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ZoOHPraxiscope: Turning the Overhead Projector into a Cinematographic Device

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The ZoOHPraxiscope combines the overhead projector with a spinning picture-disc and it works similar to the Zoopraxiscope. The Zoopraxiscope is a historical device that was invented by Eadweard Muybridge to animate sequences of pictures. The ZoOHPraxiscope allows to combine direct animation and shadow play with cinematographic animation. Using custom made electronics to control both flicker frequency and rotation speed of picture-discs, it is possible to play with various regimes of animation. As motion and light flicker are directly coupled to sound, the device is also a performance instrument for audio visual performances.

1 Introduction

The ZoOHPraxiscope is a modified overhead Projector (OHP) and a re-implementation of a historical device for animating images, the Zoopraxiscope. The Zoopraxiscope was developed in 1879 by the photographer Eadweard Muybridge, to project and animate sequences of pictures showing animals in motion (Hendricks 1975). My purpose of modifying the overhead projector into a cinematographic device is not to create a detailed replica of the Zoopraxiscope, but to fuse two modes of animation in a playful way. In previous work I have used the overhead projector for creating shadow plays of moving objects, the first mode of animation. I use it for creating audiovisual performances (ray vibration 2015) and as philosophical toy to convey scientific insight about the theory of embodiment (Faubel 2013). The second mode of animation is based on cinematographic animation similar to the animation technique of the Zoopraxiscope. With the presented setup these two modes of animation, shadow play and cinematographic animation can be fused and mixed.

1.1 Early cinematographic devices

Fig. 1 A Zoopraxiscope disc, as it was used in the Zoopraxiscope developed by Eadweard Muybridge (source Wikipedia)

I refer to Eadweard Muybridge's invention of the Zoopraxiscope as device for displaying animated images, mainly because the device's name can be easily changes to ZoOHPraxiscope. I could have equally referred to Franz von Uchatiu's Kinetoscope or Ottomar Anschütz's Electrotachyscope. All these inventions and innovations share the technological combination of a picture disc (see Figure 1.) combined with a Laterna Magica and a shutter mechanism. All devices appear in a timeframe of only 45 years between 1845 and 1890 (Füsslin 1993). This era is often designated as pre-cinema, but as Zielinski writes this is a shortsighted reduction, because the variety of different approaches and of the motivations that drove the persons involved was too large (Zielinski 1999). What drove people like Muybridge or the chronophotographers Marey and Janssen was not the invention of cinema but the idea of using photography to reveal a deeper truth about the world (Canales 2011).

This quest for truth is well demonstrated in the biography of the photographer Eadweard Muybridge, who had developed an apparatus to prove that a horse has all the feet off the ground during gallop (Muybridge 1878). He used an array of photographic cameras connected to switches triggered by strings attached across the path the horse would run along. Using this technique, he succeeded in taking a series of photographs showing a horse with all feet off the ground during gallop.

The Zoopraxiscope is a device he then developed for animating such motion sequences and for showing these sequences to a broader audience.

1.2 The Overhead projector

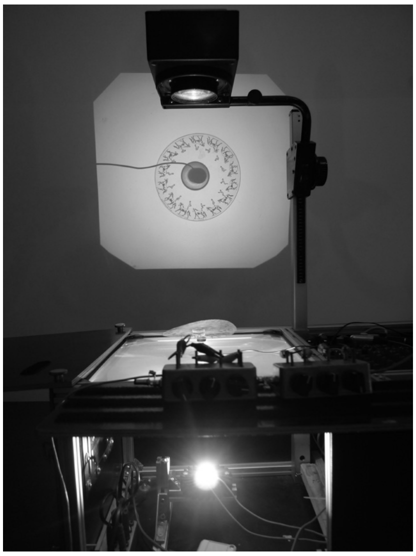

Fig. 2 The ZoOHPraxiscope, A custom build overhead projector with a high power LED as light source and a Zoopraxiscope-disc printed on a transparency

When taken out of the context, where the overhead projector is known best, the classroom, instead of being boring as we remember it, the overhead projector is surprisingly fresh.

