Photo-Chromeleon: Re-Programmable Multi-Color Textures Using Photochromic Dyes

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ABSTRACT

In most situations in the real world, once an object is fabricated, the color is permanent and cannot be changed again. For the Emerging Technologies exhibit, we will present a technology to create re-programmable multi-color textures that are made from a single material only. This technology is based on photochromic dyes that can switch their appearance from transparent to colored when exposed to the light of a certain wavelength. By mixing cyan, magenta, and yellow (CMY) photochromic dyes into a single solution and leveraging the different absorption spectra of each dye, we can control each color channel in the solution separately. Our approach can transform single-material fabrication techniques, such as coating, into high-resolution multi-color processes. In addition, as the color-changing process is fully reversible, users can recolor objects multiple times.

CCS CONCEPTS

• **Human-centered computing** → Displays and imagers.

KEYWORDS

Personal fabrication, programmable matter, multi-color textures, color change, photochromic

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1 INTRODUCTION

Programmable matter that has the ability to change its physical properties (color, shape, density) holds the promise of a future in which objects will re-configure themselves according to a user's needs. One aspect of programmable matter is color, which would allow objects to change their appearance repeatedly. For instance, in clothing, accessories could be altered to match the main outfit and textiles could be recolored for different events in the same day. To update the appearance of objects, researchers started to use photochromic inks, that can switch from transparent to colored when exposed to light of a certain wavelength. Since the inks are bi-stable, the color remains even when the light source is removed. This process is fully reversible, therefore enabling users to recolor the object as many times as they desire. However, a major limitation of using photochromic materials is that they are single-color only, i.e. each material can only transition from transparent to one color and back to transparent. To bypass this limitation, we present an approach by mixing cyan, magenta and yellow photochromic dyes into a single solution and leveraging the different absorption spectra of each dye, we can control each color channel in the solution separately, which results in a range of colors across the CMY color space [Jin et al. 2009]. Since our approach uses only a single solution, we can transform single-material fabrication processes, such as coating, into high-resolution multi-color techniques (Figure 1).

2 END-TO-END SYSTEM

Users spray the photochromic coating onto the surface of an object, then use our interface to transfer a digital texture onto the physical object. Once the desired texture has been determined, the program automatically computes the light projection for the object at different angles. Once the light projection has finished, a new texture will be generated on the surface of the object. The system pipeline is shown in Figure 2.

The hardware setup and component layout is shown in Figure 3. For color initializing, we use a UV light which can automatically turn on/off using a digital controller. For the light projection, we use a modified DLP projector. For 360{°} projection on the object, we use a rotating platform that is controlled with a stepper motor. Users place the target object on the top of the platform. The color changing process then runs automatically.

3 APPLICATIONS

Photo-Chromeleon can be used to customize any object. The pattern produced is erasable and the process can be repeated. Based on this, users can personalize their belongings and appearance on a daily basis, without the need to buy the same object multiple times in different colors and styles. Also, in a showroom or sales scenario, a re-programmable color-changing coating could enable potential buyers to explore different textures or patterns on a product before

