Sketching on 3D Structured Surfaces

Ayuri Tomohiro
Future University Hakodate
a-tomohiro@sumilab.org

Yasuyuki Sumi
Future University Hakodate
sumi@acm.org

Abstract
This paper presents a sketching tool that enables its users to draw and paint on 3D structured surfaces. Users of the proposed system take a picture of target objects and sketch with reference to the taken picture. They can not only sketch on the pictures but can also change their viewpoint of the sketched environment, since the system captures 3D structure by using a depth sensor as well as RGB data. Trial usage of the system shows that our users can rapidly extract their target objects/space and extend their ideas by taking pictures and drawing/painting on them. This paper also discusses the feasibility of extension of the simple idea from personal usage to collaborative spatial designing by multiple designers, by enabling the merging of 3D sketch spaces.

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Introduction
Sketching is an intuitive and powerful method to capture and externalize designers' ideas. We propose a sketching tool to enable designers to understand and design the 3D structure of target objects and spaces, by using a tablet PC and a camera with a depth sensor.

Users of the proposed system can take a picture of target objects and sketch with reference to the taken picture. They can not only sketch on the picture, but also change their viewpoint of the sketched environment since the system captures 3D structure using a depth sensor as well as RGB data. Resultantly, users can easily understand and manipulate the target objects by sketching, and then extend their ideas by drawing the textures they picture in their minds onto the 3D surface.

This paper presents our current prototype of the proposed system and examples of its usage, to show that our system facilitates its users' rapid extraction of

target objects and spaces seen from their individual viewpoints.

Related work

Many technologies have been proposed to aid 3D sketching. One example is Teddy [1], which helps its users to intuitively sketch 3D models using 2D drawings, but it does not capture the 3D structure of real objects. Another approach is to use pictures to guide the users' drawing, such as in [2] and [3]. However, the drawing in these approaches is limited to the fixed viewpoints of the reference pictures. We aim to enable users to change their viewpoint in the sketched environment and share their sketch with other users.

Basics of Sketch System and Current prototype

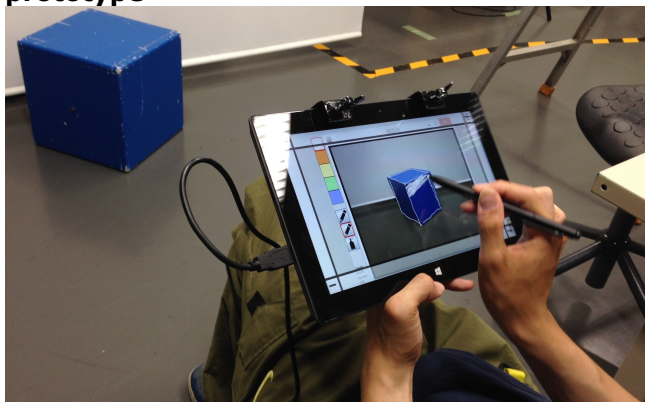

Figure 1: Current prototype in use

Figure 1 shows a current prototype in use. The system was prototyped using Processing. We use tablet PCs as sketching devices, and the ASUS Xtion as a depth sensor.

