Development of an Interactive 3D Herbaceous Bed Designer

Philip Paar, Timm Dapper, Jan Walter Schliep

Laubwerk GmbH, Potsdam/Berlin · philip.paar@laubwerk.com

Abstract: The authors describe an agile approach for developing a web service for an interactive, online 3D herbaceous plants bed and border designer. The ultimate goal is to create photorealistic views in (near) real-time for interactive 3D garden designs. This paper starts with a brief history of 3D garden software. It then focuses on the software design of prototypes of the 3D herbaceous bed and border configurator, different rendering approaches and presents first visual results.

Keywords: 3D garden, herbaceous beds, 3D plants, 3D visualization, cloud rendering

1 Introduction

Readers may have used the IKEA Kitchen Planner or Home Planner (IKEA 2017), a 2D/3D CAD program running in the web browser, which lets the user plan, visualize, and order IKEA items online. This application is indoor-only. Since their first appearance in the late 1990ies, DIY garden designer 3D software packages have already been marketed as easy-to-use, photo-real, and realistic tools for the user's "dream garden". Some titles such as DATA BECKER "3D Garten Planner" (ZINK et al. 1999) have meanwhile been discontinued (the last release was "3D Traumgarten Designer" V. 11 (2011); DATA BECKER became insolvent in 2014), others such as Chief Architect (2016), "Home Designer Software", formerly branded Better Homes and Gardens Designer (2003-2008) have been frequently updated. They promise simple growth simulation, a plant encyclopedia, a gardeners' calendar, real-time walk-through, and hundreds or even thousands of plants and accessories. Usually, these 3D applications have made use of billboards for plants, either from cut-out photos or from rendered 3D models. There are online applications such as the discontinued "Virtual Garden" (BBC 2014) and "My Garden" (GARDENA 2016) that are based on Adobe Flash, an Internet browser plugin technology the days of which are numbered. In "My Garden", users can draw and plan a garden, e. g., and drag and drop Gardena products, in (2D) top view in a hand-drawn style.

Obviously, in the age of 'apps', there are also smartphone and tablet (3D) garden apps, such as the French "Home Design 3D Outdoor Garden" for iOS (ANUMAN INTERACTIVE 2017). The graphics quality is clearly inferior compared to state-of-the-art computer games (Fig 1). Nevertheless, it gets an average rating of 4 out of 5 stars (APPLE ITUNES STORE 2016). On Android, there have been 1-5 m downloads (GOOGLE PLAY 2017). There are critical comments, including user Denise Bontoft who reviews the app: "(…) I downloaded this and paid hoping to be able to produce a 3D version of my planned garden before my landscaper comes to do the garden. Controls are fiddly and only straight lines appear to be allowed in our garden, I can't think of anything worse for flower beds. Also there is a huge lack of plants available, (…). While I love the idea, it's not much use until more added, unless it's only meant for imagination play." An anonymous user warns: "Don't waste your time. I'm just going back to basic pen & paper planning" (GOOGLE PLAY 2017).

Journal of Digital Landscape Architecture, 2-2017, pp. 198-205. © Wichmann Verlag, VDE VERLAG GMBH · Berlin · Offenbach. ISBN 978-3-87907-629-1, ISSN 2367-4253, e-ISSN 2511-624X, doi:10.14627/537629020.

Fig. 1: Home Design 3D Outdoor & Garden (screenshot by ANUMAN INTERACTIVE 2017)

While on one hand, many people seem to be interested in 3D garden and flower bed design, on the other hand, powerful yet easy to use applications are still missing. In late 2015, the authors were contacted by one of the leading chains in the German and European building and DIY market. Their markets usually also include garden centers. We were asked to provide a tender and some work samples for an innovative project that aims to provide the prototype of an interactive 3D herbaceous bed and border designer for their website. At first, the client only expected a sort of real-time 2D photomontage. While it is the central concern of the client to test prototypes with their website users and measure their reactions, this paper does neither specifically consider the design of the herbaceous beds, the design of the web front-end, nor presents results of the user tests. That all lies within the client's responsibility. Instead, we present our approaches to the computer graphics software implementation, and the first visual results.

2 Material and Methods

We use different methods to create the images. In general, the image processing uses 3D plant models of perennials, grasses, or small shrubs. These 3D assets are created combining procedural techniques with handcrafted details (DEUSSEN & LINTERMANN 2005). The textures for leaves and flowers are partly taken from original photography of the specific species or cultivar, partly synthetic or from a similar plant, if original photos are not available. The authors have created one 3D model of each of selected 200 species and cultivars, around one third of a typical garden center's plant assortment. For the representation of bed borders and the ground, we make use of procedural textures of soil surfaces, lawn, stones, and wood, etc.

