An Interactive 3D Product Design Tool for Mobile Pre-commerce Environments

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Abstract

Today more and more products and services are being bought and sold over electronic commerce (e-commerce) systems. However, the majority of time spent online by e-commerce users is used for searching for information and making decisions with regard to the products of interest. Pre-commerce services help a customer from the very beginning of his interaction with an e-commerce system with the objective of eventually leading to a transaction. Such a service usually keeps interacting with customers until a personalized purchasing plan has been worked out. In this paper, we propose an interactive 3D product design system to enhance the user's pre-commerce experience. In the proposed system, interaction with customers may take place at different stages of a transaction independently. Before a transaction, possible products details will be presented to customers for their consideration. After that, our interactive design module visualizes customer's requirements in a what-you-see-is-what-you-get (WYSIWYG) way so that the customers can spell out their requirements in greater detail than existing systems. After the transaction, feedbacks from customers and suppliers are recorded online. Products can be customized in detail by customers through the novel 3D drawing tool provided by the system interactively and in real-time. In such a pre-commerce platform, customers can participate in various facets of a transaction in more meaningful and empowering ways.

Keyword: painting on surface, pre-commerce, interactive product design

I. Introduction

Electronic commerce (e-commerce) has been growing rapidly over the past decade. At the beginning, the main functionalities of such systems focused to the facilitation of transactions and the delivery of products/services. Nowadays, massive amount of user behavior data are being analyzed to decide what products are best suited for each individual customer. E-commerce systems are moving from generic marketplaces to increasingly personalized shopping experience providers. Such a trend of personalization is not only transforming the transactions carried out in e-commerce systems, but is also spawning new modes of interaction. One of such new concept interactions is called *Pre-commerce*.

A closer look at the customers' collective behavior when using e-commerce systems reveals that the vast majority of their time and effort are spent in searching for information related to the products of interest before making decisions as to whether to make a transaction. These activities leading to a transaction are referred to as pre-commerce activities by the industry. A wide range of technologies (e.g., user feedbacks and ratings analysis, brand incorporation in popular social games, reaching out to customers through online social networks, etc.) have been created for businesses to influence their customers' decisions through pre-commerce activities.

In this paper, we propose an interactive 3D product design tool to add a new dimension in pre-commerce. Through such a tool, users can not only view products, but also modify them to their liking in great details. The tool enables a customer to draw on sophisticated 3D surfaces of virtual product models and dynamically modify the material used in each part of the product, and it can be easily ported onto mobile devices for anytime anywhere usage. This can potentially empower customers to express their preferences in such a way that the producers can gain deeper insight into the customers' liking and produce more personalized products to capture the long tail of their business.

The rest of this paper is organized as follows. In Section II, we provide a review of current literature related to the 3D drawing methods. Section III describes the technical details of the methods used in the proposed interactive 3D drawing tool. Finally, discussions and possible future research directions are presented in Section IV.

II. Literature Review

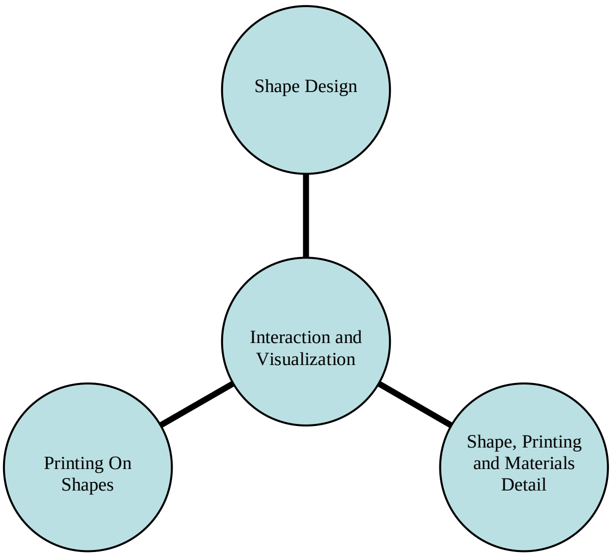
Although interactive digital painting on plane surface has been well developed [5] [6] [8], automatic painting style rendering of images [11] and videos [9] has efficient algorithms, interactive painting on curved surface is still a challenge for academic research and engineering. Schmid [2] presented a technique to generalize the 2D painting metaphor to 3D that allows the artist to treat the full 3D space as a canvas. They propose a canvas concept defined implicitly by a 3D scalar field. Extending their own work, Baran [3] presented a method for rendering 3D paintings by compositing brush strokes embedded in space. The challenge in compositing 3D brush strokes is reconciling conflicts between their z-order in 3D and the order in which the strokes were painted, while maintaining temporal and spatial coherence. The smoothly transitions between compositing closer strokes over those farther away and compositing strokes painted later over those painted earlier. It is efficient, running in O(n log n) time, and simple to implement.

