIC RECORDING

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ABSTRACT:

Aim of this paper is the description of a procedure to generate from 3D photogrammetric measurements a 3D geometric CAD model which fulfils the requirements to hidden-line and rendering functions. The building is recorded with a technique known as multi image photogrammetry using a Rolleiflex 3003 metric réseau camera. Image orientation is performed with a bundle adjustment program supported by control points. In addition to the geometric model a light model has to be defined and material assignment is necessary as well to present the building in a photorealistic shape. RolleiMetric MR2, AutoCAD and AccuRender software packages were used to produce the photorealistic presentation of the Palais Grand Ducal in Luxembourg.

Dieser Beitrag beschreibt die Vorgehensweise zur Erstellung eines 3D-CAD-Modells aus photogrammetrischen Meßwerten. Das Modell wird zum Zweck der Visualisierung erstellt und erfüllt die Anforderungen an Verdekkungsalgorithmen. Mlt dem Verfahren der Mehrbildphotogrammetrie erfolgt die Aufnahme des Gebäudes unter Benutzung einer Rolleiflex 3003 metric Réseaukamera. Die Orientierung des Bildverbandes erfolgt mittels Bündelausgleichung unter Benutzung von terrestrich bestimmten Paßpunkten. Zur Erzeugung photorealistischer Darstellungen ist neben dem geometrischen Modell ein Licht- und Materialmodell zu definieren. Anwendung fanden die Softwareprodukte RolleiMetric MR2, AutoCAD und AccuRender.

INTRODUCTION

The Palais Grand Ducale in Luxembourg stands as a symbol for history of the Grand Duchy of Luxembourg. Built from 1572 until 1574 in the art of Spain late renaissance and continued 1741 in baroque style, this building had to survive several sieges in four centuries and later became one of the biggest castles in Europe.

Today, the palais is used as the ofiice for the Grand Duke and for representation purposes for international meetings. As the lime stone was destroyed for environmental reasons, the palais and the chamber of deputies were renovated between 1994 and 1995. In those years Luxembourg was capital of cultural heritage. For this reason and for archiving purposes, the engineering company Kneip & Ass. in Luxembourg received from the city of Luxembourg the order to produce two-dimensional drawings of the facades scaled 1 by 100.

Depending of the local situation and limited access, the procedure of multi image photogrammetry using a Rolleiflex 3003 metric 35 mm réseau-camera and the RolleiMetric MR2 software package was selected.

From the final two-dimensional drawings and the three-dimensional photogrammetric measurement results a 3D-model was produced with the AutoCAD release 12 drawing editor. The geometric model then is presented wit the rendering program AccuRender release 2.0, a software that is working complete inside the AutoCAD drawing editor.

ON SITE MEASUREMENTS

Approximately 140 photos were taken with a Rolleiflex 3003 metric réseau camera using different lenses from 18 up to 60 mm. Image scale varies from 1: 10 for details up to 1:100 for overview purposes. The recording procedure in multi-image photogrammetry is to cover the object with a bundle of images from different photo positions. Figure 1 shows some of those photo positions and part of the palais. The photos have to be taken with a metric camera. By metric camera we mean that the position of the projection center relative to the image area is known. Parameters of lens distortion must be known by calibration. The Rolleiflex réseau cameras represent such a kind of recording equipment. Orientation of the image bundle was supported by several natural control points measured with an accuracy in the range of one centimeter.

Figure 1: Part of the palais with some photo positions

Evaluation of the image material was performed with the RolleiMetric MR2 software package. Measurements were taken on a digitizer in eight times enlarged prints. Standard deviation of the image measurement was given with 0.015 mm after the bundle adjustment. Accuracy of orientation points in the object is 0.01 m. Architectural details were taken from a minimum of three photos. The measured values like points and polylines were converted into Intergraph´s Microstation. A complete set of two-dimensional facade drawing were evaluated .

3D-SURFACE-MODELLING

Based on 3D photogrammetric measurement results and the 2D drawings, produced within Intregraph´s microstation, a 3D surface model was produced with the AutoCAD release 12 drawing editor.

At the outset a very roughly 3D model was generated by using the ground plane and the facade drawings as flat walls. From this first model the final complete 3D-model was derived with special considerations of layer definitions.

Separation was done according to materials. For example a window is separated into glas, wood and stone material. Furthermore some special details like ornamenmts of the masonry were designed in layers.

The complete model had a size of 5 Mbytes. By cleaning the drawing from unused references the size of the drawing reduced to a useful amount of 3.5 Mbytes.

