Annotation interaction and relocation using a Handheld Projector

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ABSTRACT

Previous work has established that projectors may be used to visualize and interact with virtual information in a physical space, allowing a user to annotate surfaces and objects of their environment. However, other implementations have not dealt with the information being tied directly to objects in the physical space, and have also not considered how to re-find the objects and annotations. This project proposal seeks to use existing projector and proximity tracking toolkits to implement a system for anchoring information to physical real-world objects, and implement a method of relocating these annotations in the world.

1. INTRODUCTION

The uses for handheld 'pico' projectors may first appear limited to projecting image or video against a wall like a normal projector, but with a smaller and more portable device. By being able to project onto any surface, however, this creates the potential for other types of interaction. Computerized information could be 'embedded' into a physical environment that corresponds to a real world space with physical objects and surfaces (Figure 1). Because the information in the virtual space would not be visible in the real world, a projector can then used to visualize the information as it corresponds to surfaces in the real world (Figure 2). This interaction essentially allows a user to annotate their surrounding environment by adding images and text onto walls and around objects.

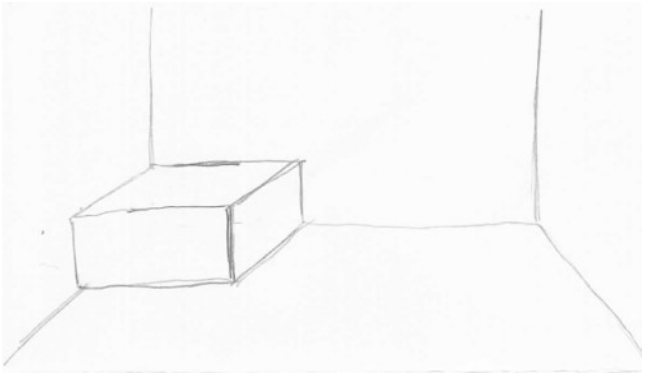

Figure 1: Physical environment. Virtual information is 'embedded' into its space, but is only visible when viewed upon with a projector

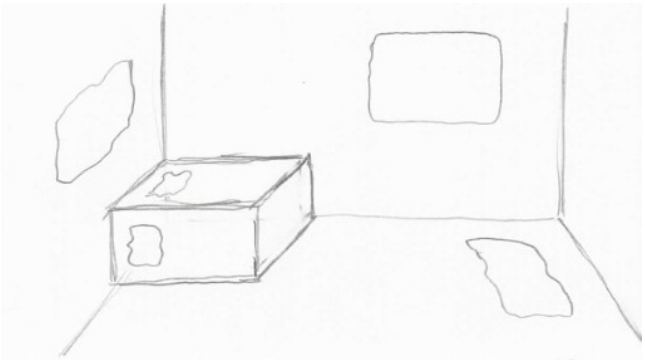

Figure 2: Physical environment with virtual information visible. Virtual space overlays the physical environment according to the available surfaces

Previous work by Cao et al. [3, 4] created these notions of virtual spaces for virtual information and physical surfaces for the projector to project against. While a system of using a projector to display virtual annotations in real world space is possible [3,4,5], there are two problems:

(1) Annotations are added to surfaces rather than objects. If an annotation is intended to be added to an object using this system and the object is moved after, the annotation will no longer be on the object.

(2) There is no method for finding annotations in the physical space after they are added. This would be problematic if there are many annotations and cannot be recalled from memory.

The purpose of this project will be to devise a system for resolving both problems. This system will allow for anchoring annotations to objects in the real world, and for locating the physical objects and annotations within the physical space.

Example usages of such a system include being able to attach annotations to specific objects to convey importance or meaning. For instance, a user may anchor meaningful notes to a personal item such as a coffee mug. Or, a user may attach reminders for sporting events and meetings to a sports bag. A user might also attach notes to their walls, similar to how one might attach post-it notes, but could now benefit from attaching to a larger area and greater variety of surfaces. Having a system for finding these notes in the world allows for keeping track of potentially many personal reminders. Such a system for relocating notes may also be used to locate lost or misplaced items within a space.

Using portable projectors to visualize virtual information in a physical space allows for these types of interaction, and this project intends on expanding its usability by offering additional functionality.

2. RELATED WORK

Related material and research for this project can be classified as being either directly relevant to projectors, or being relevant to user interfaces for tracking and interacting with virtual objects.

2.1 Projectors

There has been plenty of research on the usage of portable projectors for interactions. The system devised by Cao and Balakrishnan [1] used a projector fitted with a handle and set of controls and a pen for drawing and interaction, and was tracked using a series of Vicon cameras. The projector was shined on physical surfaces to reveal virtual information in a similar manner to using a flashlight to explore a dark room. Their research studied and analyzed interaction techniques using this system, such as manipulating virtual objects and using the pen to write text on surfaces. Follow-up work by Cao et al. [4] built upon their system to include multi-user interaction and to analyze interaction techniques with multiple projectors.

