A Nonluminous Display that Controls the Evaporation Velocity.

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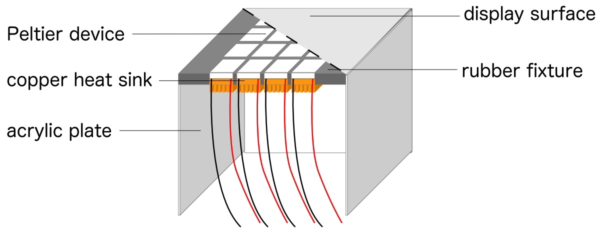

Figure 1: Proposed system configuration

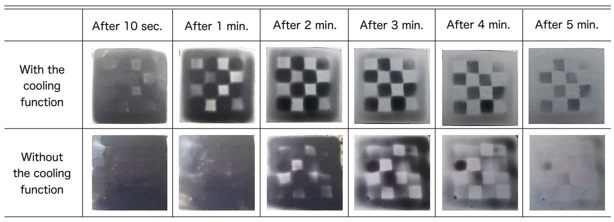

Figure 2: Changes in the display surface

1 Introduction

In this paper, we propose a novel ambient display technology that uses variations in moisture across a nonluminous material surface to render target images.

In recent years, various unconventional display systems have been proposed. These systems often make use of objects commonly available in our surroundings. For example, the "dorm light show" [1] uses windows of a dormitory as a pixel matrix, with the ON/OFF state of each room's light fixture expressing the 1-bit luminosity of a target image. Another unconventional system, Rainterior [2], projects images onto water surfaces using the ripples made by coordinated raindrops.

It is well known that the color of the surface of a road darkens after a rain shower, and reverts to its original color as the road surface dries. We propose an imaging system that makes use of this visible transformation between a wet and dry surface as a motif for display. The proposed system controls imaging by controlling the dryness of a nonluminous display material.

2 Proposed System

Figure 1 shows the structure of our proposed display, consisting of a surface material, a rubber fixture, temperature control devices, a heat sink, and an acrylic plate.

For prototype purposes, we selected as our surface material an allochroic paper typically used in Japanese calligraphy. Since this paper is extremely thin, it must be backed by a rubber fixture for stability and durability. Peltier devices, which are square-shaped discs with varying surface temperatures, are used to control the temperature of the display surface. In this way, surface temperatures can be varied from 20 to 60°C.

In our prototype system, Peltier devices are mapped onto a 4×4 matrix. Each Peltier device corresponds to a single pixel of the display, and a heat sink made of copper is attached to each device so that excess heat can be radiated away, as shown in Figure 1.

The surface of our display can transition from wet to dry on a per pixel basis. After water is sprinkled across the display surface, the system can control the evaporation rate at each pixel location by changing the temperature of the corresponding Peltier device. Wet regions of the surface correspond to the color black, and dry regions to white. Hence, immediately after water is sprinkled across the surface, the entire display is black.

To change a pixel to white, the system sets the corresponding Peltier device to "hot," and to change it to black, the corresponding Peltier device is set to "cold." These control settings enable the absorbed water to evaporate at different rates, with the intended pattern appearing after 1 or 2 min, and then disappearing a couple of minutes later, as shown in the upper column of Figure 2. Although the heating function is what performs the transformation of black pixels to white, both cooling and heating functions are necessary, especially at the edges of the image where the temperature of one pixel can affect the temperature of neighboring pixels, causing them to "blur" (see lower column of Figure 2).

3 concluding remarks

We proposed a nonluminous display that makes use of the phenomenon of evaporation. To support expression of more detailed forms, like letters and symbols, we intend to increase the number of Peltier devices in future prototypes. Furthermore, given the limitation of the current system to black and white patterns, we would like to test materials that change color when they absorb water.

References

[1] Dorm Light Show: `http://www.collegehumor.com/video/4034511/dorm-light-show`

[2] Okude, E. and Kakehi, Y.: Rainterior: An Interactive Water Display with Illuminating Raindrops, In *Proc. ITS2011*, pp. 270–271 (2011).

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