Creating Instantly Disappearing Prints Using Thermochromic Paint and Thermal Printer in an Interactive Art Installation

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Abstract. This paper outlines the techniques used in an interactive art installation, called *Time Axis*, created by the author. The installation invites viewers to take a portrait of themselves in front of a wall-mounted device that is embedded with a camera and thermal printers. The image captured by the camera will be printed on paper by the thermal printers. One of the thermal printers is loaded with some custom-made thermochromic paper that changes color reversibly when temperature is changed. Images printed on the thermochromic paper will disappear due to heat loss to surroundings after a few seconds of being printed out. Thus, the participants will witness the silhouettes of their portraits appearing and dissipating on paper instantly. The mechanical noise generated by the printers is manipulated by a digital resonator and sent through a pair of headphones to be listened by the participants to intensify their experience.

Keywords: Thermochromism, thermal printer, temporary image, ephemeral, fading, interactive art, installation.

1 Introduction

1.1 Interactive Visual Art Installations: Digital vs. Analogue

Interactive art is a genre of art that involves the participation of viewers that makes dynamic changes to the contents of the artwork. The exploration of the participants and the dialogue between the audience and the system creates meanings to the artwork. In many interactive visual art installations, due to the nature and requirement of dynamic visual contents, the presentation technology is usually based on digital media, such as computer screen, projection and head-mounted display. A vast range of augmented reality works use projection mapping technique and modern mobile computing devices.

On the contrary, creating visual interactivity using ordinary, physical object, such as a piece of paper or wood, without digital media and mechanical actuation of the object is traditionally challenging for artists and designers. Today, media artists create artworks that left the screen and lie in more direct, tangible physical phenomena [1]. They study the sciences of materials to explore new possibilities for art making and

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design. Creating interactivity on ordinary, analogue objects can bring these everyday objects to life and manifest highly compelling and spectacular aesthetic due to human's strong desire and enjoyment for magical experience.

1.2 Chromism: Approaches to Achieve Visual Interactivity on Ordinary Physical Objects

Chromism is a process that changes the color of a compound reversibly. In recent decades, wide ranges of chemical materials that can give chromic (color-changing) phenomena have become commercially available and commonly used in consumer products. Chromism is usually induced by external stimuli, such as irradiation and heat, which alter the electron density of substances and give rise to a change in electron states of molecules. Two major types of chromism are thermochromism and photochromism. Thermochromism is the most common chromism. It refers to the property of substances to change color reversibly when temperature is changed. It is utilized by the work *Time Axis* to be presented in this paper. Photochromism is induced by light irradiation. This phenomenon is based on the isomerization between two different molecular structures, light-induced formation of color centers in crystals, precipitation of metal particles in a glass, or other mechanisms. We will discuss some artistic projects that have exploited thermochromism or photochromism techniques to achieve color-change on physical objects.

1.3 Related Works

There are a number of interesting works recently appear in the art scene that have employed chromism techniques. *Thermochromic Clock* (2011) by Che-Wei Wang and Taylor Levy (CW&T) [2] is a 4-digit 7-segment timepiece, where each segment in the display is made with nichrome wire and then covered by a thick layer of black thermochromic paint. Time is displayed by applying voltage to the nichrome wire. As the wire sustains an electric current, it heats up the surrounding thermochromic paint, causing it to become transparent.

Apart from thermochromic paint, many artworks have been created with photochromic paint/ink to produce temporary visual effects on physical objects. There are a number of interactive art installations that exploit phosphorescent (glow-in-the-dark) paint or materials excited by sequenced light. An audio-visual installation *Fade Out* (2010) by Daito Manabe and Motoi Ishibashi [3] uses an infrared camera to capture a portrait of a viewer in dark. It then uses a laser projector to project a ray of laser beam that moves on a screen painted with phosphorescence paint to render the captured portrait pixel by pixel. The trace of the laser beam leaves the screen a glowing image of the portrait that fades away in around 30 seconds.

Temporary Printing Machine (2011) by rAndom International [4] also uses photochromism technique to depict viewers in a transient light portrait. As the viewer stands in front of an empty canvas that is coated with a layer of light-sensitive material, his/her image is slowly revealed by an array of sequenced light source

moving slowly accross the canvas. The portrait gradually fades away and leaves the canvas empty again.

The Book That Can't Wait (2012) is a literary book created by publishing house Eterna Cadencia in collaboration with creative agency draftFCB, for an anthology of new Latin American authors. The book is printed in light-sensitive ink that begins to disappear when the book is opened and expose to light and air for the first time. The ink will completely disappears within two to four months of opening the package, urging purchasers to actually completely read the book shortly after they buy it.

