Creating Platforms to Support Craft and Creativity in Game Controller Design

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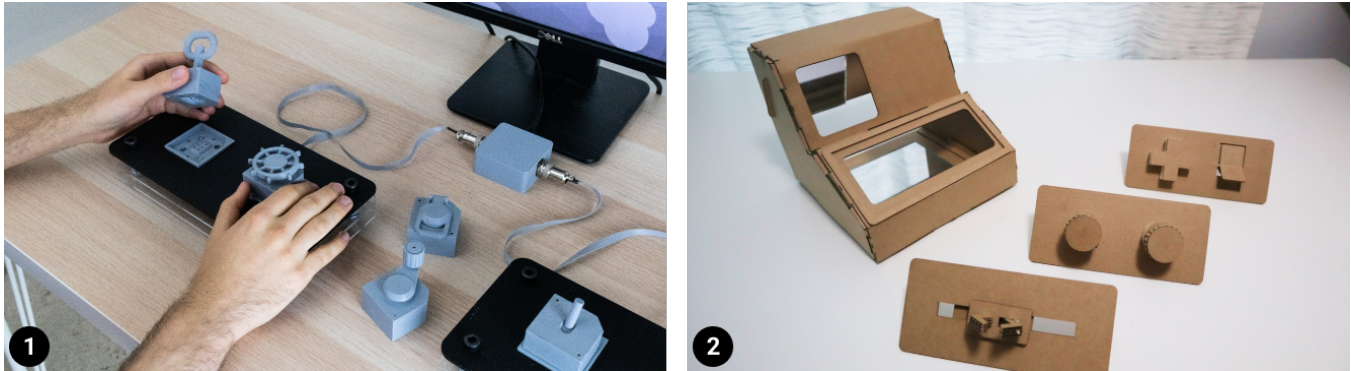Boulder, CO, USA

Figure 1: The HOT SWAP controller with swapping inputs. 2) Tinycade with three control panels.

ABSTRACT

Alternative Controllers (Alt Controls) enable game designers to creatively explore how humans interact with games and challenge the status-quo of game interfaces. Alt Controls, however, require technical skills and fabrication infrastructure that often make them inaccessible to the average designer. Tangible User Interface researchers stand to benefit from the unique approach that Alt Controls promote. My research aims to bridge the gap between game developers and Alt Controls through the use of everyday materials and crafting techniques. In this paper, I discuss a framework for physical computing that uses computer vision (Beholder) and an example introductory platform for Alt Controller design (TinyCade). Further research will refine this framework and incorporate the perspective of other game designers.

CCS CONCEPTS

• **Human-centered computing** → **User interface design**.

KEYWORDS

Game Design, Tangible Interfaces

1 INTRODUCTION

In the field of game design, the Magic Circle [6] refers to the intangible boundary created by the rules and mechanics of the game that enables players to suspend disbelief when playing the game. For example, when players control Mario in one of the many Super Mario Bros games, they do not question how he can jump several times his own height or why he must stomp on mushrooms. Players simply overlook these factors for the sake of entertainment. They resolve any cognitive dissonance between the athletic skills of the average plumber and those of Mario by accepting the logic of the game and its designers. The Magic Circle enables game designers to create contrived situations which question the defaults of interaction design. Beyond the screen, however, the Magic Circle extends into the game controller itself. Alternative Controller (Alt Control) games alter the standard physical relationship between the player and controller to create unique non-standard experiences.

An Alt Control game typically consists of a bespoke interface designed to deliver an experience that would not be possible with the traditional mouse and keyboard or gamepad format. For example, the game Octopad [10] takes a classic NES (Nintendo Entertainment System) controller and splits it into eight individual game pads with one button each. This turns every NES game into a real time team-coordination challenge. To increase story immersion, some Alt Control games include narrative context directly into the interface. For instance, Cook Your Way [11] immerses players in

the immigrant experience with the goal of educating people on how the process strips people of their culture. To this end, it uses faux kitchen tools, complete with a knife and pot. The Magic Circle allows these controllers to make sense in the context of their game, and it enables game designers to probe new perspectives on Tangible User Interfaces (TUIs). I view Alt Control games as a fertile testbed for researching TUIs, and my research will support game designers in this endeavor.

Unfortunately, the current creation of Alt Control games requires a wide range of additional skills outside of traditional game development: i.e. physical computing, digital fabrication, hardware programming, etc. Even once a developer learns these skills and accesses the fabrication process, there is likely only one or two copies of the controller, which limits the potential audience. The average game designer cannot create a production line for one experimental game.These barriers make it difficult for even the most creative game designers to find success in Alt Control.

2 RESEARCH OBJECTIVES

My research aims to remove these barriers by creating tools and techniques that enable designers to create, easily replicate, and share their unique controllers. Through my experience creating Alt Control games independently and in collaboration with other Alt Control designers, I have identified the following goals for my work: to create tools and techniques that help designers overcome the skill and knowledge barriers of physical computing; to simplify the production of Alt Control games; and to support wide sharing of bespoke controllers with players. I aim to create a TUI platform that supports at-home, low-cost fabrication of Alt Controls games.

3 BACKGROUND

This research is motivated by two avenues that I have traveled as a designer: designing games and creating tangible user interfaces. In the following section, I will outline the present state in the research and commercial space for creating TUIs and contrast it with what Alt Control game designers actually use in their practice.

3.1 Techniques Developed Through TUI Research

Both fabrication tools and interface prototyping tools are active topics in the TUI research community [14, 15]. Reactivision [8], for example, employs fiducial markers to make interactive table tops. It was initially designed for collaborative music interfaces, but they have since made their framework open source for others to build upon. Acoustruments [9] uses 3D printed air channels to create tangible interfaces that are sensed through a smartphone's microphone. The advantage of this approach is that it uses a device that will already be available to many designers, smart phones.