Molyneaux et al. [5] examined techniques of creating virtual spaces in a physical environment. They described their techniques in regards to "infrastructure", or having a system of sensors around the test space to create a model of the surrounding environment and to track the projector within it. One technique used a series of Kinect cameras mounted to the ceiling of their test space to create a model of the room for the virtual information to reside. Their other technique did not use such an infrastructure and relied on a Kinect mated to a projector to sense the surfaces of objects in front of it to display the projection on.

2.2 User interfaces

The Halo interface [2] was a system devised for locating items off-screen for a PDA mapping application. The interface works by drawing a ring around the item when it is off-screen, and enlarging it such that part of the ring is visible on the edge of the screen as the user moves further away. By doing this, the direction and distance of the off-screen item could be inferred more easily. A similar technique for locating hidden items with a portable project could certainly be implemented.

Baudisch's other work [2] discussed techniques of interacting with items either too far away or over a larger area such that direct interaction would be unfeasible. These techniques may be studied to create an interface with the portable projector for interacting with annotations without having to walk up to them.

3. PROPOSED SOLUTION

This project will use the existing Projector Toolkit, which in turn uses a system of Vicon cameras and the already existing Proximity Toolkit for tracking movement. A specially designed and prepared space under the cameras will be used as the testing area for the project. A portable projector will, of course, be required. However, a tablet computer running Windows will also be required in order to use part of the Projector Toolkit, and to act as a control device for specific features. The tablet will be mated with the projector to create a single combined unit for ease-of-use, maneuverability, and testing. The projector will use a similar flashlight metaphor [3,4,5] to display virtual information when pointing at its location in the world.

With the Vicon camera infrastructure and the tablet and projector hybrid, the solution will consist of two parts that will solve both problems in this project:

3.1 Anchoring annotations to objects

A system for creating annotations will be implemented. For this, a basic user interface (Figure 3) for adding, removing, and editing new annotations will be created. The interface will also include using the Windows tablet for creating the content of the annotations and for filtering through the different annotations to display.

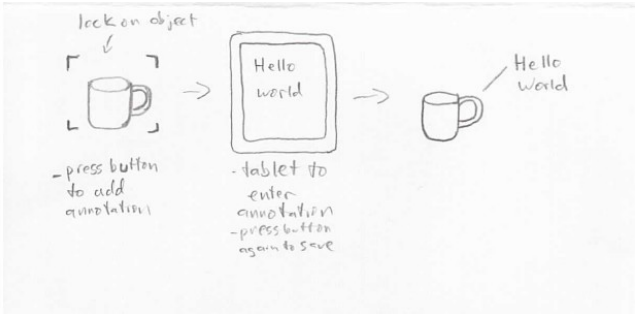

Figure 3: Work flow for adding annotation to object. An object is first locked-on to by the projector to indicate an annotation should be added. The tablet is used to enter the text of the annotation and is saved. The annotation is then anchored to the cup and will remain with it in the physical space.

Figure 4: Physical objects with annotations. Annotations are anchored to an object and will display in the area surrounding it when viewed with a projector

At the end of this first step, a user will be able to add an annotation to either the wall or floor, or anchor it to an object with markers for the Vicon cameras to track. These annotations will be displayed when the projector shines over them (Figure 4).

3.2 Relocating

After the system for adding annotations is in place, the second major step will be to implement a method of locating off-screen annotations. A variety of methods may have to be implemented and tested if time permits, such as the Halo interface [2], and simple mechanisms using arrows or lines.

This relocation system will also be used to point the direction towards the marked objects in the environment. The tablet will be used to control what annotations or objects this system will be

pointing towards, and will be implemented first in the previous step.

4. TIMELINE

Table 1: Timeline of dates to complete tasks by

Date	Task to be completed
Sept. 28	Hand in project proposal
Oct. 5	Finish experimentation with Projector Toolkit
Oct. 12	Finish experimentation with Proximity Toolkit
Oct. 19	Finish annotation system
Nov. 23	Finish relocation functionality
Nov. 30	Hand in final report
Dec. 4	Final presentation

5. REFERENCES

[1] Baudisch P., Cutrell, E., Robbins, D., Czerwinski, M., Tandler, P., Bederson, B., and Zierlinger, A. Drag-and-Pop and Drag-and-Pick: techniques for accessing remote screen content on touch- and pen-operated systems. *INTERACT (2003)*

[2] Baudisch, P. and Rosenholtz, R. Halo: a Technqiue for Visualizing Off-Screen Locations. *CHI (2003)*

[3] Cao, X. and Balakrishnan, R. Interacting with dynamically defined information spaces using a handheld projector and a pen. *ACM UIST (2006).*

[4] Cao, X., Forlines, C., and Balakrishnan, R. Multi-User Interaction using Handheld Projectors. *ACM UIST (2007)*

[5] Molyneaux, D., Izadi, S., Kim, D., Hilliges, O., Hodges, S., Cao, X., Butler, A., and Gellersen, H. Interactive Environment-Aware Handheld Projectors for Pervasive Computing Spaces. *Pervasive Computing (2012)*