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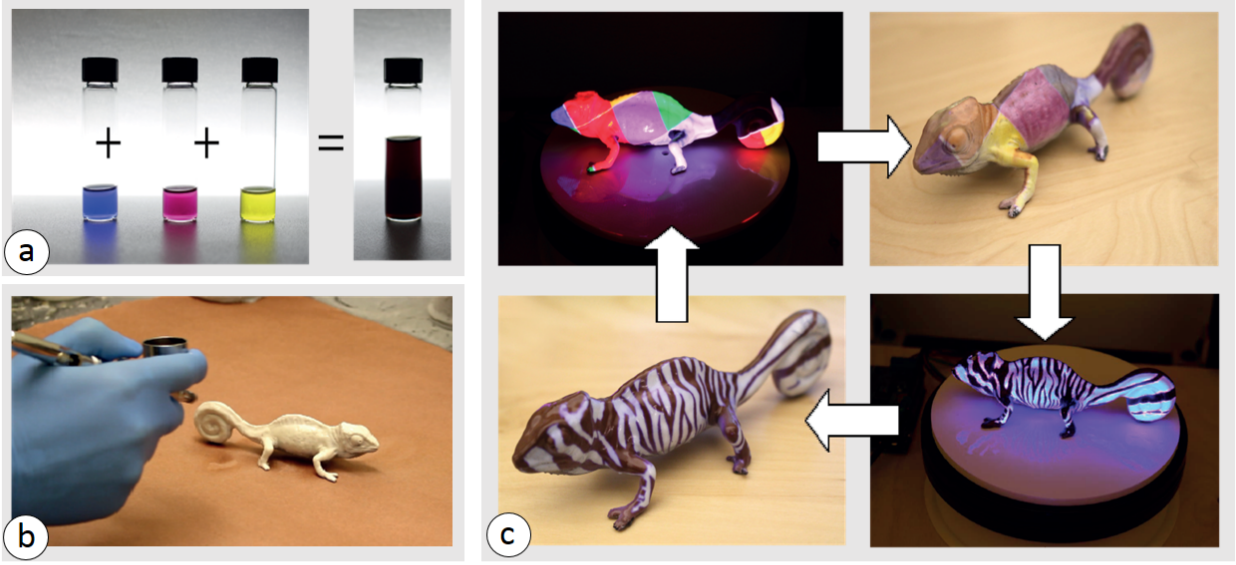

Figure 1: We can create re-programmable multi-color textures from a single material. (a) We mixed CMY photochromic dyes together to create our multi-color ink. (b) After coating the object, we use (c) a UV light source and a projector to control each color channel on a pixel-by-pixel basis, resulting in high-resolution multi-color textures that can be reapplied multiple times.

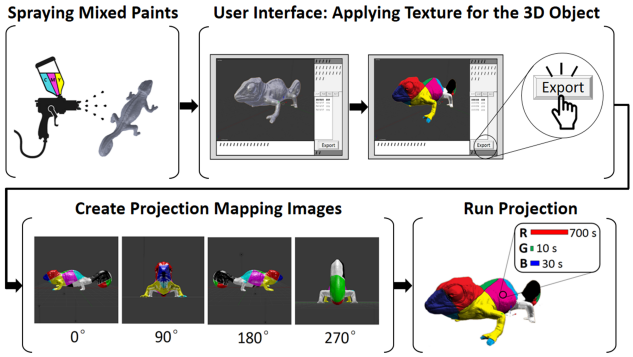

Figure 2: Overview of the end-to-end system.

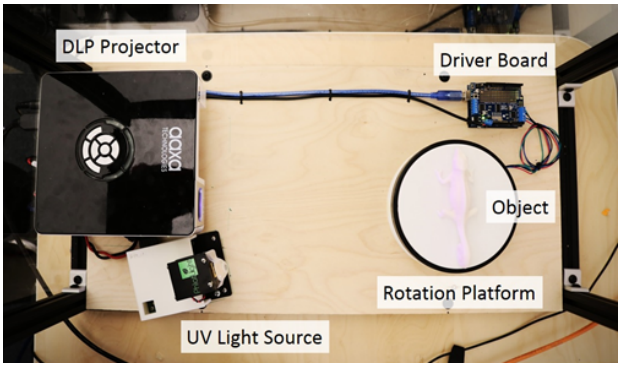

Figure 3: Hardware setup.

Figure 4: The same phone case and the same shoe re-programmed two times with different textures.

making a final choice. For this Emerging Technologies exhibit, we will present two applications of our system: a phone case and a shoe coated with our photochromic dyes (Figure 4). We will apply the first pattern onto the surface of the object, then erase it and re-create another pattern onto the same object. Participants will be able to see the color changing process in action.

REFERENCES

Yuhua Jin, Isabel P. S. Qamar, Michael Wessely, Aradhana Adhikari, Katarina Bulovic, Parinya Punpongsanon, Stefanie Mueller. Photo-Chromeleon: Re-Programmable Multi-Color Textures Using Photochromic Dyes. In Proceedings of the 32nd ACM User Interface Software and Technology Symposium (UIST 2019). http://doi.acm.org/10.1145/3332165.3347905