Bespoke high-fidelity visualization of tiling

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1. Introduction

Customers wishing to redecorate a room, such as a kitchen or a bathroom, with new tiles, face the difficult task of visualizing how will that room actually look like with the new tiling. Although the customer might have access to interior design magazines and tiling visualization applications, these use pre-defined room sets and do not take into consideration the actual lighting conditions within the room being retiled. This leads to poor levels of realism, due to a low correlation between the lighting simulation and the real world, and, ultimately, to a lack of user confidence in the simulation results [Til11].

This paper describes the development and validation of a new service allowing products, such as tiles, to be viewed on a computer authentically in the actual lighting conditions of the area in which they are to be installed. This service leverages recent developments in physically based global illumination and High Dynamic Range (HDR) imaging, enabling real-world lighting to be accurately captured, transferred to a computer and used to relight any choice of tile in a highly realistic manner [BADC11, Deb98, DCR06].

By improving correlation between the lighting simulation and the real world performance, users will be able to visualise, with confidence, what a chosen tile will look like in their own room before any actual tiling takes place. Enhanced customer confidence on the visuaization results is expected to significantly reduce wasted time and effort in deciding on the right choice of tile for a particular environment and, ultimately, to increase the market share of the tiling company adopting this technology. Developed initially for the tiling market, the resultant system will be equally applicable to other interior design products,

2. Workplan and Visualization framework

Deployment of the above described service entails three major stages: design of an appropriate pipeline for capturing, rendering and visualization, development of a demonstrator and validation of the results. Figure 1 presents the proposed pipeline, including the following stages:

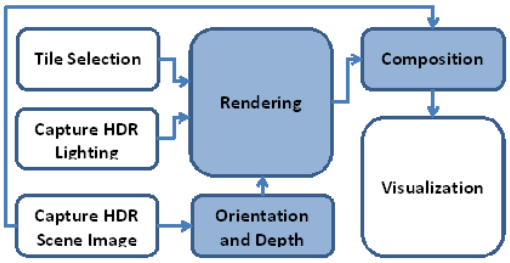

Figure 1: *Data capturing, rendering and visualization pipeline.*

Tile Selection - the user selects the appropriate tile from a database that contains the tile texture and tabulated BRDF;

Capture HDR lighting - the user captures an HDR environment map, representing incident light, using the multiple exposure functionality of a mobile device and a fish eye lens, which allows capturing the whole hemisphere;

Capture HDR Scene Image - the user captures an HDR image of the wall being (re)tiled; this image includes a marker that is used by the next stage to estimate the orientation and depth of this wall w.r.t. to the camera;

Depth and orientation - these are calculated from the previous image using the included marker and functionality similar to that present on the ARToolkit [KBP*00],

Rendering - a physically based global illumination renderer simulates the light transport from the HDR environment map to the camera as scattered by a wall tiled with the new choice of tiles;

Composition - the rendered image is composited with the HDR scene image and

Visualization - the composited image is tone mapped and presented to the user.

A demonstrator of the proposed pipeline is being developed, following a client-server architecture. Stages related to the user interface (depicted as white boxes in figure 1) run on the client, whereas stages requiring intensive computations (blue boxes in the same figure) run on an high performance multicore server. This demonstrator is now on an intermediate development stage; the whole pipeline is in place (as illustrated in figure 2), but lighting from the HDR environment map, the tone mapping and the wall orientation estimation functionality still require further calibration. Furthermore, the tiles reflective profile has to be accurately measured using a goniophotometer, which is planned to happen over the next month.

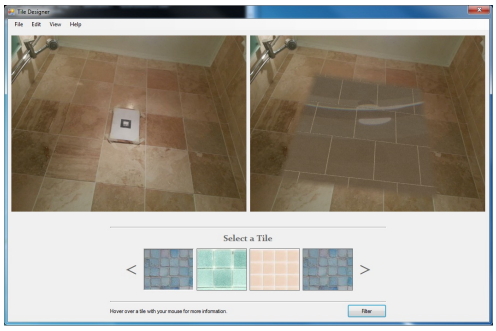

Figure 2: *Demonstrator user interface.*

The final stage entails thoroughly validating the system's efficiency and usability, the correlation between the lighting simulation and the real world, and the users' acceptance of the proposed service. Validation will be carried out through detailed user studies. Users will be required to perform direct comparisons between the system renderings and actual test rooms tiled with a given choice of tiles. A visualisation suite has been prepared (see figure 3), where hook and loop fixing rolls allow rapid tile changes. It also features 5 different types of light fittings, which can be switched on/off and dimmed independently, allowing for a wide range of lighting conditions. The room also features a large window to add natural light. Results from these user studies will further allow refining the system as necessary.

3. Conclusions

In this paper we proposed a new virtual tiling service allowing, for the first time, costumers to have a high degree of confidence in visualisations of their real world settings with the virtual tiles. Our novel demonstrator will engage the users directly in the design of an environment, assuring them that their needs and expectations are satisfied within a virtual building before the design is finalised. The whole pipeline for data capturing, rendering and visualization is in place and can be demonstrated, although it still requires calibration and validation, which will be carried out through user studies.

Figure 3: *Visualization Suite.*

Future work will include the above mentioned calibration and validations stages. The utilization of a fish eye lens is perceived as a potential obstacle to wide product acceptance from potential users, since these have to have access to this piece of equipment; alternatives will be studied, including the viability of using HDR panoramas.

The proposed service is expected to bring about a step change in the way tiles are chosen and to represent a significant increase in tiling companies' profile and competitiveness through substantial added value for customers. Developed initially for the tiling market, it is expected that the resultant system will be equally applicable to other interior design products.

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