Transparent and Flexible Touch/Force Sensor for Morphing Surface

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Abstract
This work introduces a force sensor array measuring contact force based on intensity change of light transmitted throughout optical waveguide. For transparency and flexibility of the sensor, two soft prepolymers with different refractive index have been adopted. The optical waveguide consists of two very thin cladding layers and a core layer. The top cladding layer is designed to allow light scattering at the specific area in response to finger contact. The force sensor shows a distinct tendency that output intensity decreases with input force and measurement range is from 0 to -13.2 dB.

Author Keywords
Flexible, force, sensor, film, transparent

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

Introduction
Recently, in order to enrich functions of the touch sensor, a touch panel simultaneously measuring pushing pressure as well as contact is considered as a substitution of conventional touch panel. Especially, it has been reported that pressure based interaction

improves usability. For example, there is a possibility that pressure based keyboard improves key clicking performance on a touch screen [1]. The feature of touch sensor as well as its function has been considered to be a crucial factor to improve feasibility for practical applications. For example, the sensor needs to be transparent if it would be laid on a touch screen device and to be thin and flexible if it would be integrated with curved surfaces of flexible display. However, the touch sensor still requires compliant technologies to satisfy flexibility and transparency in aspects of material and sensing structure.

Here, we design a force sensing mechanism based on optical waveguide using transparent flexible prepolymers with different refractive index [2]. This paper describes sensing mechanism based on optical waveguide, material design and force sensor fabrication and performance test result.

Method

A transparent and flexible force sensor with optical waveguide works based on following principles. As shown in Fig. 1, the optical waveguide consists of two cladding layers and a core layer made of soft polymers with different refraction index. As shown in the figure, bottom cladding layer is closed while top cladding layer is opened at the specific area which is a sensing area allowing finger contact. In general, the light inserted in a core layer pass through the core layer and total reflection induced since its reflection index is higher than that of cladding layer or air. However, if human finger touches at the sensing area of the top cladding layer, diffuse reflection and light scattering occurs at the contact area and the detector composed of photo diodes measures decreased light intensity for each channel. When a user increases contact pressure, the contact area between the finger and sensing area increases and diffuse amount of the light also increases. Thus, the transmitted light measured by the detector decreases as the contact pressure increases. Moreover, since the optical waveguide made of polymers allows bending motion without light scattering and forming a thin film, this sensor could be applied to various surfaces as well as a plat touch screen.

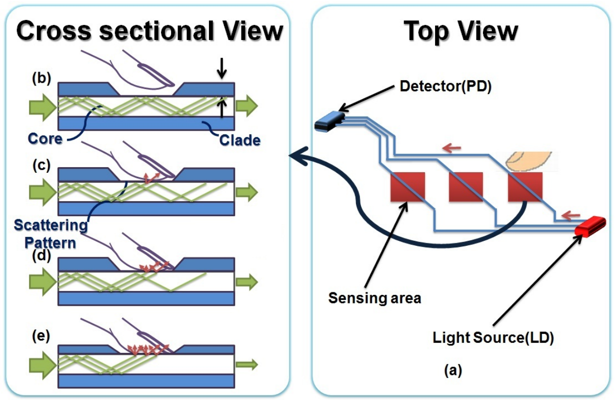

Figure 1. Working principle.

Implementation and Measurement

Figure 2 shows a sample of implemented force sensor. The thickness of the clad layer is 20 μm its refractive index is 1.43. The thickness of the clad layer is 10 μm its refractive index is 1.51. 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.

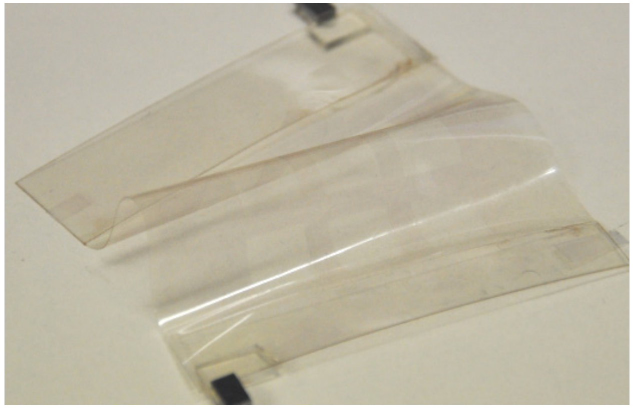

Figure 2. Implemented sensor.

Figure 3 shows changes of contact force and output intensity according to time while a subject participates in an experimental task. An apparent trend is observed that output light intensity decreases as input pressure increases. (Pierson correlation coefficient between contact force and output intensity is -0.936.) In addition, the value of signal to noise ratio (S/N) of the output signal is 97.8.

Our research team is focusing on the flexible and transparent user interface including haptic feedback actuator as well as touch sensor.

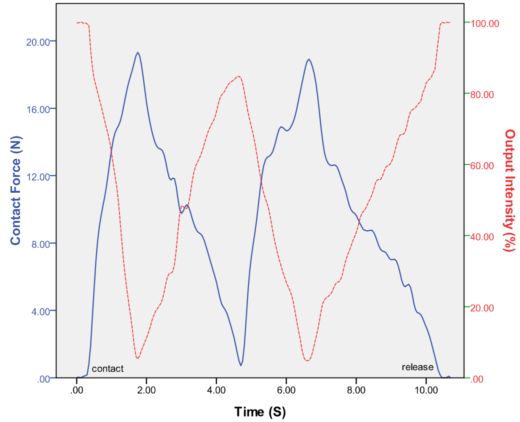

Figure 3. Test result.

Acknowledgements

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References

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