Take for example the performances of the group loud objects (loud objects 2015), using soldering irons they assemble electronic circuits that produce sound on the overhead projector. While one follows a shadow play of hands, soldering irons and smoke, at some point these shadow objects start to emit rhythms and sound and become loud. An other example are the performances by Klaske Oenema (Oenema 2015), a singer-songwriter and storyteller. While she sings, she unfolds a story using images that are scratched or drawn onto found transparent objects and placed on the overhead projector. I think that even though these two examples are very different in style, one being loud, noisy and experimental, the other being silent, harmonic and poetic they share the same magic, the magic of the Laterna Magica and of the shadow play.

1.3 LED technology & cinematographic animation

I have been working on a technological update of the overhead projector, primarily driven by the wish to reduce its energy consumption in the context of a project for creating a mobile overhead projector[1]. With the development of high power LEDs it has become possible to reduce the power consumption by a factor of ten and still deliver enough light intensity for classroom presentation. But most importantly for this project, it has also become possible to easily switch the light source on and off at the fraction of a second. While standard halogen bulbs have a non-negligible afterglow, a LED may be switched on and off at high frequency. The complicated mechanism of a film projectors shutter may be realized simply by turning the LED on and off. Combined with a rotating disc it possible to easily create an animation based on the principle of the Phenakistoscope.

This new possibility has triggered new interest in pre-cinema animation techniques and there are quite a number of projects making use of LEDs for creating animations. A recent popular example are the animation of three-dimensional objects (Smoot et. al. 2010, Dickson 2003).

1 “Overheads on bike”, A project in collaboration with Tina Tonagel and Ralf Schreiber, funded by ON – Neue Musik Koeln e.V.

There are a number of very good artistic projects that revive technologies such as Zoetropes, Phenakistoscopes or Zoopraxiscopes. A first example are the mesmerizing performances by the group Sculpture (Sculpture 2015), who use pictures-discs in combination with a high-speed shutter camera and a video beamer. A second example is the installation Kiss-o-scope by artist Amanda Long (Long 2015). She developed a custom software to render live streams of camera images into a Phenakistoscope display projected by a beamer. Common to these projects is that they feature an obsolete technology that has none the less never lost it's magic.

Combing the overhead projector with a high power LED and a rotating transparent disc allows to project to a broad audience but most importantly for combining direct animation and shadow play with cinematographic animation. This combination of direct and of cinematographic animation is the innovative contribution of this project.

2 Turning the overhead projector into a Zoopraxiscope

To use the overhead projector as a Zoopraxiscope requires to modify the light for being able to quickly turn it on and off and a system for creating spinning images.

2.1 Replacing the light bulb with a high-power LED

A standard overhead projector is equipped with a 250 Watt light system. It uses a 24 Volt Halogen lamp that is operated with a current of 10 Ampere. To provide such large amounts of current requires a big transformer that converts the 220 Volt Ac current into 24 Volt DC current. Because the halogen lamp is an incandescent lamp a lot of heat is produced. As a consequence most overhead projectors are equipped with an active cooling system. Because the lamp emits light in all directions a mirror is placed behind the light bulb to reflect the light in direction of the fresnel lens. In front of the lamp a diffusing lens is mounted that spreads the light so that the fresnel lens is illuminated homogeneously.

With the introduction of affordable high-power LEDs it has become possible to greatly simplify the overhead projector and to drastically decrease its power consumption, while providing approximately the same light intensity.

To run a 20 Watt LED a constant current provider is needed, these can be bought off the shelve. A 20 Watt LED that runs at 14 Volt will draw a current of 1.4 Ampere, which can be provided by very cheap and very small switch-mode power supply. High power

LEDs are arrays of LEDs that are mounted on a surface. The light they emit is directional and covers an angle of approximately 120 degree and no extra lens is needed to homogeneously illuminate the fresnel lens. High-power LEDs may be passively cooled, it is sufficient to mount them on large cooling block. All in all, replacing the halogen lamp with a LED is very simple and also simplifies the projector. The active cooling fan, the big transformer the optics with the bulb can be removed and leave ample space for installing a bigger cooling body with the LED mounted on.

2.2 Controlling the high-power LED

All standard constant current drivers for LEDs offer a pulse width modulation (PWM) interface for dimming. This interface is intended for dimming the LED, by turning it on and off at a high frequency at which no flicker is perceived. But it can operated at any frequency. In order to create the illusion of continuous motion from discrete images, the rate has to be at around 18 frames per second as in standard cinema.

Fig. 3 The bi-core unit, left potentiometer controls on-time of the LED, right potentiometer the off-time.