For efficient data handling the CAD system enables the user to work with external refernces.The content of external drawing parts is ownly shown but not loaded into the drawing itself. That is different from inserting blocks. Moreover changes made in the referenced drawings are automatically updated in the current drawing. Therefore any drawing including XREF's is available in the latest version.

Referenced Layers, block definititions, line, text and dimensions styles are named dependent symbols. Is a drawing loaded as an XREF, an access to those dependent symbols is impossible. Thus layers only existing in the referenced drawing can not declared as current layer. One consequently can not draw on such layers. However depending symbols can be linked into the main drawing for allowing access to them.

Figure 2: Photorealistic presentation of a part of the palais.

MODELLING FOR PHOTOREALISTIC PRESENTATION

McNeill's software package AccuRender offers the opportunity of photorealistic presentation of 3D surface or solid object models according to the AutoCAD drawing editor. Materials and their structure can be assigned to surfaces and objects. Light modelling and defining environmental elements, such as sky and clouds, background or ground planes are amongst the features available. The complete software functionality is available directly in the drawing editor.

Material and object properties. Material can be assigned to an entity via the entity itself, via the layer or the colour definition. Selection of material is possible from libraries. Libraries can be mangaged by the user himself by editing existing or importing new materials. Those bitmaps can be generated by scanning photos.

Defining the base colour of a matrial includes diffuse colour, reflectivity, transparency, gloss and glow. Furthemore patterns such as wood, marble or granite e.g. can be assigned to objects, called procedural patterns.

Bitmaps are two dimensional patterns which are wrapped around an object like elastic paper. The material's scale is pre-defined and can be altered. Automatic repetion of the material's shape results in covering the complete object.

Object properties are pattern orientations, bitmap areas from the object, surface changes by waves or resolutions wich are directly assigned to the objects. Materials, showing marble, wood or other patterns are variant with the orientation. Assigned is the origin, as well as the x and y direction related to the world co-ordinate system within the AutoCAD editor. This assignment can be overloaded, so that the pattern of a wooden furniture is automatically shown from the right perspective.

Bitmaps require slightly different treatment. Dependig on the repetition of rectangle areas intersection edges can show different patterns.