In a first test, the aim is to create and compare two images of one herbaceous bed design using two different approaches. The client has specified the simple planting design with framing borders of stone. The first approach, originally suggested by the client, is a photomontage based on single plants images, pre-rendered with an alpha mask and placed on a hexagon grid with an underlying soil texture. The second approach uses an offline 3D rendering technique. The 3D plant models and other 3D objects and surfaces are placed in a 3D scene using the software MAXON Cinema 4D[1], the scattering plugin Laubwerk SurfaceSPREAD[2], and the renderer "VRAYforCinema4D"[3].

RÖHRICHT (2005) describes a system that handles rule-based distribution of plants and crops within vegetation types and fields. KIRCHER (2011, 2012) describes an approach for randomly mixed perennial plantings for planting design. While these publications would definitely be relevant for ecological planting design, we decided to rely on the rule-based, procedural SurfaceSPREAD plugin.

Based on the visual test results, presented in the next chapter, we were commissioned to develop an extensive prototype for the client's website and online store based on the offline 3D rendering technique, i. e. pre-computed renderings in VRAYforC4D. Here, the 200 different plant species and cultivars are involved. The plants are classified as structure/framework plants, accompanying plants, as well as ground cover, and filling plants. Then, we develop the logic of sensible combinations of plants and their placement on the virtual beds. For this purpose, the client delivered herbaceous bed designs and a database of plant characteristics, e. g. demands such as soil type. The numerous combinations could then be limited due to render time, and budget constraints from 2.5 billion theoretical permutations to 500 k variations, i. e. images to be rendered. A template 3D scene for different bed designs and sizes was created in Cinema 4D. The Cinema 4D scene file is quite large: 4 gigabytes. Within the 3D modeling software, the 3D plants are procedurally distributed ("scattered") on the herbaceous beds using the SurfaceSPREAD plugin in combination with scripting in Cinema 4D ("Xpresso", and "Python"). The scripts control the visibility of the plant models and automatically create the combinations.

3 Results

Details of the two images of the first test are shown in Fig. 2. The 2D plants for the photomontage/compositing shown in sample (A) come with back lighting and cast shadows on the ground. Sample (B) is a rendering of the full 3D scene rendered in VRAYforC4D.

Example images of the extensive prototype also rendered in VRAYforC4D are shown in Fig. 3 and 4. The processing of the 500 k images takes many months on a small render farm. A single image requires between two and ten minutes in 880 × 495 pixels resolution.

The visual results of both the extensive prototype and the frontend of the 3D herbaceous bed designer are live on the Internet (OBI 2016, Fig. 3). A web design agency was commissioned with the design of the frontend. Users can currently choose from predefined bed forms, the locations factors sunlight (sunny, partial shade, shady), and soil type (loam, humus) as well as for different styles.

[1] maxon.net
[2] laubwerk.com
[3] vrayforc4d.net

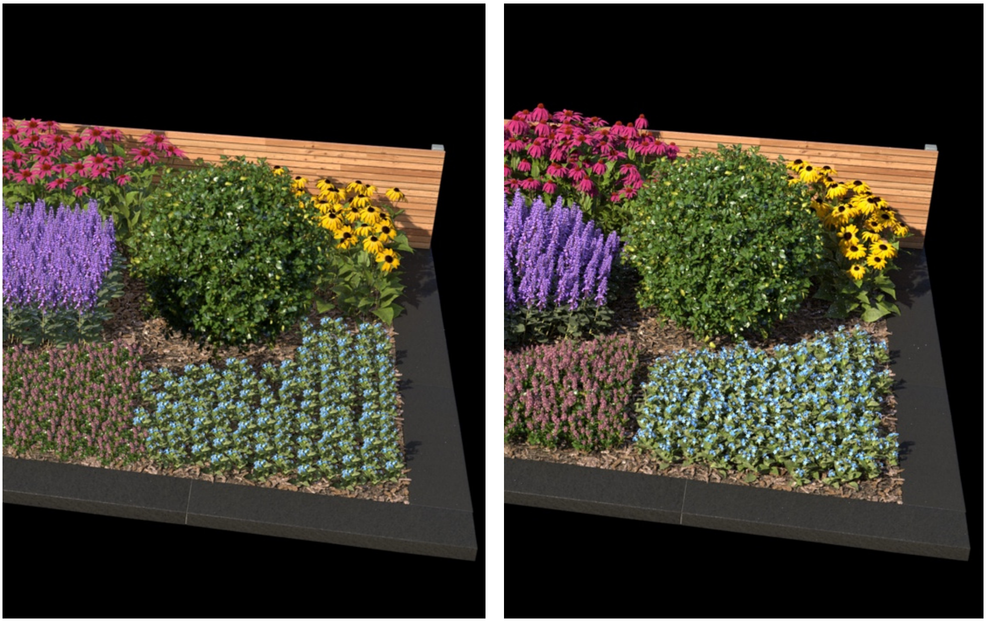

Fig. 2: Picture details of a first test of 3D herbaceous bed and border designer. Left: 2D photomontage. Right: 3D rendering.

