An Elastomer-based Flexible Optical Force and Tactile Sensor

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INTRODUCTION

The principle goal of the proposed research is to investigate the design and application of an optical-based sensor (See Figure 1). The sensor can sense both force information and tactile information in one elastomer.

Fig.1 The design of the elastomer-based flexible optical force and tactile sensor. Left is the manufactured prototype, and right is the exploded view of the sensor structure.

SENSING PRINCIPLE

The raw images are received by the camera, then converted into binary. Once a force is applied, the pins are pushed towards the supporting plate and each pin contact area increases, see Figure 4. We analyse the pixel number of three force-pins areas and one tactile-pins area.

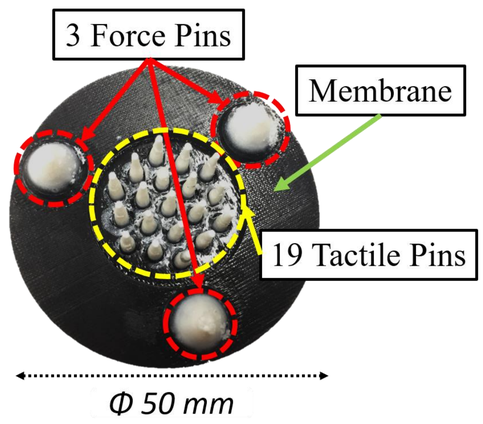

Fig.2 Manufactured elastomer with three components: (1) Three reflective pins for normal force measurement; (2) Membrane as the contact medium; (3) Nineteen thinner reflective pins for tactile information.

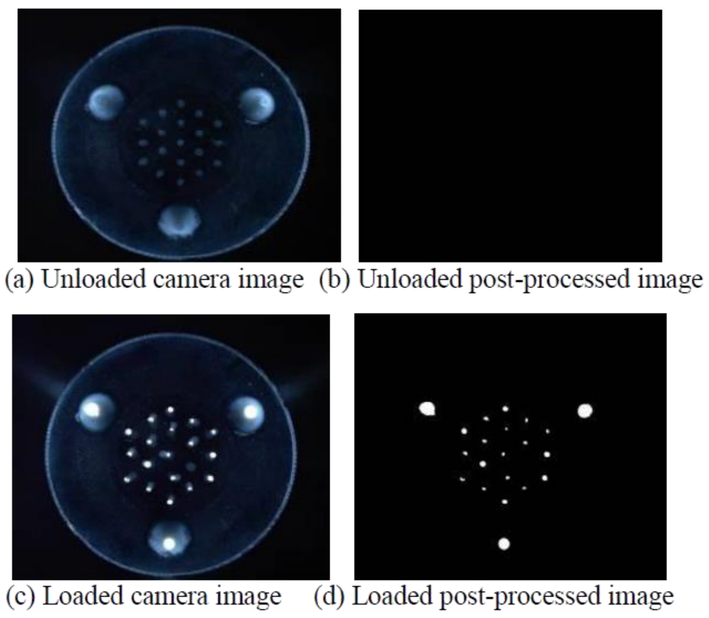

Fig.4 Camera view and post-processing view illustrating the deformation of the reflective elastomer.

SENSOR DESIGN

The proposed sensor consists of

- A flexible elastomer (1) with its fabrication process shown in Figure 3;
- A Flexure structure (2) with cantilever beams (3) that enables the movement of the elastomer.
- A CCD camera (4).
- A LED array (5) to illuminate the elastomer via the light plate (6) for effective image capturing.
- A top cap (7) and a base part (8).

