Reconstruction of Scene from Multiple Sketches

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ABSTRACT
This paper discusses the feasibility of extension of expressive style with multiple 3D sketches drawn by a sketching tool that enables its users to draw and paint on 3D structured surfaces. Users of our 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 discribes a notion of reconstructing scenes from multiple sketches.

Author Keywords
Sketching; interactive illustrations.

ACM Classification Keywords
H.5.2 Information interfaces and presentation : User Interfaces: Graphical user interfaces

INTRODUCTION
Sketching is an intuitive and powerful method to capture and externalize designers' ideas. We already proposed 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 [1]. 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. We extended our system to collaborative spatial designing by multiple users, by enabling the merging of several 3D sketches. This arrows the users not only to merge several sketches to extend their sketch space and mix different viewpoints, but also to conduct spatial designing by multiple users. 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.

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RELATED WORK
Teddy [2] helps its users to intuitively sketch 3D models using 2D drawings, but it does not aim at expressing individuality and originality. There are other approaches involving sketching on 3D models that place importance on individuality and originality, such as in [3] and [4]. However, the drawing in these approaches is it does not capture the 3D structure of real objects. We aim to expand the sketching of real objects and enable users to change their viewpoint in the sketched environment and share their sketch with other users.

DRAWING AND INTERACTIVE VISUALIZATION
We use tablet PCs as sketching devices, and the ASUS Xtion as a depth sensor. The resulting sketches are 3D and allow users to change their viewpoints. Users begin by taking pictures of target objects, as with a normal camera. At the same time, the system captures 3D depth information with RGB information. Users can intuitively draw on the pictures and externalize their ideas on them. Afterwards, they can explore the sketched environment by changing their viewpoints. 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

Merging different viewpoints
Figure 1 (c-e) shows an example of prototyping a pseudo 3D object with two sketches (a,b) from different viewpoints. These sketches are drawn from different viewpoints. The subject of one of the sketches is the surface of a box, the subject of the other is the inside of the box. By merging sketches, users can make a sketch which depicts the box from two viewpoints.

Expanding a space
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 two 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

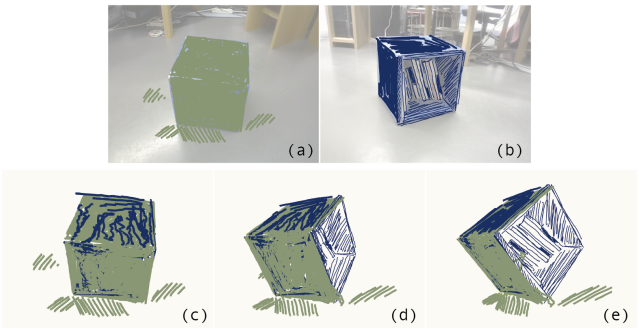

Figure 1. (a-b) Two sketches of a box drawn by the user from two viewpoints. (c-d) The result of merging.

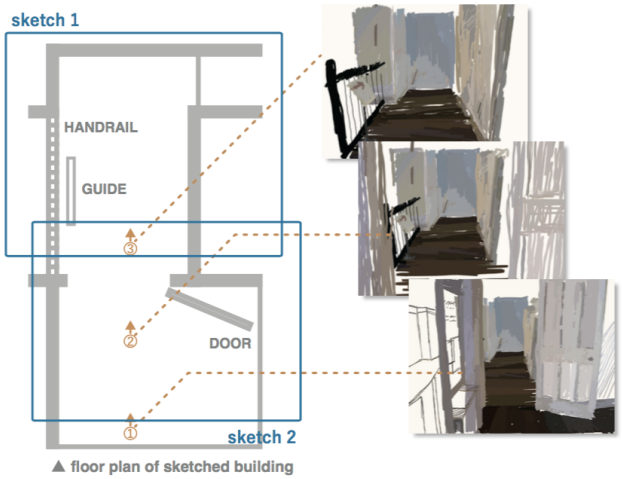

Figure 2. Example of prototyping a pseudo 3D space with two sketches.

painting on them several times in order to better capture his experience of touring the building. Our system enables users to easily capture and rethink the target environment, and then encourages their rapid prototyping through trial and error.

Animation with time-lapse sketches

Figure 3 is an example of 3D animation using three sketches (Figure 4a-c). In this animation, time-lapse sketches are displayed and switched in sequence: A, B, C, B, A .... As shown in Figure 3, it is possible to change the viewpoint while animating the sketch. Just by drawing a few sketches, users can reproduce motion and the lapse of time.

Collaborative sketch

Figure 5 (d-f) shows three sketches (a-c), drawn individually by three different users from three different viewpoints, which have been merged to create one plaster figure. The expressive style is a mix of the three user's styles. In this example, each user takes a photo form a different viewpoint and sketches, then each sketch is shared in real time on their canvas. This arrows the users to look all around each other's viewpoints, check individual points of focus and points of view, and exchange ideas and discoveries.

Figure 3. Capturing a series of frame from animation while change the viewpoint.

Figure 4. Three time-lapse sketches.

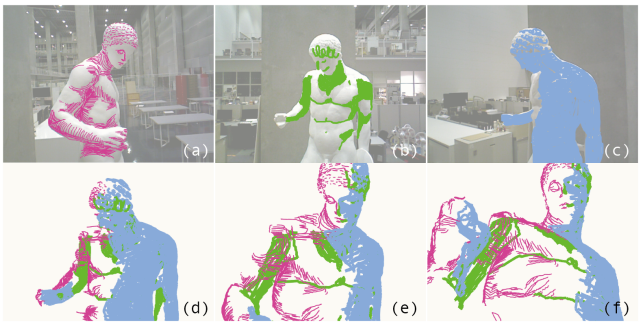

Figure 5. Sketch of a plaster figure. The expressive style is a mix of the three user's styles.

CONCLUSION

In this paper we discussed the feasibility of extension of expressive style with multiple 3D sketches drawn by a sketching tool that enables its users to draw and paint on 3D structured surfaces. The trial usage showed that, by combining multiple sketches, we can make sketches that mix multiple viewpoints, virtually walk through and look around the sketched space, and produce collaborative sketches of objects. We aim to realize collaborative spatial designing from multiple sketches and facilitates its users' rapid extraction of target objects, access to spaces seen from their individual viewpoints and exchange intuitively exchange of views.

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