AcrySense: Interactive Carved Acrylic Board

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Abstract

The carved acrylic boards have become popular along with the diffusion of carving machines (e.g., laser cutters). When a carved acrylic board is illuminated from its side, the carved patterns emerged beautifully. We propose an interactive technique, "AcrySense", which can add input functions to a carved acrylic board in a simple and inexpensive configuration. The AcrySense mainly consists of LEDs, Photo Transistors and a microcomputer attached under a carved acrylic board. This paper describes the concept and implementation of the system.

Author Keywords

Acrylic board, carving, interactive surface, LED, photo diode

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design

Introduction

The carved acrylic boards have become popular along with the diffusion of carving machines (e.g., laser cutters). When a carved acrylic board is illuminated from its side like a LCD backlight, the carved patterns emerged beautifully. The carved acrylic boards illuminated with LEDs (acrylic carvings) are used in daily goods such as ornaments and signboards (Figure 1). We propose an interactive technique, "AcrySense", which can treat an acrylic carving as an interactive surface.

Figure 1. Example of the carved acrylic boards illuminated with LEDs

AcrySense

The purpose of our project is to add input functions to an acrylic carving in a simple configuration. We focused on the change of light passing through the board by touching a carved area with a finger. We therefore tried to apply this "touch" operation to the input method of the AcrySense (Figure 2). The AcrySense estimates the touched position based on the change of the light inside the board. We applied light-emitting diodes (LEDs) as light sources and photodiodes (PDs) as light sensors for simple and inexpensive configurations.

Sensing method

We explain the sensing method in detail. Figure 3 shows the change of the light inside the board when a user touches a carved area. First, when the board is illuminated from the side with LEDs, the board leaks some light through the carved patterns (Fig.3 left).

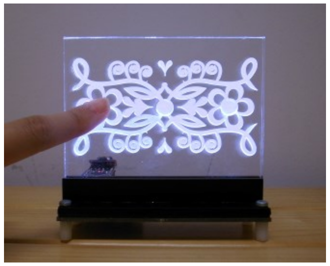

Figure 2. Usage of the AcrySense prototype

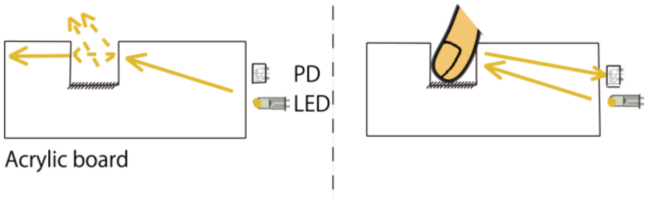

Figure 3. The change of the light detecting by PDs (side view)

Then, the patterns become bright because of the leaked light. When a user touches a carved pattern, the leaked light is reflected off the finger, goes back toward the LEDs, and detected by the PDs attached next to the LEDs (Figure 3 right). In this case, the quantity of light going back toward the LEDs changes depending on the carving depth: the light reflect off the shallow pattern becomes slighter than the deep pattern. Using this feature, the AcrySense can assign certain input areas (deep pattern) along with common carvings (shallow pattern)[1].

[1] The depth of patterns is easily adjusted by carving machines.

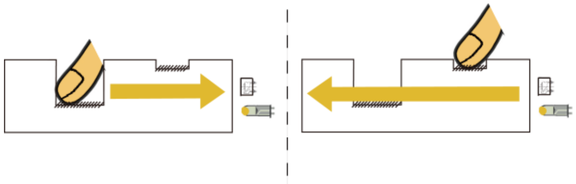

Figure 4. The comparison of light reflecting off deep pattern and shallow pattern. The quantity of light going back to the LEDs changes depending on the carving depth.

Implementation

We developed a prototype system as shown in Figure 5. The prototype mainly consists of a main board and a carved acrylic board. The main board (70 mm x 100 mm) is attached under the acrylic board. We attached three pairs of surface mounting LEDs and PDs on the main board (Figure 5 right). These devices are controlled with a microcomputer (Arduino Pro Mini). Each PD is attached next to a LED to measure the quantity of light going back to the LED. The carved acrylic board (100mm x 100mm x 5mm) is created from a common acrylic board using a laser cutter and is easily replaced via original connector parts.

Next, we explain the detection procedure of the AcrySense.

1. First, the system performs an initialization process: the system turns on all LEDs and detects reflected light using each PD sequentially to calculate touch threshold of each PD[2].
2. The system repeats the above detection cycle continuously. When a user touches an input area (deep pattern), the reflected light detected by a PD becomes stronger.
3. When some input values exceed the thresholds, the system then estimates the touched area based on the differences of input values and thresholds.

[2] Users should not to touch anywhere on the board in the initialization process.

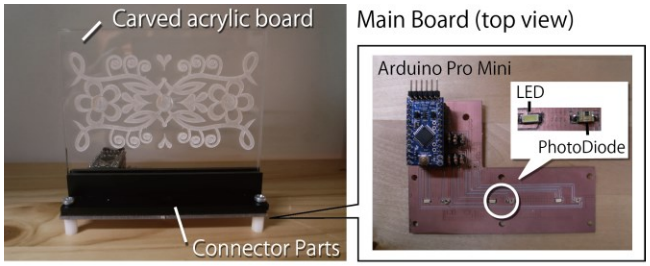

Figure 5. The AcrySense prototype

Examples and applications

Figure 6 shows the examples of the acrylic carvings. The left picture shows flower patterns: the center of each flower was deeply carved and works as a touch sensor. The right picture shows geometric patterns: a horizontal line was deeply carved and works as a linear touch sensor. Since the input pattern is quite thin in the latter case, users need to use something like a brush or toothpick.

We have developed two simple applications: a standalone illumination and a remote controller. The former system works as an interactive illumination: a user can change brightness, blink patterns or colors[3] by touching certain areas of the acrylic carving. The latter

[3] Although the current prototype does not support to change colors, this function can be developed just by replacing white LEDs with full-color LEDs.

system works as a remote controller of room lights or home appliances. Figure 7 shows examples to control three room lamps: a user can turn on/off each light by touching three areas of the acrylic carving.

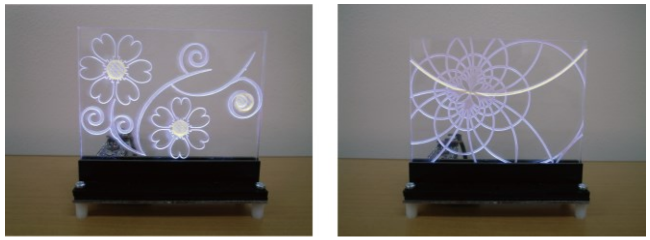

Figure 6. Examples of acrylic carvings

Figure 7. Application to control room lights

Related Work

In this section, we describe the studies on surface sensing. FTIR (frustrated total internal reflection) is a major technique [1]. Many researchers proposed FTIR based systems [2, 3]. However, since these systems detect a touch position based on the IR images taken by a camera, the systems require some space above or under the surface. The LightCloth [4] proposed a fabric interface which is an input and output device that enables illumination, bi-directional light communication, and position sensing with a light pen on soft cloth woven from diffusive optical fibers. Our system has a compact and inexpensive configuration with LEDs and PDs that requires no special devices for detection.

Conclusion

In this paper, we proposed an interactive system, "AcrySense", which can treat an acrylic carving as an interactive surface in a simple and inexpensive configuration. We focused on the change of light passing through the board by touching a carved area with a finger. We applied this "touch" operation to the input method of the AcrySense. We have developed two simple applications. We plan to explore potential applications of this system in daily environment.

Acknowledgement

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