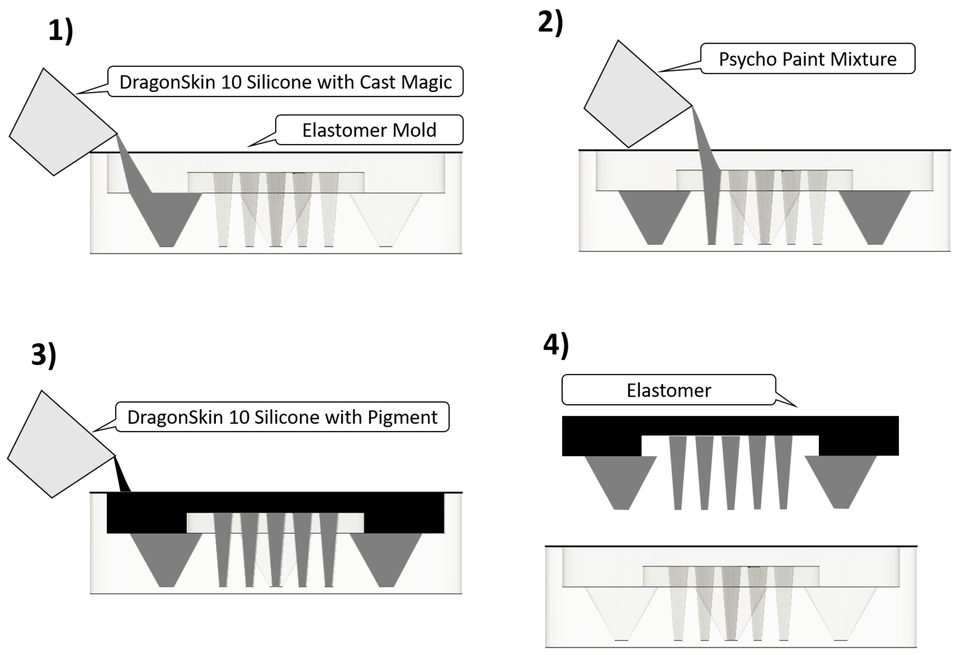

Fig.3 Four steps for the elastomer fabrication.

RESULTS

The relationship between the normal force F_z and the number of activated pixels of pin areas S_i is

$$F_z = -0.0081S_1 + 0.1375S_2 + 0.026S_3$$

The proposed sensor using one elastomer can measure real-time normal forces from *0N* to *70 N* (6.6% error), and the pressure distribution can be visualized via grayscale colormap (Figure 6) at the same time.

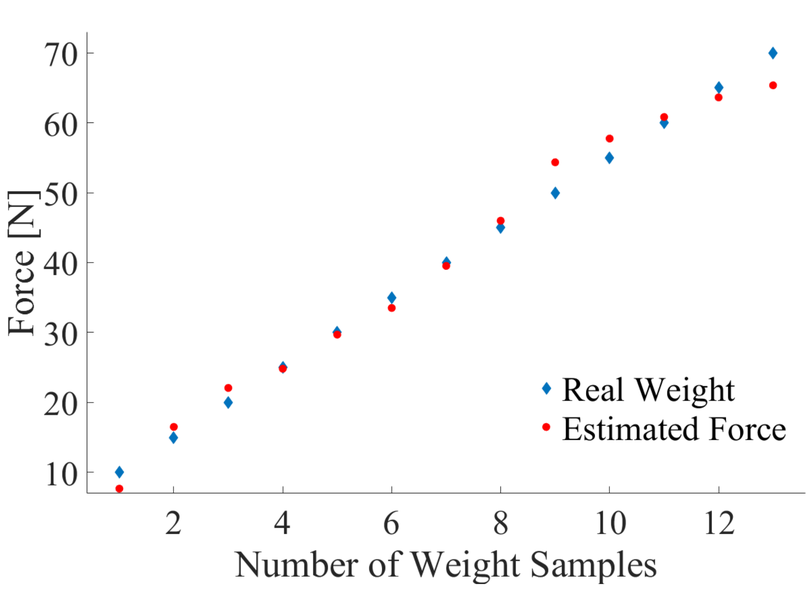

Fig.5 Static normal force response of the sensor using weights for loading. Each weight is 1kg.

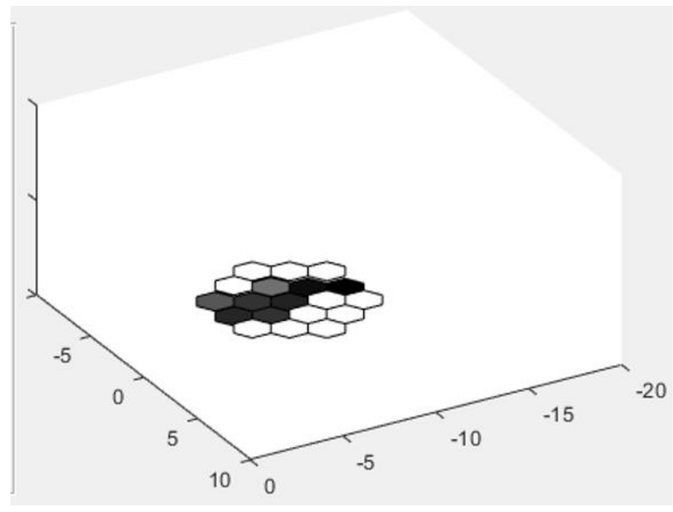

Fig.6 Visualisation of the tactile information in the form of pressure distribution, when applying pressure to the membrane. Black section refers to the highest pressure while white section refers no pressure.

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