Fig. 3: Example of a 3D rendered herbaceous border design

Fig. 4: Variation of the design of figure 3

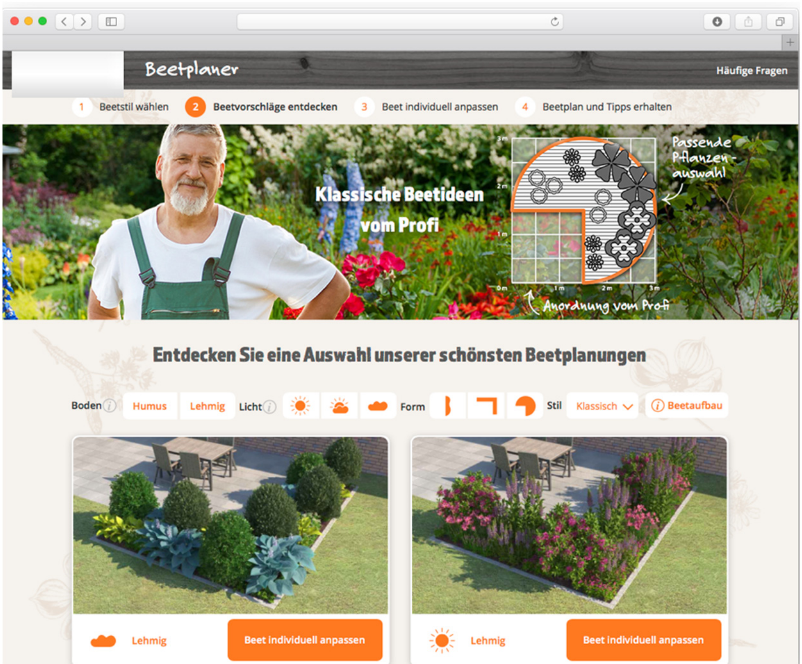

Fig. 5: Homepage of the online herbaceous bed and border configurator (screenshot)

4 Discussion

By comparing the two samples of the first test (Fig. 2), it becomes clear that the 3D scene (B) looks more realistic due to the more natural looking placement of the 3D plants (using random noise for rotation and scale) and computed shadow casting. The compositing technique (A) is insufficient for simulating shadows cast by plants on other plants. Furthermore, it is largely limited to the pre-computed views and lighting conditions, while a 3D scene is flexible and customizable.

Therefore, we have successfully applied the full 3D rendering approach to the extensive prototype. However, the computational effort and necessary resources for the sheer number of combinations of the pre-computing approach is very high. Users will probably not request every theoretical permutation but this is hard to predict. The pre-computed imagery approach is not flexible when it comes to additional changes, e. g. other views, different lighting, or new plants and materials. It is already clear that the final system should be able to offer the whole plants assortment (600 + objects), more parameter and design options.

Currently, most of the plants have been modeled in peak bloom, even though many do not bloom at the same time. At present, differing blooming periods and growth patterns are not shown and therefore can be misleading. Still, this limitation was necessary for pragmatic reasons and time constraints, i. e. to deliver a reasonable prototype with the pre-rendered images in time.

5 Conclusion and Outlook

The current prototype is limited to a small subset of the plant assortment that could theoretically be offered, a single viewpoint, a single camera position, and a small number of planting shapes and layout variations. Most of these limitations were imposed to limit the number of permutations to make if feasible to go with a database of pre-rendered images. Some limitations were also introduced, to postpone problems like a procedural creation of the exact positioning of structure, and companion plants. It became clear, that lifting any of these constraints will require a shift from pre-computed imagery to on-the-fly image generation.

Options to do so would be local image generation on the customers' computer, either by using web-browser based 3D rendering (WebGL), or moving to a standalone application or creating images on the fly on a cloud rendering platform.

The user experience of the first two options would depend highly on the configuration of the customers' computer, which may limit the number of possible users and the achievable graphics quality. Developing standalone software requires the user to install separate software, which complicates usage and will therefore limit user acceptance. Furthermore, developing and supporting standalone software that supports a wide range of platforms, including mobile devices is a very complex endeavor on its own.