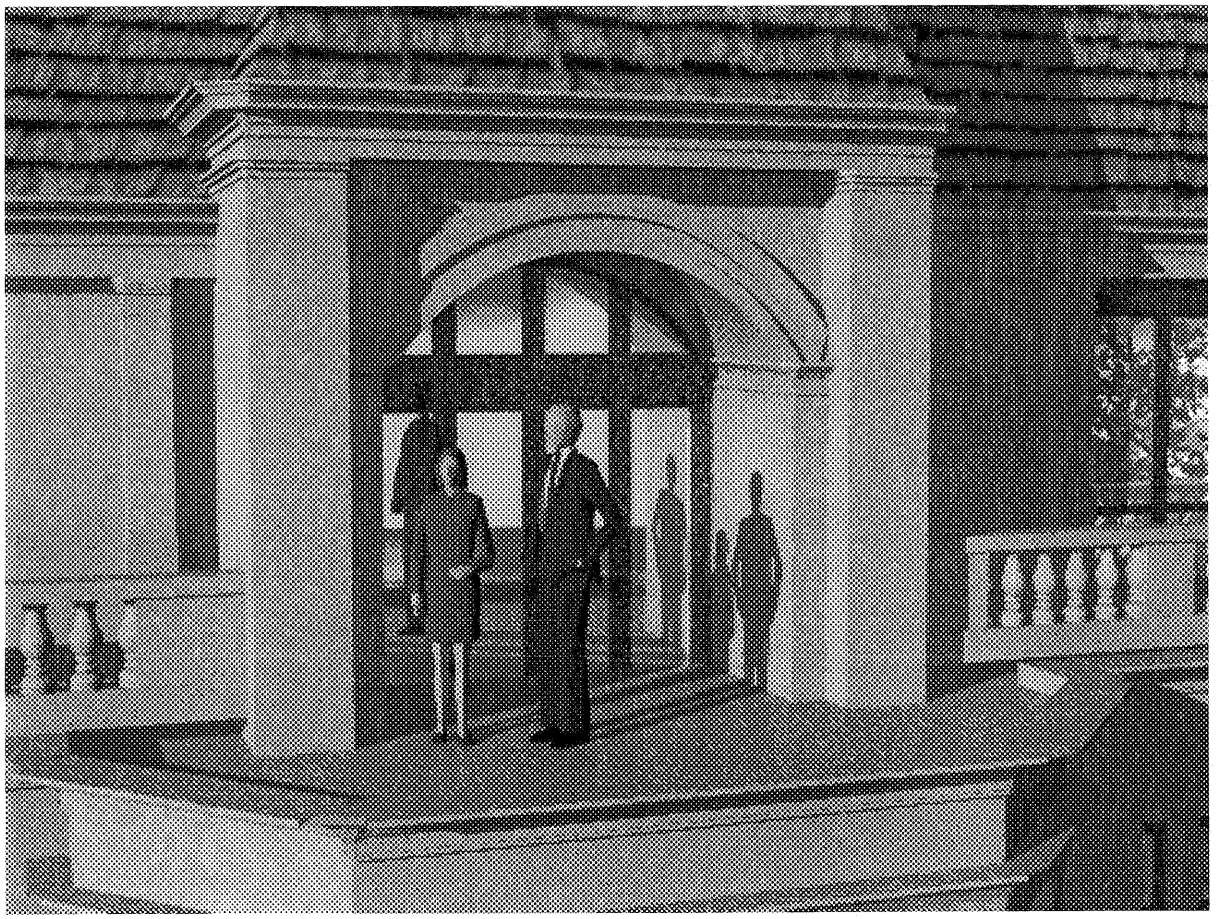

Figure 3: Rendering with acessories from the library People for People

Wave information can produce the effect of uneven surfaces and have influence to light refelection.

Light modells. The following parameters have to be considered when targeting to a realistic presentation: The colour of the object itself (the diffuse colour), surface properties, reflections, shadows , light colours and the light sources.

The light model in general is a result of three different types. Ambient light, diffuse light, specular light. The colour of an object depends on the influence of these light forms at one point of time.

Ambient light is the the illumination of a scene and provides the basic colour. There´s no specific source for ambient light. Therefore the ambient colour for an object is constant. This light´s intensity does not diminish with distance.

Diffuse light is reflected from object surfaces. Non glossy objects reflect light in all directions. One can observe from an arbitrary position the same intensity for a special point. Diffuse light is only dependent from the light position relative to the observer.

Intensity results from the angle between light direction and surface normal vector. Intensity decreases with larger angles.

The specular component reproduces the bright shining light, accepted from a billard ball. Specular light is the light of a light source beeing reflected directly to the viewer.The highest intensity occurs when the viewing direction fits the direction of reflection, otherwise it decreases rapidly.

AccuRender contains a vast an flexible set of ligt modelling tools. Among them are apart from ambient light a distant light, point light, spot light and focuses spot light as well as parallel light in a linear and rectangular light source. Light sources ar in general invisible but can be visualized in a transparent body.

Properties of anly light source are the intensity , shadow and penumbra, the position and the light colour.

With exeption of distant and indirect light, a light source looses intensity by distance, either invers linar or

invers square. Inverse linear shows better results when rendering.

Environment and landscaping. The realistic environment includes elements without part of the original AutoCAD drawing but should nevertheless contained in the rendered image. These elements include background and ground plane as well as three global lights, indirect light, fog and haze as well as depth cue.

Is a modell shown in a perspective view a background should be imagined as an infinity globe around the model and the ground as an infinitiv surface underneath.

On the globe colours, cloudes and bitmaps are projected, wich can set the model into a realistic or even surrealistic surrounding. Ground can be covered by different materials. Fog and haze could simulate the effect of normal haze in the background up to real fog. Colours of haze correspond to background colour.

Vegetation act as normal 3D objects, producing shadows and beeing reflected.

FINAL RENDERING OF THE SAMPLE

Samples of final rendering are given in the figures 2 and 3. Recommended for a natural view is a perspective transformation. Light marble is assigned to the walls, windows are defined as bright gray and strongly reflected metal in which the deep blue sky with the choosen cumulous clouds reflects. The light is the one in Luxembourg shining on August 29, 1995 at 12.30 pm selected from the AccuRender light source menue.

At the top of figure 2 one can observe some leaves of an oak tree. Renedering time for this image on a 75MHz 486-computer with a resolution of 1280 x 1024 pixels was approx. 57 minutes.

Depending of the high amount to memory capacity figure 3 is shown in a resolution of 640x480 pixel only. Rendering time for this image was approx. 73 minutes. Size of the tif-format file is 1 Mbyte.

In this image are som relfections to detect. In the window on the right one can observe reflections of the oak tree in front of the window. Reflections of the persons shadows are detectable as well. Background with cumulous clouds is shown as the mirrored image in the windows. The people are supplied from the library People for People which is delivered with predefined materials for the AccuRender program.

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