In addition to researchers, some game companies have developed their own controller creation tools frameworks. The XBox Adaptive controller [12] uses a simple barrel jack interface to enable players to customize the controller to suit their specific needs. Like the MakeyMakey [7], this platform is only an emulator of another standard interface, but it occupies the middle ground between the MakeyMakey and the freeform Arduino. A more player-friendly technique can be found with the Nintendo Labo [13]. In these kits,

players assemble thoroughly refined die cut cardboard templates into functional controllers. Unfortunately, this platform is limited exclusively to Nintendo and only works with the Nintendo Switch IR sensor. Many of these techniques are limited and still not explored by Alt Control designers due to proprietary software or the cost of digital fabrication tools (i.e. laser cutters, 3D printers, etc).

3.2 What Alt Control Designers Actually Employ

As is evident through examining the Alt Ctrl GDC [4] archives, two platforms currently dominate the space of Alt Control design: Arduino [1] and MakeyMakey [7]. Arduino is the most popular electronics prototyping platform, and is pervasive in the hobbyist electronics space. Its open platform includes a programming tool that many other companies have built upon. Its key restriction, however, is that to make a reliable interface requires understanding the mechanics of electricity in detail. Makey Makey, on the other hand, is a very limited keyboard emulator circuit board which enables exclusively digital input and keyboard emulation through completing an electrical connection. This limitation, however, makes it an incredibly approachable platform for beginners, and it can work with any game that operates through keyboard control.

4 CURRENT WORK

My approach can be considered as Research Through Design [2]. I am a practitioner, creating Alt Controller games and developing tools and techniques to overcome the challenges I encounter along the way. In this section, I will outline the projects that are core to my work and development as a researcher.

4.1 HOT SWAP

Hot Swap [5] is an Alt Controller game based around forcing players to reconfigure the controller during play. We developed this game to challenge the idea of a "default" or "static" control scheme present in most commercially available games. In this game, six distinct inputs represented the six main actions in the game: a crank to set the speed, a helm to turn the ship, a hatch to load cannons, a wick to fire them, a key to open treasure chests, and a fire button to put out flames. Each of these inputs was made with the mechamagnets technique [17]. Additionally, the game featured only two input slots for each of the two players, meaning only four actions could be performed at a time. This forced players to constantly swap controls back and forth and navigate the physical space around them. Through HOT SWAP, I gained first-hand experience of Alt Control game design. While creating this game, we needed to hone our skills in 3D printing, designing printed circuit boards, and hardware programming. After we completed the project, I desired a way to circumvent the need for these skills, which eventually led to the development of Beholder.

4.2 Beholder

Beholder offers an alternative approach to physical computing through the use of Computer Vision rather than electronics. This work started with the project Printed Paper Markers [16], which combined papercraft techniques (i.e. kirigami) with fiducial markers to create wireless paper interfaces. By observing the position,

rotation, and presence of the marker, we can treat each marker as an input. For example, a paper spring, when pressed closed and completed, contains a detectable marker that acts as a button. By leveraging fiducial markers in this way, we can easily prototype interfaces on the fly, using only paper and a printer. We have created a Javascript library built on top of the ArUco detection algorithm [3] for designers to easily include in their projects. We continue to develop this approach with projects like Tinycade (explained further below). In the future, we plan to create a public repository of examples to assist designers in applying these techniques in their own work.
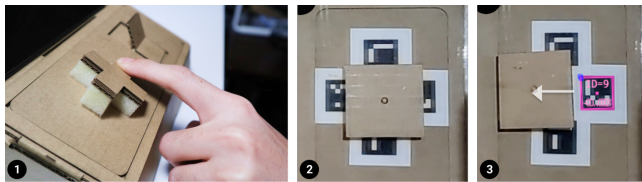

Figure 2: 1) A Tinycade control panel with the d-pad right button pressed. 2) The computer vision view of the resting state for the d-pad. 3) The computer vision view of the d-pad right actively being pressed

4.3 Tinycade

Tinycade is a platform designed to help game designers build their own mini arcade games by hand. Building upon Beholder, we created a mini arcade cabinet powered by just a smartphone. The phone simultaneously acts as both display (through the screen) and sensing device (through the rear facing camera). On the inside, Tinycade holds two mirrors that will redirect the camera's view toward the control panel, enabling the whole assembly to work. The Tinycade base also features an empty slot into which interchangeable control panels can be inserted to extend the number of games playable on the system (see Figure 1 for examples). With this platform, a designer can craft functioning game controllers out of everyday materials using only cardboard, a toothpick, insulation foam, and four markers. The directional pad (d-pad) featured in fig 2 was created with these material constraints . When the right button is pressed, the blocker is moved in the opposite direction of the marker on the right, revealing it for detection. Tinycade is intended to be an introductory platform for interface design, where the only barrier to entry is the ability to work with cardboard and program a little Javascript.

5 CONCLUSION

Through my current work, I have gained an understanding of what is necessary to create Alt Control games. Creators need tools that meet them where they are, rather than requiring them to acquire new skills or technology. They also need to be able to share their games with players to get feedback and because game designers simply enjoy sharing their games with an audience. In order to support game designers, I will continue to develop projects like Beholder and Tinycade. In my future work, I plan to continue to create games with other designers and use insights from those games to further

improve the Beholder system. From my own experience making TUIs I have also learned the importance of supporting education materials around any technology. I will establish a strong base of resources for Beholder with open source tutorials and workshops so that it can reach as many people in the Alt Control community as possible.

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