Therefore we are currently experimenting with a cloud-based rendering service. This service would compute preview images on the fly on a server while the user interactively modifies the scene. This can provide high image quality because the same render engine can be used as before. It also makes the image quality and render times independent of the customer's hardware and does not limit the number of target platforms because the technical requirements on the client machine are only marginally higher than with the previous version. The question is if such a platform could already handle the interactive rendering of user requested visualizations within a short latency time of less than 2 sec.

The current prototype is based on the still experimental "V-Ray Cloud" software from Chaos Group Labs[4], a version of the Academy Award-winning V-Ray renderer surrounded by a framework that allows it to run on a server farm. Every detail of the rendering operation and the scene being rendered can be interactively manipulated using regular web protocols like HTTP and WebSockets. This allows the dynamical switching of arbitrary geometry elements (such as plants, planting bed borders, lighting camera, etc.) directly through the UI in the customer's browser. To limit the latency to acceptable levels for interactive use, a progressive rendering technique is applied. As a result, a low-quality version of the image is transferred to the customer as quickly as possible to give a rough impression of the scene. That low-quality image is then progressively refined and the image updated to reach full image quality after a few minutes. While the final result still takes awhile to compute, the first results are available almost instantly, even with the rendering software running on relatively modest configurations like an i5 2.7 Ghz.

This technology would lift any restrictions on the amount of permutations being created and opens the door to limitless variations. For example, the depiction of seasonal change, i. e. the appearance of the bed on a seasonal or monthly basis would be very powerful, and improve the accuracy of our representations.

Our approach of creating a configurator for 3D outdoor scenes with a scalable cloud rendering service could certainly be very interesting for other areas of application such as landscaping, landscape architecture, architecture, and real estate visualization. We believe that A/B testing of different designs and compositions with a near-to-real-time online visualization would not only be attractive to vendors, but also in landscape architecture research.

References

ANUMAN INTERACTIVE (2017), Home Design 3D Outdoor and Garden. http://www.homedesign3d.net (Jan. 10, 2017).

APPLE ITUNES STORE (2017), Home Design 3D Outdoor and Garden. https://itunes.apple.com/app/id978726175?mt=8 (Jan. 10, 2017).

CHIEF ARCHITECT (2016), About / Story. https://www.facebook.com/ChiefArchitect/info (Oct. 13, 2016).

DEUSSEN, O. & LINTERMANN, B. (2005), Digital design of nature: computer generated plants and organics. Springer, Berlin/Heidelberg/New York.

Gardena (2016), My Garden. http://www.gardena.com/int/garden-life/my-garden/ (Oct. 13, 2016).

GOOGLE PLAY (2016), Home Design 3D Outdoor/Garden. https://play.google.com/store/apps/details?id=fr.anuman.HomeDesign3DOutdoorGarden&hl=en_EN (Jan. 10, 2017)

[4] https://labs.chaosgroup.com/index.php/tag/v-ray-cloud/

IKEA (2017), IKEA Home Planner.
http://kitchenplanner.ikea.com/US/UI/Pages/VPUI.htm (Mar. 20, 2017).

KIRCHER, W., MESSER, U., FENZL, J., HEINS, M. & DUNNET, N. (2011), Optimizing the Visual Quality and Cost Effectiveness of Perennial Plantings by Randomly Mixed Combinations – Application Approaches for Planting Design. In: BUHMANN, E, ERVIN, S., TOMLIN, C. D. & PIETSCH, M. (Eds.), Teaching Landscape Architecture. Proceedings at Anhalt University of Applied Sciences 2011. Wichmann, Berlin/Offenbach, 320-332.

KIRCHER, W., MESSER, U., FENZL, J., HEINS, M. & DUNNET, N. (2012), Development of Randomly Mixed Perennial Plantings and Application Approaches. In: BUHMANN, E., ERVIN, S. & PIETSCH, M. (Eds.), GeoDesign, 3D Modeling and Visualization. Proceedings at Anhalt University of Applied Sciences 2012. Wichmann, Berlin/Offenbach, 113-115.

OBI GMBH & CO. Deutschland KG (2016), Beetplaner.
https://traumgarten.obi.de/beetplaner/ (Jan. 10, 2017).

RÖHRICHT, W. (2005), oik – nulla vita sine dispensatio. Vegetation Modelling for Landscape Planning. In: BUHMANN, E., PAAR, P., BISHOP, I. & LANGE, E. (Eds.), Trends in Real-Time Visualization and Participation. Proceedings at Anhalt University of Applied Sciences 2005. Wichmann, Heidelberg, 256-262.

ZINK, O., BUES, M. & SETZER, S. (1999), 3D Garten Planer. Goldene Serie. CD-ROM and manual. Data Becker GmbH + Co. KG, Düsseldorf.