Shader Printer

Daniel Saakes* JST erato

Masahiko Inami JST erato Keio University

Takeo Igarashi JST erato Tokyo University

Naoya Koizumi Keio University

Ramesh Raskar MIT

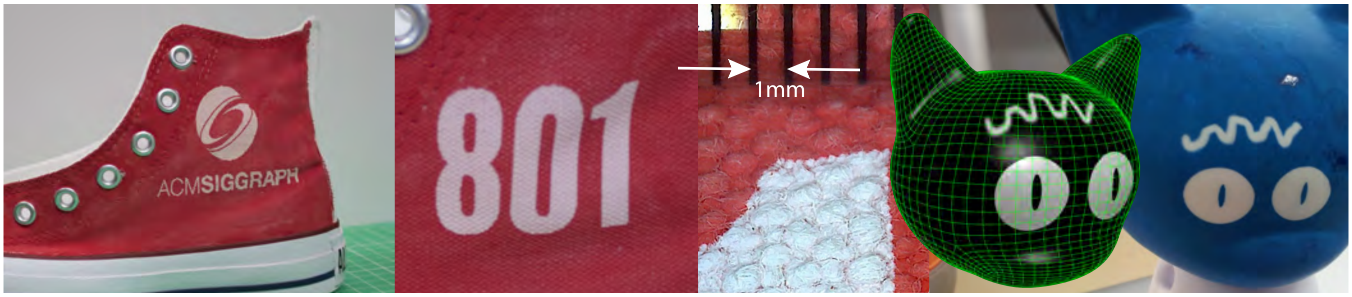

Figure 1: *Our Shader Printer allows projected imagery to persist on objects, providing a low-power, flexible and reversible manipulation appearance. We paint the object surfaces with a color dithered thermochromic ink and print or "erase" color images with a laser projector.*

Abstract

Recently, spatial augmented reality regained popularity in media arts and in the field of tangible, embedded interaction [Holman and Vertegaal 2008], by using 3D objects as information displays. The advantage of projected graphics is obvious: it allows for updatable appearance of 3D objects without refabrication. However, in many everyday objects such as fashion and shoes, projector technology is not feasible due to power and tracking requirements, and the need for a darkened environment. Users cannot take the objects outside the calibrated projector setup.

We introduce a novel concept of a stateful projector display that uses bi-stable color changing inks. We augment non-planar and complex painted surfaces by projecting high resolution imagery that persist. Similar to e-ink, graphics last without requiring additional power and are rewritable.

Our printer builds upon earlier Emerging Technologies demonstrations [Saakes et al. 2010] and [Hashida et al. 2011] that used mono-stable photosensitive materials and near UV projectors. Because our system uses bi-stable thermochromic materials, our "prints" persist for at least a month, and are least 10 times rewritable. That makes the "Shader Printer" concept is useful for various applications that are not catered by traditional displays or fabrication technologies. For instance, fashion items such as shoes or bags, wallpapers, and floors can be updated frequently. Design prototypes can be tested outside the laboratory environment in outdoors and in real-use scenarios. Another application could be very large size, high resolution information displays that are constantly updated.

Our workflow starts by coating a target object with bi-stable, thermochromic inks. We scan the object to obtain its geometry. We apply graphics as 2D textures on the 3D model in modeling software. In the printing process, we align the 3D model with the object. For each point (pixel) on the object, we estimate the color with a scanning laser. We compare the obtained color with the intended color from the textured model, and a writing laser then makes the color selectively transparent by applying heat. Depending on the ink used, a second process (for instance freezing the object) reverses this process and makes the inks opaque to allow for updatable content.

We have tested two bi-stable thermochromic inks. The first is harvested from frixion pens that come in a colored state. By heating above 70 degrees Celcius, the ink becomes white and stays that way until it is cooled below -10 degrees Celsius and reaches the second stable state. The other material switches to the colored state when the material is heated to 180 degrees Celcius and then cooled down quickly. The translucent state is achieved by heating the material up to 120 degrees before cooling it down slowly.

The opportunities for projector displays using bi-stable inks are immense. The Shader Printer fills a niche of non-planar surfaces and supports applications of dynamically attaching images onto complex surfaces allowing for non-traditional displays. Finally, low costs enable easy adoption of the new technology.

There are several limitations in our technology in the area of pixel density and color reproduction that obviously can not match the years of research in commercially available display or laser systems. However, we hope to have demonstrated the advantages of a Shader Printer system.

References

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*e-mail: daniel@saakes.net

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