A second parameter besides the frequency at which the LED is turned on and off is the duration of the on-state of the LED. This is an important parameter for continuously rotating picture-discs. In order to have stable image without motion blur the on-time has to very short. This short on-time corresponds to the thin slits in the classical zoetrope cylinder. When the slits are too wide the animated image is blurry (Füsslin 1993). Analogously when the on-time is too long the image becomes blurry.

Both parameters, frequency and on-time can be controlled with a very simple analog circuit, the bi-core oscillator (Hasslacher & Tilden 2002) (see also Figure 3.). While there exist other oscillator circuits, I use the bi-core, because it can also drive motors. This offers the possibility to couple the flicker frequency with driving the motor, in order to synchronize both. With the two variable resistors of the bi-core circuit, the on-time and the off-time can be controlled independently.

Fig. 4 The Picture-disc is mounted on a dc-motor. The motor is fixated with vacuum cup on the screen.

2.3 Driving spinning discs

To spin the picture-discs, I use standard dc-motors with a gearbox that directly drive the discs The motors are mounted on a holder with a vacuum cup, so that the motors can be quickly positioned on the overhead projector. The motors carry an acrylic discs, that holds the picture-disc printed on a transparency (see Figure 4.). For controlling the rotation speed, again I use a bi-core oscillator. For creating a continuous rotation instead of an oscillation the potentiometer for the right spin is set to zero, so that the motor will only turn to the left. The speed can be controlled by a third potentiometer that controls the current for driving the motor.

2.4 Spinning discs and flickering lights

Being able to control both the flicker of the LED and the rotation of the spinning disc allows to play and search the magical moment when the animation appears. There is a huge parameter space in which the illusion of continuous motion is perceived. It starts at around 12 frames per second and goes up to 40 frames per second. The number of single images on the picture-disc and the rotation speed of the disc determine the number of frames per second. The flicker of the LED then needs to be adjusted accordingly, for example, a picture-disc with 16 images that makes one rotation per second requires 16 flickers per second.

2.5 Combining sound and vision

When used in the shadow play animation mode, the combination of sound and vision is based on directly listening to oscillatory signals that generate movement of a robotic structure, or to couple these signals to analog synthesizers. This technique of combining sound and vision is described in more detail in the paper Rhythm Apparatus on Overhead (Faubel 2014). The same set-up is used for driving the spinning picture-discs. Using an oscillator circuit to drive the rotation of the picture disc may seem counter-intuitive at first sight. But it allows to rhythmisize the continuous rotation of the picture disc. At naked eye this rhythmic structure is not visible, the motor just seems to turn. But when the rotation is combined with flicker from the LED, not only the cinematographic animation becomes visible, but also rhythmic discontinuities in movement of the picture disc.

3 Software scripts for creating Zoopraxiscope picture-discs

I developed software-scripts to generate Zoopraxiscope picture-discs, using the software framework processing.[2] These scripts generate minimalistic animations of simple shapes, such as expanding hexagons, rotating and expanding rectangles, or triangles moving in circles. Figure 5. shows two examples of such picture-discs. The script to draw the rotating rectangles is shown below.

