Study of Image processing for magnetic flexible gripping transfer robot

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Abstract: In recent years, robot hands using soft materials have been studied. By using a soft material, you can easily grab fragile or various-shaped objects. Many of these soft grippers are pneumatically driven. However, it is required to use an air compressor which is not favorable for agricultural robots or field robots. Therefore, we propose a gripper that uses a magnetically functional fluid for the fingertip and investigated the characteristics. Furthermore, we also employed image processing techniques with the visual sensual camera to extract the contour of objects. This enables us to obtain information such as shapes, centroid, area…which we can use to perform Object detecion using the Raspberry Pi. And in conjunction with the Arduino, we can conduct the automatic grasping for the flexible fingertip robot system.

1 Introduction

Recently, the ongoing research of robot hands and grippers capable of effectively grasping objects with diverse shapes and sizes using flexible materials are becoming more and more important. In this research, we propose a flexible gripper that functions by a magnetic field that can be driven by highly versatile electric energy and a magnetically functional fluid as the flexible material for the fingertip that can be driven by this magnetic field.

Furthermore, to help with the labor shortage problem, we also implemented an automatic object detection program that can accurately make detection despite being interfered with by the background noise. In this research, we focus on verifying the characteristic change of the magnetic functional fluid and specifying that our program can detect the object's features in real-time against environmental interference.

2 Structure of the magnetic flexible fingertip

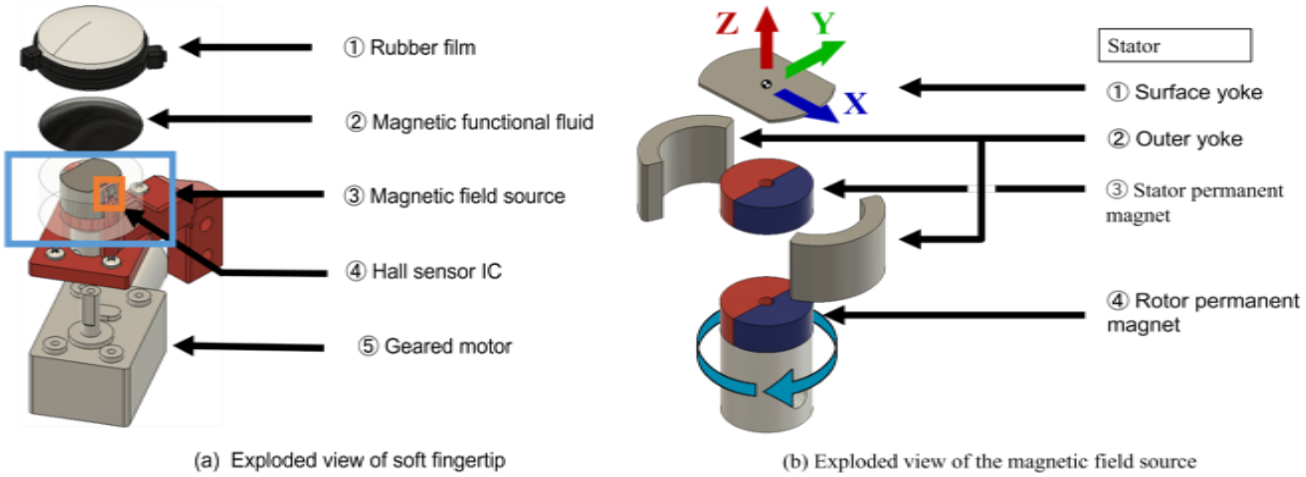


Figure 1: Structure of the soft fingertips

Figure 1 shows the structure of the magnetic flexible fingertip deverloped in this research.

(1) Rubber bags: to seal the injected magnetic functional fluid

(2) A magnetic functional fluid: Using a magnetic compound fluid (MCF) that is a mixture of magnetic fluid and MR fluid.

(3) A magnetic field source constructed using two permanent magnets and a yoke
(4) A hall sensor IC: used to detect the deformation of the magnetically functional fluid
(5) A motor with reducer: that is self-locked by a worn gear so that control can be performed without considering the anti-torque from the rotor side.

3 Object detection by image processing

The first step was to perform noise reduction. In this research we can use the OpenCV and reduce the background noise by turning image from RGB to HSV, then turn it into gray image and use Gaussian Blur function and threshold to reduce noise by separating foreground and the background.

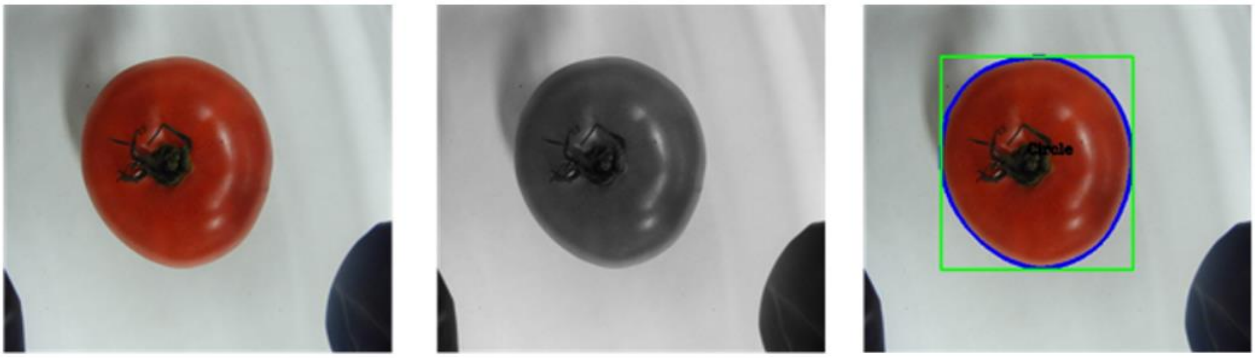
Next, contour detection of the object is performed. After blurring, that results image is used. The Intensity Gradient Magnitude (G) is calculated as follow:

$$G = \sqrt{G_x^2 + G_y^2} \quad (1)$$

The direction (θ) for each pixel is calculated as follow:

$$\theta = tan^{-1}\left(\frac{G_x}{G_y}\right) \quad (2)$$

Here, Gx is the Gradient in the x direction. Gy is the Gradient in the y direction.
Figure 2 shows the results of these processes.



(a) Raw image (b) Gray and blurred image (c) Contour detected image

Figure 2: Image processing from raw image data

4 Conclusion

In this study we created a robot system using a flexible fingertips and automatic detecting by OpenCV image processing. As the results, the following was confirmed:

1. The characteristic, applicability of magnetic functional fluid is verified
2. We had created a program to detect the boundary of object accurately even in the normal condition with background noise to apply for the magnetic flexible gripper.

References

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