Interactive 3D Zoetrope with a Strobing Flashlight

Sarah Kushner
University of Toronto
Toronto, Canada
sak@cs.toronto.edu

Paul H. Dietz
University of Toronto
Toronto, Canada
dietz@cs.toronto.edu

Alec Jacobson
University of Toronto
Toronto, Canada
jacobson@cs.toronto.edu

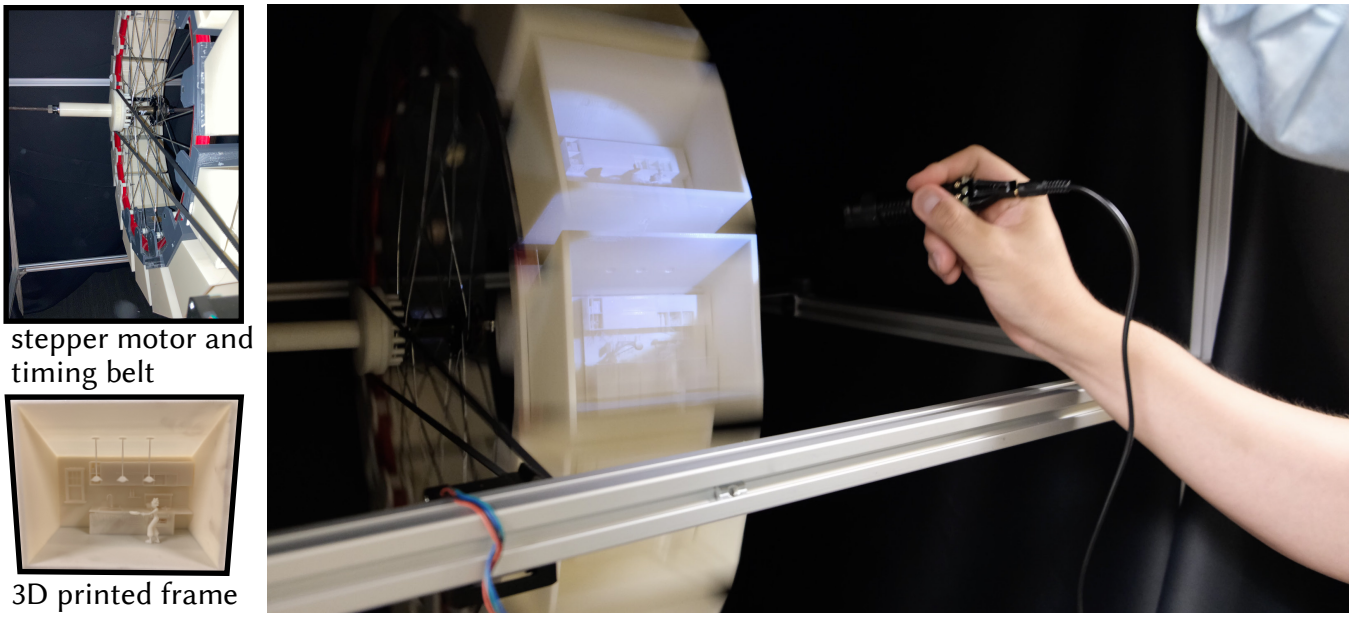

Figure 1: Users can interactively view our bike wheel zoetrope by shining a synced strobe flashlight into the animation.

ABSTRACT

We propose a 3D printed zoetrope mounted on a bike wheel where users can watch the 3D figures come to life in front of their eyes. Each frame of our animation is a 9 by 16 cm 3D fabricated diorama containing a small scene. A strobed flashlight synced with the spinning of the wheel shows the viewer each frame at just the right time, creating the illusion of 3D motion. The viewer can hold and shine the flashlight into the scene, illuminating each frame from their own point of view. Our zoetrope is modular and can have different 16 frame animations substituted in and out for fast prototyping of many cinematography, fabrication, and strobe lighting techniques. Our interactive *truly* 3D movie experience will push the zoetrope format to tell more complex stories and better engage viewers.

KEYWORDS

animation, 3D printing, zoetrope, fabrication

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1 INTRODUCTION

Zoetropes are an old but powerful animation device defined by a sequence of images or figures around a spinning cylinder. They can be seen as not only a precursor to traditional film, but also as an equally effective, however limited, storytelling medium.

In the late 19th century, the photographer Eadweard Muybridge popularized the zoetrope and brought it to public audiences in what might be the first ever movie "theatres," where viewers could pay to see a short periodic animation of animal locomotion. The limitations of this format are that it is 1) non-interactive and it 2) only allows for short repetitive looping stories. In this demo, we approach problem 1) by introducing a novel interactive element.