2 http://processing.org

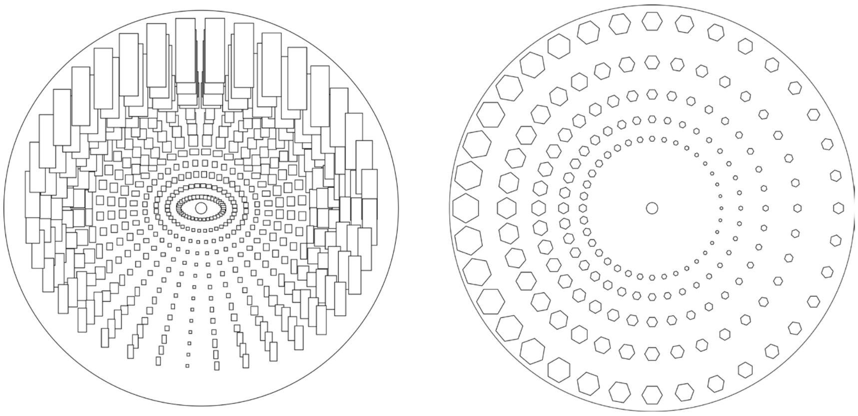

Fig. 5 Example Picture-Discs generated with the software. The left disc is generated by the script below, when animated it shows rotating rectangles, the right disc produces expanding hexagons.

```
num_frames=36;
void draw()
{
  pushMatrix();
  translate(width/2, width/2);
  rectMode(CENTER);
  rotate((-2.0*PI/(num_frames)*ctr++));
  for (int j=1; j<15; j++)
    for (int i=0; i<num_frames; i++)
    {
      rect(j*20*sin(i *-2.0*PI/num_frames)
           + 20*sin(i *-2.0*PI/num_frames),
           j*20*cos(i*-2.0*PI/num_frames),
           5+exp(j/5)*4*sin(2*PI/(num_frames*2)*i),
           5+exp(j/3)*2*sin(2*PI/(num_frames*2)*i));
    }
  popMatrix();
}
```

Code to generate the rotating and expanding rectangles, expansion is a function of the angular position and the distance from the center.

4 Playing with direct animation and with cinematographic animation

For playing with direct animation and cinematographic animation, I use basic shapes such as squares and print sequences of for example a rotating square on a picture disc with a single square at the center (see Figure 6. for an example). These basic shapes lend very well for mixing both animation styles. When used in in direct animation the center square rotates back and forth or appears as circle at high rotation speeds. In this mode what is special is that the signals that drive the motors are also used to generate sound. As matter of fact sound and movement are always in sync. Because of the rotation, the outer patterns smear out and are just perceived as some texture. When flicker is turned on suddenly the outer shapes appear and are perceived as rotating. As the discs are turning at different speeds the clear perception of animation does not appear at the same time. Performing with this setup is really about playing with perception (see Video in linked in Figure 6.).

Fig. 6 A video showing an example of mixing direct animation with cinematographic animation (https://vimeo.com/129420374)

5 Conclusion & Outlook

I have presented a setup that allows the fusion of shadow play and cinematographic animation. It is based on a simple and cheap modification of the overhead projector. It is fun to play with these different modes of animation and tuning in and out of animation and flicker. Even for the cinematographic animation it is possible to drive the discs rhythmically. At the naked eye the discs seem to be rotating continuously, when flicker is turned on the animation seems to stop rhythmically. As the signals driving the rhythms are connected to sound, even for the animation the sound is in sync with these rhythmical stops of the animation.

As the modification of the overhead projector is really easy and cheap, I plan to develop a workshop for modifying the overhead projector. In this workshop participants will learn very basic skills on electronics but also in a second part they will start experimenting with animation. While it is handy to use a software to print out picture-discs of animations, it is also much fun to work on animation directly by, for example, drawing simple shapes by hand. The key element of the workshop would be based on this tangibility of animation.

References

Barber, S. Muybridge: The Eye in Motion. Solar Books, 2012.

Canales, J. Desired machines: Cinema and the world in its own image. Science in context 24, 03 (2011), 329–359.

Dickson, S. A three-dimensional zoetrope of the calabi-yau cross-section in cp4. Leonardo 36, 3 (2003), 230–232.

F**aubel, C. Rhythm Apparatus for the overhead projector – a metaphorical device.** In Proceedings of xCoAx 2013, Conference on Computation, Communication, Aesthetics and X (2013), M. Verdicchio and M. Carvalhais, Eds.

F**aubel, C. Rhythm Apparatus on Overhead**, International Conference on New Interfaces for Musical Expression, Goldsmiths, University of London; (2014)

Füsslin, G. Optisches Spielzeug: oder wie die Bilden laufen lernten. Verlag Georg Füsslin, (1993).

Hasslacher, B., and Tilden, M. Living machines. Robotics and Autonomous Systems 15, 1 (1995), 143–169.

Hendricks, G. Eadweard Muybridge: the father of the motion picture. Grossman Publishers, (1975).

Long, A. http://www.amandalong.org/kiss-o-scope.

loud objects. http://www.loudobjects.com/.

Muybridge, E. Descriptive Zoopraxography, or the Science of Animal Locomotion Made Popular. Library of Alexandria, (1893).

Oenema, K. http://www.klaskeoenema.nl/.

Sculpture. http://tapebox.co.uk/.

Smoot, L., Bassett, K., Hart, S., Burman, D., and Romrell, A. An interactive zoetrope for the animation of solid figurines and holographic projections. In ACM SIGGRAPH 2010 Emerging Technologies (2010), ACM, p. 6.

Zielinski, S. Audiovisions: Cinema and television as entr'actes in. History. Amsterdam: Amsterdam University Press (1999).