Transparent and Flexible Interactive Skin for Morphing Surface

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Abstract

This paper describes technologies for a transparent flexible visuo-haptic display module. We have developed a thin 3x3 flexible visual display and an actuator array based on polymer technology. A flexible actuator has nine EAP (Electro Active Polymer) actuator cells providing thickness change movement. A transparent and flexible display film and a flexible transparent force sensor are identically designed with 3×3 array pattern to fit for the arrangement of actuator cells. The pressure sensor is installed under the integrated module. The performance of the actuator is proved to be sufficient for satisfying perceivable range of human touch sense and the integrated system is designed to provide interactive haptic feedback in accordance with user input.

Author Keywords

Flexible, force, sensor, actuator, display, transparent

ACM Classification Keywords

H.5.2 [Information Interfaces and Presentation]: User Interfaces; H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems

Introduction

Beyond the conventional flat display interfaces, designers and researchers have imagined noble, innovative interface paradigms, especially by granting flexible and physically active features to a touchscreen. Although enormous technical changes await to accomplish such “morphing” functionality, several researchers have already attempted to implement reconfigurable visuo-haptic interfaces with linear actuators and visual display units.

Recently, feasible technologies for flexible display with high resolution have been proposed, and there are needs for flexible actuators working together with the display device. Particularly, electroactive polymer (EAP) has been considered as a powerful candidate for the flexible actuators. Although EAP has no constraint in morphology and it can be easily formed into flexible thin films, the thin film actuator requires efforts to be a feasible actuator providing user perceivable haptic feedback for mobile devices.

In this paper, we propose a novel flexible visuo-haptic display which is an integrated device composed of a flexible actuator and sensor array and a highly flexible visual display. The flexible actuator is fabricated using EAP and it is designed to generate rapid movement of thickness change. Since a flexible display is laid on the actuator array, the flexible display is designed to be very thin and flexible to avoid interference with transmittance of actuator response.

Method

The visuo-haptic display was fabricated by integrating a flexible actuator into a flexible, transparent display and pressure sensor. Figure 1 shows an illustrated conceptual design of the proposed system. The flexible display was placed on the flexible actuator. Pressure sensors were attached on the bottom of active area of the 3×3 array actuator to detect position and contact force in response to finger touch at a contact point. For the pressure sensors, we have developed a transparent and flexible force sensor with a thickness of 0.05 mm in order to avoid interference with flexible motion of the integrated system.

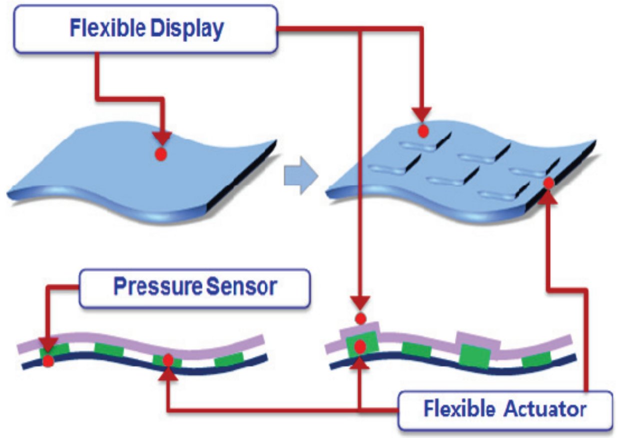

Figure 1. Configuration of visuo-haptic display.

Implementation and Measurement

Figure 2 shows a sample of implemented force sensor. Its working principle is based on the relation between light scattering amount and contact force using optical waveguide [1]. The measurement rage is 0 to 20N. The thickness of the clad layer is 20 μm. The thickness of the core layer is 10 μm. Two polymers’ elastic modulus is smaller than 0.5GPa and transparency is higher than 0.9. In order to show its flexibility and transparency, we have attached the implemented sensor to the skin as shown in the figure. All polymers have been newly composed for the research.

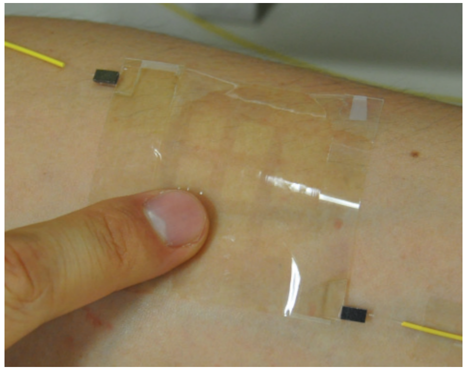

Figure 2. Implemented sensor.

Figure 3 shows electro-active polymer (EAP) based actuator array. All components including polymer material and electrode for this actuator array are transparent and flexible. The shape of actuator is designed to create normal displacement. It can vibrate with a frequency of 0 to 1kHz and a displacement of 0 to 30um. The arrangement pattern of the actuator is identical with the sensor.

Figure 3. Implemented actuator.

As shown in Figure 4, a flexible display based on optical multi-waveguide was fabricated in a thin film architecture by using prepolymers for both cladding layers and a core layer. The scatter patterns were designed to image alphabet characters. Each scatter pattern consists of circles with 30 ~ 50 μm diameter in order to improve efficiency and uniformity of scattered light signals from the patterns. Finally, a top cladding layer (thickness: 20 μm) which is partially opened at specific area was formed on the core layer via spin coating and UV curing process in sequence.

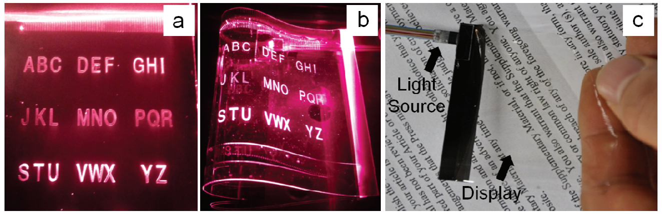

Figure 4. Test result.

In this position paper, we do not describe implementation process in detail for security. But we can discuss all technical methods and future approach at the meeting.

Acknowledgements

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References

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