Zoetropes have already been exhibited in the graphics and HCI communities [Koutaki 2019], [Yokota and Hashida 2018], [Smoot et al. 2010], [Miyashita et al. 2016]. Typically zoetropes are a passive experience, analagous to regular movie watching. Our zoetrope installation lets users take a more active role in consuming this new media by providing them with the power to light the scenes how

Figure 2: Our zoetrope is surrounded by curtains so that its lights do not affect nearby exhibits.

they choose. Because our medium-sized zoetrope is still periodic, the viewer will see the same animation over and over. This interaction lets the viewer discover different aspects of the animation they hadn't considered in previous revolutions or just to enjoy the animation for longer in more interesting ways.

2 DEVICE

2.1 Electronics

A stepper motor is attached to the bike wheel gear via a GT2 timing belt and pulleys. A 7.1:1 gear reduction allows us to compute the number of revolutions per second that the motor needs to spin for the bike wheel to spin at 8 frames per second. A small flashlight LED strobes in sync with the wheel spin. The user can explore the animation by moving the light how they want to.

2.2 Interaction

The flashlight not only acts as the strobe mechanism which creates the illusion of motion, but also as a tool for a user to explore and engage with the animation. The user can focus on different details of the character or environment during subsequent spins of the wheel, which can lead to different understanding of the story. Right now the flashlight is a plain white LED, but in future versions, the colour of the light could affect the story or what is visible in the scene, effectively hiding some objects in the scene until the light changes. Similarly, we could replace the flashlight with a small projector, both colouring the scene and strobing the wheel.

2.3 Installation

In our submission and video, we demonstrate our concept with a sturdy aluminum extrustion frame and threaded rod holding up the bike wheel. We hang black curtains around our enclosure to ease light pollution into other exhibits and give each viewer a more comfortable and personal viewing experience (see Figure 2).

2.4 Modularity

In order to expand the type of stories that can be told within a zoetrope, we create a *3D Cinema Prototyping Stage*. Unlike the usual

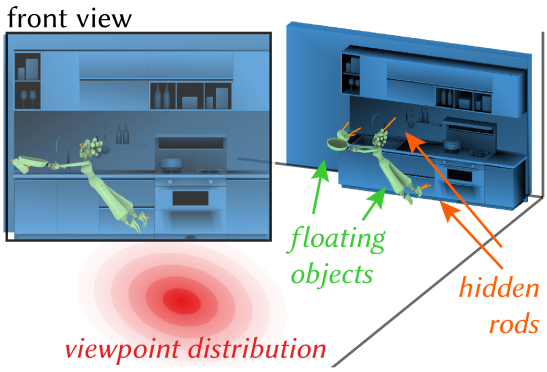


Figure 3: We run our hidden rod generation algorithm on each frame of the animation.

3D zoetrope which might contain a single object for each frame, we focus on making it easier for an artist to express a full scene. For rapid prototyping, each frame of the animation can be fabricated separately and clipped onto the zoetrope frame with extra strength magnets.

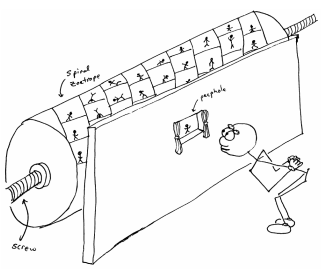
3 HIDDEN SUPPORTS

Many existing cinematography techniques in traditional film serve the storyteller's purpose. Part of our work is to find technically interesting and visually effective ways to achieve these strategies in the 3D fabricated world. Being able to replace a frame or two of an animation is key in rapid prototyping of these 3D printed storytelling methods.

The first of these cinematography problems we tackle is known as *hidden wire removal*, and refers to the technqiue of suspending objects in air and later removing the visual artifacts of rods and wires which can distract from the focus of the film. We find a sparse set of rods, shown in Figure 3, such that it is most hidden from an input viewpoint distribution [Kushner et al. 2021].

4 FUTURE WORK

Watching a 3D zoetrope animate in front of your eyes can be a magical experience. Our grand future vision is to produce and display full short 3D films from beginning to end in the form of a giant spiral zoetrope (see inset). This is a large undertaking that comes with extreme space, material, and engineering constraints. As a first step in this direction, we have presented a medium sized bike wheel zoetrope. Our eventual goal is to produce longer stories incorporating more familiar technqiues from 2D film like motion blur and depth of field. The next steps would be to engineer the spiral mechanism for a zoetrope that would tell a longer story and advance our new media goal even further.



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