Spatial Augmented Reality based Tangible CAD System

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Abstract

In current Computer Aided Design (CAD) systems, designers are commonly restricted to a traditional workstation environment with mouse and keyboard. This environment is indirect from the physical object they are designing, and as such they may lose the one to one correspondence between the virtual and physical magnification of the design. In order to reduce this, we propose a Spatial Augmented Reality (SAR) based CAD system which consists of a fixed camera-projector pair, a Light Emitting Diode (LED) pen with two buttons, a wireless communication module, and a physical drawing board.

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1. Introduction

We envision SAR to be used in the near future as a design tool to facilitate the rapid design of new products [1]. CAD and CAD-like drawing tools are a predominate method which designers use to capture their concepts into a computer. We are interested in extending interactive SAR systems with user interfaces that capture CAD operations. Jones et al. introduced various interactions such as game control and a photo viewer on a complex surface using an Infrared LED stylus [2]. Our system was developed for assisting the design process by providing various convenient functionalities in a SAR environment similar to traditional drawing tools. We are interested in the research question: "How does a designer perform CAD interactions in an intuitive manner within a SAR environment?"

2. Interaction and Example Use of SAR CAD

Our SAR CAD system provides users with several novel methods in order to increase performance of the design process. While we wish to support direct manipulation of CAD operations, we had to overcome the tracking limitations of our SAR CAD system because of errors and jitters in LED tracking. To overcome the limitations of the technology, we provide six methods: Firstly, we set a range within which the LED pen's coordinates remain unchanged, which prevented unwanted jitters. Secondly, we provided snatching capability which allows graphic primitive positions to be aligned previously drawn objects. Guiding lines are also displayed (Fig. 1.b). Thirdly, we provide users with four novel functionalities: magnifying glass, mirroring, replication, and ruler detection. The magnifying glass assists users to accurately and precisely draw graphic primitives such as lines, circles, and rectangles while drawing in millimeter units (Fig.1.a).
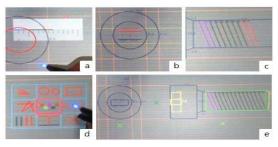

Figure 1. (a) Magnifying Glass Tool. (b) Mirroring Tool. (c) Replication tool. (d) Ruler detection. (e) the front and side view of a bolt

Mirroring brings a default option to users for drawing a graphic primitive in a reflective position from an existing one (Fig.1.b). During a design process, primitive repeatability, so to reduce these repeated actions we implement the replication operation (Fig 1.c). Due to errors and jitters in LED tracking, our SAR CAD adjusts the coordinate of the LED pen on the detected ruler's position when a user activates drawing a line function in the menu (Fig 1.d) .

An example of using our SAR CAD is to draw the side view and the front view of a bolt (Fig 1.e). The result highlights some of the advantages and limitations. Our SAR CAD facilitates design performance through our functions. Compared to current CAD system, our system provides actual drawing experience. However, we experienced a slight difference between the coordinates of the camera and projected or augmented images, so we tried several times to detect ruler on the correct position.

3. Conclusion and Future work

In this paper, we described our SAR CAD system with an example use. We believe our SAR CAD is an alternative design tool to existing CAD systems. We added a variety of design functions to make our system more accurate and convenient to perform CAD drawing operations. We have a plan to support habitual behaviors of designers such as doodling and drawing diagrams while they are using our SAR CAD system. More importantly, we will investigate how our SAR CAD may be used as a collaborative design tool which allows designers, and stakeholders to participate in a design process to share various opinions.

4. References

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