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*Poster*

# Continuous Dial User Interaction to Reduce Task Complexity in Designing Physical User Interfaces in Spatial Augmented Reality

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**Abstract**

*This paper presents an investigation into the use of continuous physical dial interaction to specify the placement of controls on designs of physical interfaces. The designs are projected on white substrates with Spatial Augmented Reality technology. The inspiration is direct physical interaction is more intuitive to the designer than the traditional CAD-based specification approach. The paper presents our initial Spatial Augmented Reality prototype.*

Categories and Subject Descriptors (according to ACM CCS): H.5.1 [Information Systems]: Artificial, augmented, and virtual realities—

## 1. Introduction

Designing and prototyping the layout of user interfaces and cosmetic features for physical systems is a costly process for many commercial applications. This research utilizes Spatial Augmented Reality (SAR) [MSWT14] methods to provide real time, interactive design feedback in a context appropriate setting [VSPG03]. SAR allows for cosmetic and functional elements to be moved and manipulated without the need for expensive physical mock-ups or additional build iterations. Rapid prototyping [PMS*10] has been applied in the design of this SAR system to ensure appropriate attributes can be manipulated to enable design alterations that are commonly performed. The SAR system alters the appearance of a life size (or scale) model of a product by projecting detailed textures onto the physical surfaces, adding new visual features and altering existing elements.

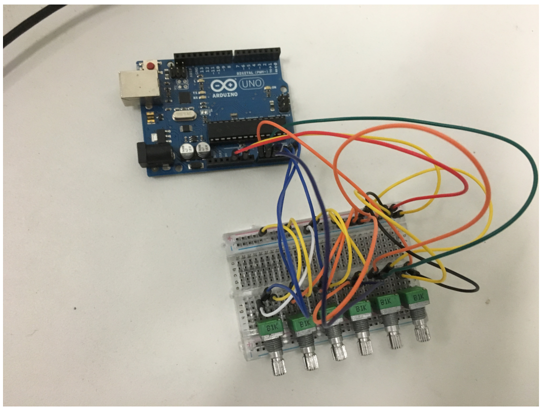

**Figure 1:** *Arduino dial interface*

This paper presents an intuitive dial based controller to provide a continuous input device to designers. This physical controller [CKD*04] provides fine-grain control over the various properties of the projected texture, such as color or size. The aim of this research is to assess whether physical controller input in an SAR system enables designers to complete their design tasks more efficiently and with less effort when compared to existing desktop design platforms. Currently these are drawn either by hand or in computer CAD package, and each design has to be created individually. Imagine creating this with continuous controls. There are dials to control the number of vertical and horizontal controls. The designer can quickly scroll through one to a hundred displayed controls. Another set of of dials controls the spacing, others control the color, and so forth. Now imagine these designs projected directly onto a control panel. The designer could scroll through hundreds of options in mere minutes, so much faster than drawing each of them.

The main contribution in this paper is an example SAR implementation that provides users with a novel, organic means of providing input for a physical UI design task. This contribution provides designers with a rapid, cost effective and interactive method of prototyping physical UI designs. Instead of the reliance on expensive clay mock-ups typical of traditional design processes, designers can leverage the interactive nature of SAR to prototype concepts. This SAR implementation aims to make physical UI design more efficient and intuitive by providing instant feedback to designers that wish to alter the surface appearance/features of the design.



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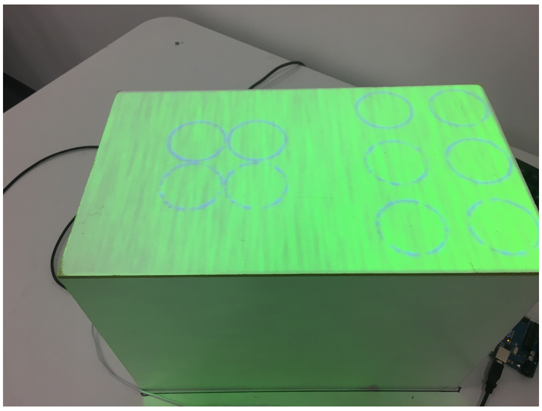

**Figure 2:** *A sample design pattern*

## 2. SAR Dial Design System

During the early stages of system development, the two key requirements were: 1) Develop a SAR implementation that leverages the natural affordance and visual cues presented by the SAR platform. 2) Design and implement an Arduino controller to provide parameter based input into the SAR module All of these points were implemented successfully in the prototype.

### 2.1. Implementation

The most expansive part of the system design was the design of the SAR Control Panel Module. This module would be responsible for driving all of the SAR system functionality. The module has been broken down into the following components which are subsequently discussed: 1) SAR module structure, 2) Arduino serial IO, and 3) drawing to SAR texture.

The University of South Australia Wearable Computer Lab SARLib C++ system was used as the platform that this research was based on. The SAR module system provides support for projector calibration, graphics, and interactions. The core functions of an application developed with the SAR system are as follows: 1) initialization, 2) update loop, 3) drawing to framebuffer, 4) mapping display to projectors, and 5) processing input.

Figure 1 depicts the physical controller developed for our SAR prototype. Six parameters in the prototype application can be controlled through the six potentiometers, which acted are the system's dials. As the Arduino communicates solely over a Serial USB port, it was important to allow for significant timing inconsistencies between the SAR module and the Arduino. The baud rate was set to 9600 bits per second.

### 2.2. Drawing to SAR Texture

To allow a designer to experiment with a design concept, visual elements are drawn to the SAR texture that represent a simple physical UI design problem. Primitive circles were selected to fulfil this requirement (see Figure 2), as they closely resemble the approximate shape of buttons and radial dials. The logic controlling the position, colour, relative spacing and alignment of these circles was determined at runtime based on input from the Arduino controller. The six parameters were: 1) circle radius, 2) number of circles in rows, 3) number of circles in columns, 4) circle X position, 5) circle Y position, and 6) relative spacing (padding) between each circle. These six parameters provided enough freedom to create reasonably complex designs using only primitive circles. The SAR systems ensures that all circles are drawn with the correct relative spacing in the appropriate locations based on their index in the current row/column.

The SAR prototype also supports temporary layout buffering. By pressing the *N* key on the keyboard, the user is able to store the current layout of circles in a buffer such that a new alignment of circles can be made without erasing previous groups. Figure 2 depicts an example of this grouping. This provided an important efficiency gain for uses as design problems that required a large number of circles with only small variances in a single parameter could be replicated quickly with minimal input from the user.

One envisioned strategy to use such a system is as follows. The system starts with a single circle. You employ the circle radius dial to construct a circle into a desired size. You then employ the number of circles in rows and columns dials to build a small control panel of equal sized controls. Next you might employ the padding dial to increase the spacing in the control panel. The next step would be to translate this group to a particular position with the X and Y position dials. You may then edit any of the parameters to fine tune the design. Finally, you press the *N* key to save this small control panel and move onto the next part of the overall design by repeating the above steps.

## 3. Conclusion

The SAR implementation within this research has indicated an effective means of accurately completing complex physical UI tasks, similar to those faced by commercial designers. This expresses the potential influence an effective SAR design system may have on traditional design processes, and how design quality can be improved through the use of such as system. By utilizing a continuous input metaphor implemented through the Arduino potentiometers, a novel input is provided to users that complements the parameter driven design commonly used in physical UI design.

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