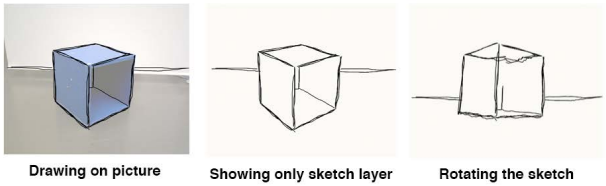

Figure 2: Stages of usage

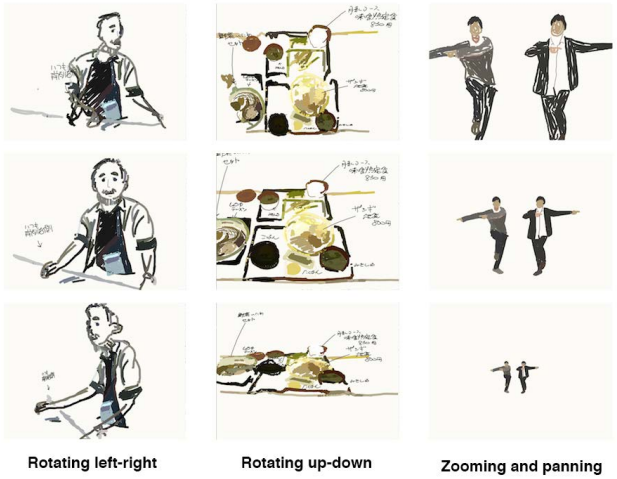

Figure 3: Examples of sketches

Figure 2 shows the stages of usage. Our users can take pictures of target objects, as with a normal camera. At the same time, the system captures 3D depth information with RGB information. The users can intuitively draw on the pictures and externalize their ideas on them. Afterwards, they can explore the sketched environment by changing their viewpoints, as

shown in Figure 3. Users repeat the process of photographing, drawing, and altering the viewpoint to complete the sketch. This repetition prompts them to observe the hidden parts and 3D structure of the target object.

Examples

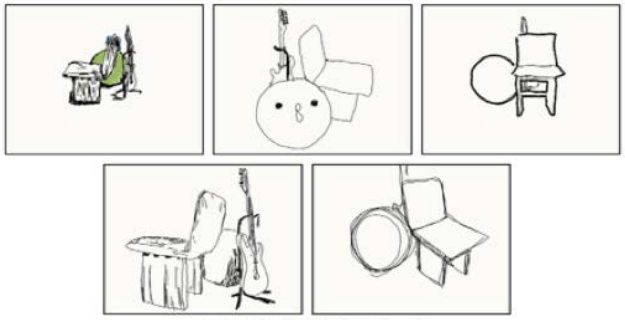

Figure 4: Sketches by five different users

Figure 4 presents sketches of the same scene (consisting of a chair, balance ball, and guitar) drawn by five different users who individually drew the scene from different viewpoints. From the sketches, we can see various ways to articulate the target objects, and various sketching techniques, i.e., drawing outlines, painting on surfaces, etc.

We observed that most of the users concentrated on carefully extracting the 2.5 dimensional structure of the target objects by altering their viewpoints within their sketches while drawing. They repeatedly examined their sketches from different viewpoints while drawing, and put additional touches to emphasize the 3D structure of the target objects. We think the repeated process prompted our users to observe and understand the target environment.

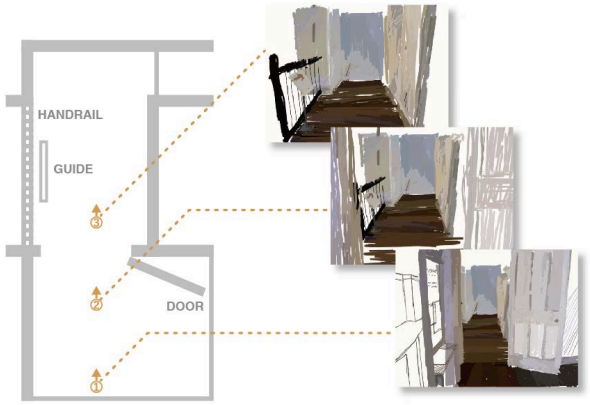

Figure 5: walking through the sketches

Figure 5 shows an example of prototyping a pseudo 3D space with two sketches. In this example, the user firstly took several pictures while walking through the hallway of an old building.

Secondly, he selected three pictures from those he had taken, drew and painted on them and then put them onto a virtual 3D canvas using our tool, so that we can virtually walk through and look around the space.

The user tried to find better locations and viewpoints by taking pictures and painting on them several times in order to better capture his experience of touring the building. We could observe that he rapidly drew several sketches and tried to build walk-through spaces in about a half hour. Our system enables users to easily capture and rethink the target environment, and then encourages their rapid prototyping through trial and error.

Summary and Future Work

This paper presents a sketching tool to enable its users to draw and paint on 3D structured surfaces. The trial usage showed that our users can rapidly extract their target objects/space and extend their idea by taking pictures and drawing/painting on them.

Future work is to extend our system from personal usage to collaborative spatial designing by multiple users, by enabling the automatic merging of several 3D sketches. We suppose the captured depth structure helps to semi-automatically match multiple sketches from different viewpoints drawn by nearby users.

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