2 Time Axis

2.1 Artistic Concept - Capturing the Permanence and Evanescence of a Moment

The title of the art installation presented in this paper is *Time Axis*. It evokes the viewers to think about what time is while seeing the installation. Time has long been a subject of study across many different disciplines. However, it is extremely difficult to define time in a non-controversial manner. Moreover, most people in the world have never thought about what time is. This art piece evokes the consciousness of the concept of time through an unfamiliar experience - taking self-portraits and watching them vanish on paper instantaneously. Photography is a process of capturing an instance of dynamic events as a permanent visual at that moment: turning fleeting matters to permanent. Still images are time-invariant, whilst still images that fade away are time-variant: turning permanent matters to evanescent. More interestingly, the evanescence of the event captured by the image is different from that of the ephemeral image itself.

2.2 Coating Thermochromic Paint on Paper Rolls

Thermochromic paper that changes color reversibly with temperature is not commercially available. We need to custom-made our own thermochromic paper with thermochromic materials, which usually come in paint or powder form. In this project, the thermochromic paper has to be in form of a roll of receipt paper or thermal paper so as to fit into a thermal printer. Thus, for convenience, we coat the thermochromic materials on regular thermal paper. The thickness and resulting texture of the thermochromic paint is crucial, because thick and frictional paint on paper can easily adhere to the print head of thermal printer and cause paper jam. The thermochromic paint used in *Time Axis* is prepared by mixing thermochromic powder in white gesso and water. The thermochromic powder is purchased from [5]. It is called thermal-dust. It comes in many different colors, while black color is picked in this project. The thermal-dust loses it color (turns white) at 30ºC or warmer. As the dust cools, it returns to its original color. Gesso is used as the paint base rather than acrylic or other common painting media, as it has been tested to give the smoothest discharge of paper from the thermal printer. We carefully applied a thin, even coat of thermochromic paint mixture with a sponge brush on a roll of thermal paper (Fig. 1),

and let the paint dry in hot air. The thermochromic paper is then rolled up and loaded into thermal printer. The thermochromic paper is reusable due to the reversibility of color change.

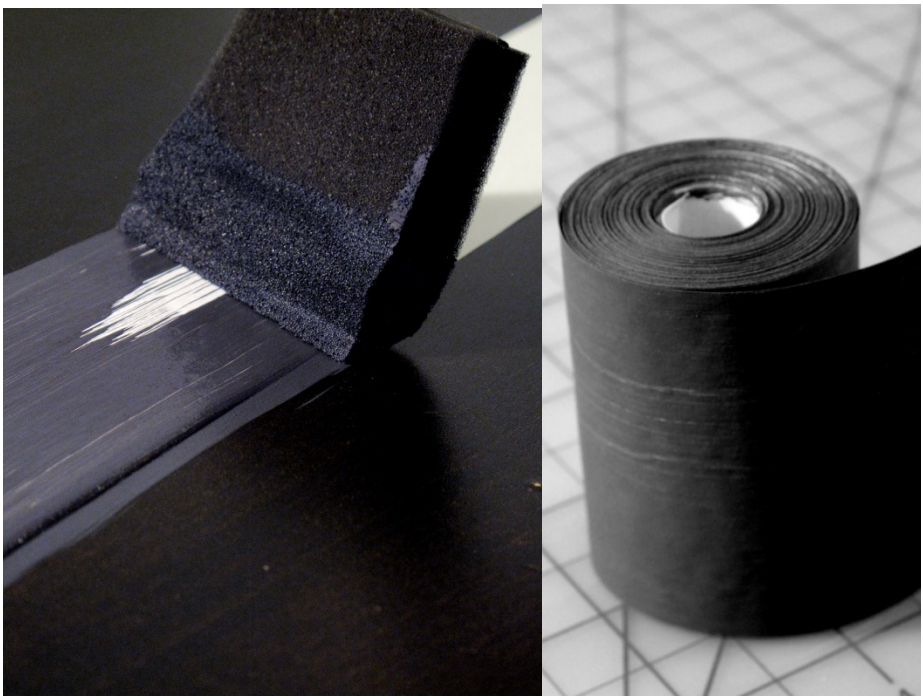

Fig. 1. Custom thermochromic paper made with a thin coat of thermochromic paint on thermal paper

2.3 Thermal Printer, Arduino and Processing

Thermal printers are a fast, cheap and reliable way to create mini paper documents. The thermal printer used in this project is manufactured by Cashino Electronic Technology in China. It became very popular among the maker community after being introduced by a famous electronic online store Sparkfun in their New Product Post in March of 2011. The most interesting feature of this low cost thermal printer lies in its communication protocol. It reads TTL serial, thus can read print data conveniently from an Arduino [6] microcontroller.

We have created a sketch in Processing [7] to capture image from a USB camera. The image is converted to binary image based on a threshold that depends on the space's light intensity. We have added some LED strips at the back of the wooden enclosure of the device to ensure enough amount of light illuminating on the viewer's face. The binary image is then sent through an Arduino to the thermal printer byte by byte. Upon receiving the packets of image data, the thermal printer's print head will heat up the thermal paper and thermochromic paper on corresponding pixels.

