zPots : A Virtual Pottery Experience Through Spatial Interactions Using the Leap Motion Device

Vinayak
C-Design Lab
School of Mechanical Engineering
Purdue University
West Lafayette, IN 47907 USA
fvinayak@purdue.edu

Kevin Lee Jr.
Zero UI
10570 Whitney Way
Cupertino, CA 95014 USA
kevinleejr@zeroui.com

Karthik Ramani
C-Design Lab
School of Mechanical Engineering
Purdue University
West Lafayette, IN 47907 USA
ramani@purdue.edu

Raja Jasti
Zero UI
10570 Whitney Way
Cupertino, CA 95014 USA
raja@zeroui.com

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Abstract
We present *zPots*, an application for gesture-free hand-based design of virtual pottery enabled by the Leap Motion device. With *zPots*, a user can shape and color 3D pots by moving bare hands in the air with minimal or no training. Unlike large-space hand-and-body movements required by depth cameras such as the Kinect, the use of the Leap motion device facilitates close range 3D interactions collocated with the personal computer. We demonstrate our application as a synergistic combination of novel spatial interactions and tool metaphors that cater to engaging and realistic experiences while supporting creativity in 3D shape conceptualization and modeling.

Author Keywords
Virtual Pottery; Shape Modeling; Design; Leap Motion; Spatial Interactions

ACM Classification Keywords
H.5.2 [Information interfaces and presentation]: User Interfaces—*User-centered design,Interaction styles,Input devices and strategies,Screen Design.*; K.8.0 [Personal Computing]: General—*Games*; I.3.6 [Computer Graphics]: Methodology and Techniques—*Interaction techniques*.

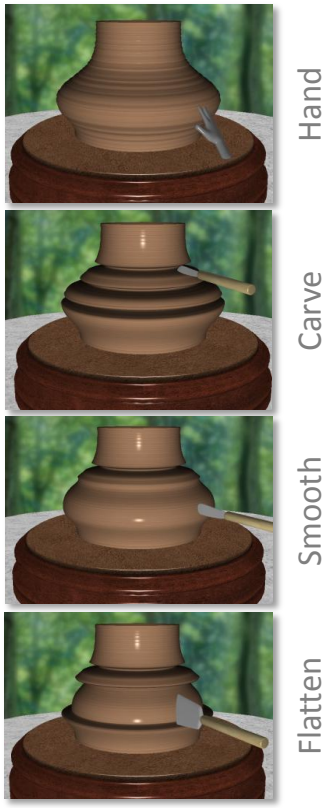

Figure 2: Evolution of a pot using the hand, carving, smoothing and flattening tools.

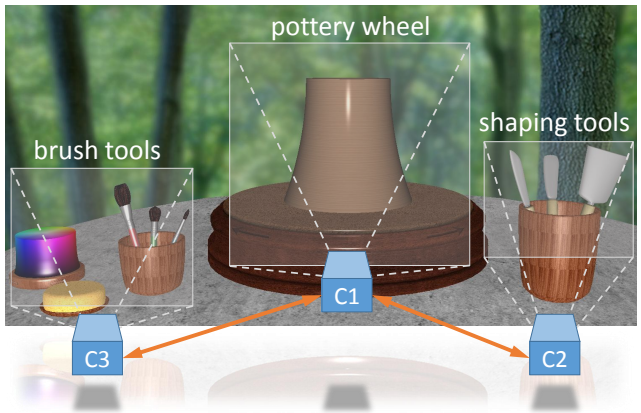

Figure 1: zPots interface showing the partitions of active interaction spaces and the associated camera locations. Cameras C1, C2 and C3 correspond to the pottery wheel, shaping tool and brush tool regions respectively. User's motion towards the left or right extremity results in camera transition.

General Terms

Design, Natural User Interfaces

Introduction

Development of 3D gestural interactions and natural user interfaces, for 3D modeling and design applications, is gaining significant momentum due to the advent of low-cost depth sensing technology. Following the success of the Microsoft Kinect for hand-and-body interactions in large spaces, novel devices such as the Leap-Motion are taking 3D interactions right at the computer desk. Spatial interactions enabled by such devices have the potential to transform the way in which 3D design content is created and shared. We explore the paradigm of *gesture-free* hand-based spatial *human-shape interactions* (HSI) with *zPots*, an application inspired by the pottery metaphor.

Research Background & Novelty

In the recent past, work specifically related to virtual pottery using direct hand manipulations has made a niche within the hand-based modeling paradigm. One of the earliest works we found is [4] wherein the authors describe a 3D stereoscopic display based interface which allows users to create pottery with their hands by wearing two-handed instrument gloves. Han et al. [2] proposed an augmented reality (AR) based pottery system for realistic pottery experience. Lee et al. [5] proposed a haptic interface for creating realistic pottery experiences using the *PHANToM Omni* device. Cho et al. [1] presented *Turn*, a system which augmented a tangible interfaces like a wooden table with 3D hand based virtual sculpting to create digital pottery using the Kinect. The work shown in [6] primarily considers axis-symmetric sweep surfaces using two handed motions for creating pot-like shapes. Han and Han [3], demonstrated an interesting surface-based approach with particular focus on audiovisual interfaces for creating 3D sound sculptures.