A high quality stylus with 6 degrees of freedom (DOFs: 2D position, pressure, 2D tilt, and 1D rotation) coupled to a virtual brush simulation engine allows skilled users to produce expressive strokes in their own style. Lu [1] presented a data-driven approach for synthesizing the 6D hand gesture data for users of low-quality input devices.

On the other side, commercial software packages like Autodesk Maya [4], 3DS Max and other traditional 3D modeling tools can model and render 3D models for sophisticated designers. General customers of a product still need heavy training to get started with these professional software [7] [10].

III. Interactive 3D Product Design System

In this paper, we have made an extension to the traditional e-commerce system to focus on pre-commerce interaction with potential customers. Interactions with customers are provided in each stage of a transaction. We explain this idea in an online 3D furniture design system. Traditional online furniture websites contain three modules: 1) Products display. 2) Online transaction. 3) Feedbacks. A pre-commerce business model emphasizes on interaction with customers before a transaction. Before a transaction, furniture details like styles, materials, colors, printings can be discussed between buyers and sellers. Furthermore, each detail of the discussion are visualized in 3D models, both buyers and sellers can operate on this model and change every detail. An overview of the proposed interactive 3D furniture design system is as follows.



A. Shape Design

Shape design module offers two level of design. For general customers, basic styles and shapes of furniture components are offered in the database. For professional customers, they demand the accuracy and surface detail of each component, surface design tools are offered to set parameters of furniture components. For example, a chair has seat, back, legs, arm and other optional components. Customers may design a chair by choosing from provided components to combine into a chair. Furthermore, users can also specify the detail of each component by modify existing one or design a new component from the scratch. We define a component surface with B-Spines which is widely used in computer aided design.

B. Painting on Surface

To painting on surface in mobile computing environments, the most convenient choice of interface is touch screen, a 2D or 2.5D input device. From the input 2D stroke trajectories, we find several matched sample strokes and synthesis a final 2D stroke footprint. After that, the generated 2D footprint is mapped onto surface along picked trajectory points. This mapping from 2D space to 3D is conformal transformation. So angles are kept and shapes of stroke will not be changed on curved surface.

To rendering a painting stroke, several sub-tasks are included: Locating corresponding mesh point of finger position on screen, computing brush footprint at each painted mesh vertex, and rendering the computed brush footprint. Each of these steps has to be implemented as efficiently as possible.

1. Locating corresponding mesh point of finger position on screen. The mesh vertex under a finger cursor is difficult since the mesh is continuously curved surface. We therefore render the mesh into a second render buffer, but instead of lighting each vertex, we encode its texture coordinates in color channels. The pixel color at the finger position then identifies the closest vertex, i.e., the center of the brush.

2. Computing brush footprint at each painted mesh vertex. The shape of brush footprint around each painted vertex is defined by finger pressure, finger tilt angle and finger rotation angle [5] [6].

3. Detecting polygons that lie completely outside the influence region. Another fragment shader is involved to finish this sub-task. To avoid unnecessary computations, in particular for small brush size, these polygons are discarded from the following transformation.

4. Applying computed footprint to each painted vertex. After colors are assigned vertices, smoothing of colors or positions [12], sculpting, extrusion, or multi-resolution deformation may be called by user interactions.

5. Normal vectors. The normal of the limit surface of Catmull-Clark subdivision surface are computed as surface normal at each painted vertex.

6. Optional operations. For multi-resolution deformations the detail reconstruction is computed. Furthermore, intuitive surface geometry deformation operation is offered by our painting metaphor. By extrusion, sculpting or dragging transformation, surface can be deformed on a coarser or higher subdivision level. The so-called multi-resolution or multi-scale deformations will preserve fine-scale geometry details whenever surface is transformed to a coarser subdivision level.

C. Materials and Details

To simulate effects of various materials, we synthesis larger texture image from customer designated material structure and map it onto product surface. In this way, system will only need to record an example image of possible materials. Since components surfaces are all parameterized, texture mapping can be implemented by graphics hardware in real-time speed. Furthermore, components surface shape and detail geometry can be modified at each stage of the design. Users can redefine a new surface and sculpture on an old surface to make global or local changes.

IV. Conclusion

In this paper, an interactive 3D products design system in mobile pre-commerce system has been introduced. We discussed how pre-commerce and interactive design with customers can help improve a customer to trust and have pleasure in e-commerce environments. We recommend that further studies can be made to mining data from customers' interaction data and provide user-friendly interaction tools while keep feasible and credible product design. Further study can allow a customer modifies his/her products design everywhere and anytime. Cooperation design among friends customers are also a future direction.

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