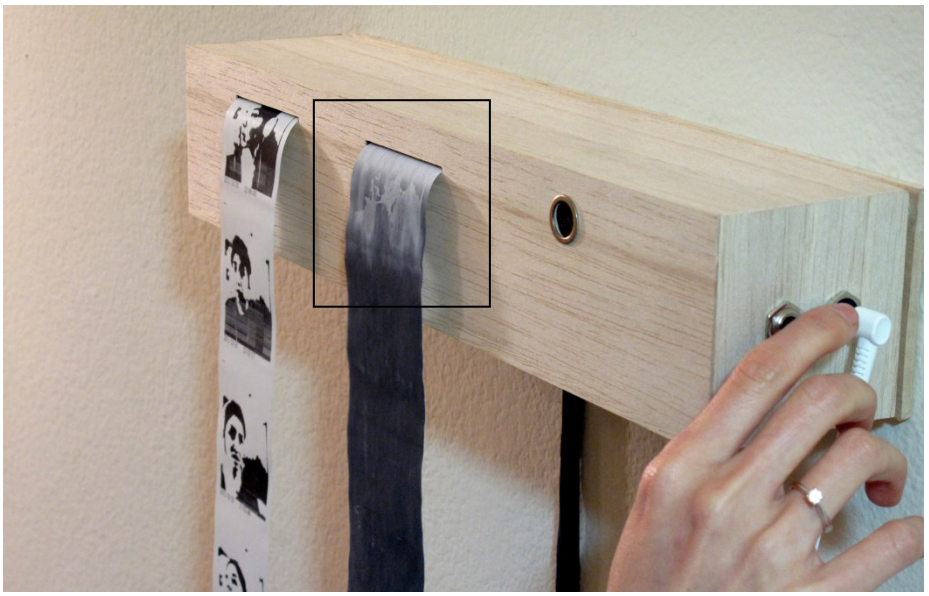

Fig. 2. Image printed on thermochromic paper slowly fades out

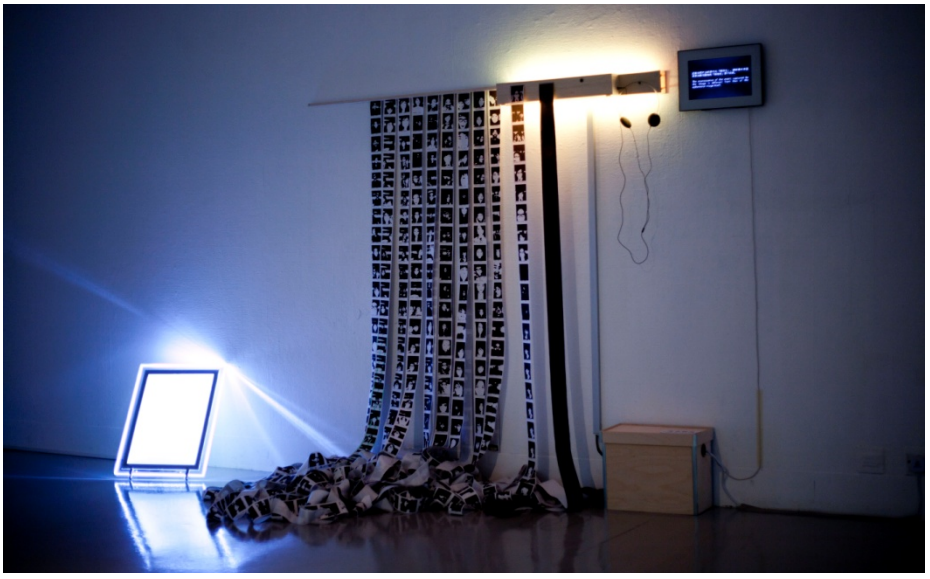

Fig. 3. Installation view of *Time Axis*

2.4 The Time Axes

At the bottom of each image of portrait, there is a time stamp to indicate the time and date when the portrait is taken. Thus, on the white thermal paper, there exists a time axis along the strip of paper pointing in upward direction. For the black thermochromic paper, the image is dissipating slowly. We can interpret that there is an imaginary time axis in on the thermochromic paper that remarks the time-variant nature of the image.

2.5 Sound

There is a notable mechanical noise produced by the thermal printers during the printing process. We have embedded a microphone in the device and put it next to the thermal printers to capture the noise. The sound is then fed to the computer and processed using software Ableton Live to generate real-time resonance effect. This intensified sound is heard by the participant through a pair of headphones and creates an immersive audio environment that mimics the condition of meditation.

3 Concluding Remarks

The disappearing image on paper can be referred to the concept of trace suggested by French philosopher Jacques Derrida [8][9]. Trace is not strictly defined, but is usually explained as the absence of presence. In *Time Axis*, the black thermochromic paper leaves a trace of portrait in the viewer's memory, which will never appear on the paper again.

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