Our main contribution towards shape modeling is *proximal persistence* - a novel paradigm which enables gesture-free hand-based interactions. *Proximal persistence*, as the name suggests, is an idea which integrates *proximity* or *nearness* to an object and *persistence*, which is the extent of time for which proximity is maintained. This is in contrast to all existing gesture-based interaction methods which propose the use of *symbolic* hand gestures to determine the user's design intent.

zPots Interface & Interaction Metaphors

In *zPots*, we aim to provide realistic and engaging user-experience while supporting simple and natural interactions. Our interface comprises of an integrated 3D scene with a rotating pottery wheel, a set of shaping tools

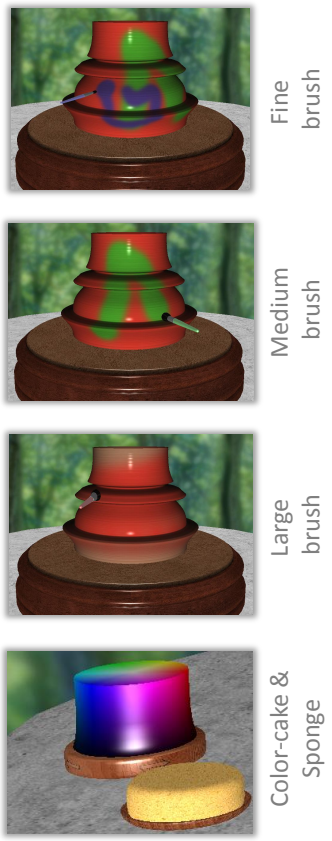

Figure 3: Decoration of a pot using the large, medium and fine brushes. The *Color-cake* can be used to select colors at any stage of the decoration process.

and brush tools overlaid on natural outdoor background. *zPots* application is a combination of four spatial interactions, namely, (a) 3D environment navigation though interaction space partitioning and 3D camera transitions , (b) robust tool selection using cylindrical zoning, (c) 3D color selection using the *Color-Cake* metaphor and (d) gesture free shaping interactions, .

We partitioned the 3D scene into three distinct interaction spaces for robust and unambiguous interactions (Figure 1). Each of these partitions, when active, map to the interaction space of the Leap Motion device. This allows for precise hand-motions in the real space and constrains the user's focus to the active area. The user can freely transition between the spatial partitions by simply moving towards the right or left extremities of the Leap motion device. The *potter's wheel* partition is the main workspace wherein a user can shape the pot by modifying the a lump of clay. The user is free to use hands or tools provided in *zPots*. The right and the left partitions represent the shaping and decoration tools respectively.

Interaction Metaphors for zPots

zPots consists of three novel interaction metaphors which enable a user to rapidly shape and decorate pots.

Shaping Tools

A user is free to use hands to provide both global and local geometric features to the rotating pot. Additionally, we provide the carving and smoothing tool. The sharpening tool allows for creating local depressions on the surface of the pot thus allowing the user to add local shape details to the profile. The smoothing tool enables the user to refine the appearance of the pot at a local scale. This is particularly helpful for mitigating local irregularities on the profile during the use of the hands or the sharpening tool. By repetitive application of a combination of these tools, the user can iterate over various shapes (Figure 2).

Brush Tools & Sponge

For pot painting and decoration, we provide three brush tools and a sponge. The large brush is designed to be used for painting large areas of the pot. Thus, while using this tool, the pot continues to rotate so as to reduce fatigue. The medium and fine brushes can then be used for rendering color details on pots. The sponge can be used to erase the paint on the pot. The key interaction implemented, for the medium and fine brushes and sponge, is the *auto-rotation* feature. When a brush tool approaches the sides of the pot surface, this feature allows for automatic accessibility of the back facing ares of the pot by means of a slow rotation. This enhances continuity of painting for the user without having to make additional effort. In addition to auto-rotation, we also provide an *independent rotation* feature wherein a user can explicitly rotate the pot by moving left or right along the potter's wheel. This feature allows for controlled accessibility of the surface of the pot.

Color-Cake

Using traditional high-resolution 2D palettes for selection of colors in a spatial interaction context is challenging due to low controllability of hands for precise position. The *Color-cake* is a 3D metaphor which resolves this issue by providing a novel and convenient method to of color selection. Our key idea is to embed the hue-saturation-value (HSV) color-space on a cylindrical surface. A user can select a color simply by positioning the brush-tip on the *Color-cake*. We implemented the auto-rotate interaction feature in the *Color-cake* metaphor such that the user is able to explore the color-space with

minimum effort. The auto-rotation provides a naturally consistent interaction context in a pottery application.

Conclusions

In this work we emphasize that geometric modeling techniques should be tailored to support the necessary spatial interactions for creative shape design applications. Our focus is to understand the natural aspects of a real-world pottery and subsequently apply the insights gained to design a corresponding spatial interaction metaphor in the virtual environment. We want to explore how the idea of proximal persistence affects user behavior, performance and preference in creative 3D modeling.

With upcoming applications for creative and engaging 3D interactions for HSI with depth sensors, the co-existence of efficiency, robustness, controllability and creative support is a challenging goal to achieve. We believe that *zPots* serves two purposes towards this goal. First, it combines new spatial interaction metaphors to provide a pottery design tool which can be used to for creative exploration with minimal or no training. Secondly, *zPots* serves as a software platform to investigate and iterate over several important research questions pertinent to spatial interactions for creative design applications.

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