A combined tactile and proximity sensor for adaptive grasping of a robot hand

Hiroto NAKASHIMA[1], Keiichiro KAGAWA[2], and Kazuhiro SHIMONOMURA[3]

1 Graduate School of Science and Engineering, Ritsumeikan University
1-1-1 Nojihigashi, Kusatsu, Shiga, 525-8577 Japan

2 Reserch Instituite of Electronic, Shizuoka University
3-5-1 Johoku, Hamamatsu Naka-ku, Shizuoka, 432-8011 Japan

3 Department of Robotics, Ritsumeikan University
1-1-1 Nojihigashi, Kusatsu, Shiga, 525-8577 Japan

E-mail: 1 rr0006pe@ed.ritsumei.ac.jp, 2 kagawa@idl.rie.shizuoka.ac.jp, 3 skazu@fc.ritsumei.ac.jp

Abstract We propose a combined tactile and proximity sensor for handling robot. Tactile sensing is based on the method known as a light conductive plate. Proximity information is obtained through depth measurement from stereo images. These tactile and proximity information are both captured by using the compound-eye camera. We describe a grasping strategy for a robot hand employing a combined tactile and proximity sensor.

Key words Tactile sensing, Proximity sensing, Compound-eye camera, Grasping control

1. Introduction

In a grasping control of a robot hand, generally multiple different kinds of sensors are used in order to get the information about the object to be handled. For example, at first, a location, a posture and a shape of the object is detected by using a camera, and then, a proximity sensor for detecting the existence of the object between the hands and deciding how to grasp. After that, tactile information is needed to observe the condition of contact between the object and the robot hand. Proximity and tactile sensors are generally based on a point measuring and its spatial resolution is low, so it is difficult to detect a small object and measure a contact condition for a complex shape of the object. We have proposed a sensing device for measuring both tactile and proximity information at high spatial resolution by using small multi-camera, and shown that the prototype device can obtain these several kinds of information which is needed before and during grasping operation through the experiment of pick-and-place task using the robot hand [1]. In this study, we describe a grasping strategy for a robot hand employing a combined tactile and proximity sensor.

2. A combined tactile and proximity sensing

Proposed device uses multi-camera for detecting multiple different kinds of information (Fig.1). The sensing device consists of a light conductive plate [2], Infrared LEDs, and multiple cameras [3]. Tactile information is obtained from the camera which is equipped with visible-light cut filter and takes an infrared image. Through the light conducting plate, contacting area can be seen in the infrared image. Proximity detection is based on depth computation using stereo

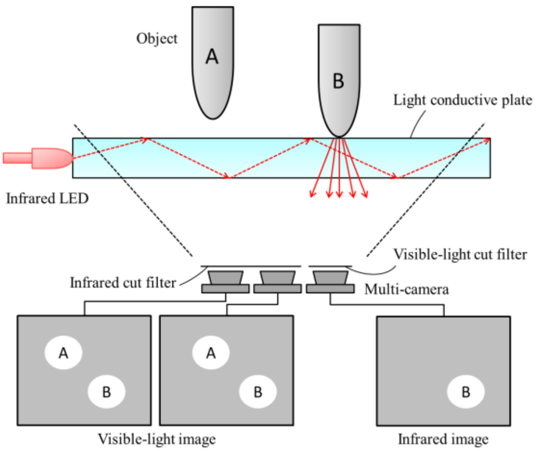

Fig. 1. Concept of the proposed sensing.

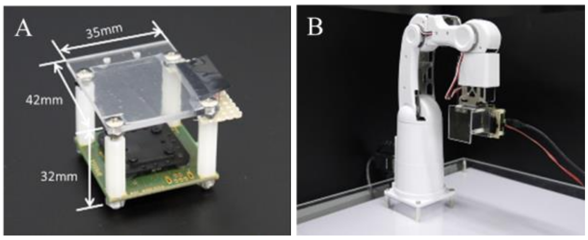

Fig. 2. Pictures of the sensor and the robot hand used in grasping control. (A) proposed sensor, (B) robot hand.

image pair from visible-light cameras which capture images of objects through the transparent acrylic board. We used a compound-eye camera TOMBO [3].It is composed of nine sets of elemental optics (called as unit) which consists of a micro-lens and a photo-sensor array. Three units have an infrared cut filter in order to obtain visible-light images for proximity detection. Another three units have a visible-light cut filter for tactile sensing base on an infrared image. By using the compound-eye camera TOMBO, the proposed sensor can get the tactile and proximity information together. Fig.2(A) shows the overall picture of the tactile and proximity sensing device. The proposed device is mounted to the gripper of the robot hand as shown in Fig.2(B). We were actually doing the grasping control using a proposed sensor.

3. Grasping control

We have constructed a robot hand system equipped with the proposed sensor. Fig.3(A) and (B) show the picture of the robot hand and the output images of the compound-eye camera in the sensor, respectively. Three images in the upper row are infrared images for obtaining a contact information. Images in the middle row are visible light images for detecting a position and distance to the object.

Fig.3(C), (D) and (E) show the processed images detecting the position (cross section of the red lines), distance and contact, respectively. We examined the automatic grasping based on these sensor information. In the experiment, the robot hand was firstly controlled so that the object position comes to the center of the image. Then, the hand approached to the object base on the distance information. After determining the grasping position, the robot hand grasped the object by using the tactile information. By using these information obtained from the sensor, we verified that the robot hand successfully grasped the objects of varied size in the same control algorithm through the experiments.

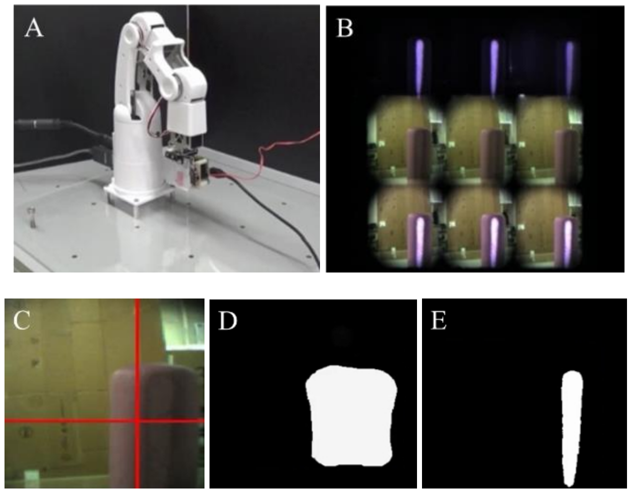

Fig. 3. Pictures of the robot hand and the output images during grasp. (A) robot hand, (B) output images from sensor, (C) image of calculating the barycentric coordinates, (D) depth map, (E) tactile detection.

4. Conclusion

We proposed an optical sensing device to obtain both tactile and proximity information at high spatial resolution. Through the experiment of the grasping control using only proposed sensor, we verified the proposed sensor can be used for control the robot hand.

5. References

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