DEVELOPMENT OF FLEXIBLE FINGERTIP USING MAGNETIC FUNCTIONAL FLUID

N. Yamashita[1,a], I. Murakami[1,c], Y. Ando[1,b], Long Bui Si[1,d]

[1]*Dept. of Mechanical Science and Technology, Gunma University. 1-5-1 Tenjin-cho, Kiryu. 376-8515, Japan*
[a]t15302114@gunma-u.ac.jp, [b]murakami@gunma-u.ac.jp [c]ando@gunma-u.ac.jp,
[d]t181b063@gunma-u.ac.jp

Abstract. In manipulators, grippers using flexible materials have beendeveloped extensively. By using a flexible material, it is possible to grasp easily breakable objects and objects with different shapes. In this research,we developed two grippers withfingertips thatrespective used two kind of magnetic functional fluid. Then, we checked its performance by making it grasp various objects. This aims to grasp objects of various shapes without breaking them.

1. Introduction

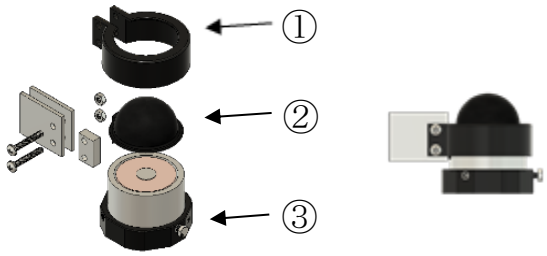
Recently, there are many studies using flexible materials for the gripperattached to the tip of the manipulator. This is because, by using a flexible material for the gripperit is possible to grasp easily breakable objects and objects with different shapes. In addition, by using a flexible material, even if there is an error in the position of the object, the gripper's fingertipscan be flexibly deformed to enable grasping.

In this research, we developed two types of grippers that used two respective types of magnetic functional fluid, namely magnetic fluid and Magnetorheological(MR) Fluid.. In which, a flexible fingertip control by magnetic field is developed and used for gripping. This aims to grasp objects of various shapes without breakage or damage them.

2. The flexible fingertip structure

Fig. 1 shows the structure of the created flexible fingertip. The flexible fingertip consists of ①upper jig, ②rubber bag containing magnetic functional fluid, and ③electromagnet. Here, two types of flexible fingertips were created: one in which magnetic fluid is enclosed in a rubber bag and one in which MR fluid is enclosed.

Next, Fig. 2 shows the structure of the used electromagnet. This electromagnet is installed with a permanent magnet at the center, and when current is applied in the direction to weaken the magnetic force of this permanent magnet (negative direction), the magnetic flux density on the surface decreases. On the other hand, when the current is applied in the direction to strengthen the magnetic force (positive direction), the magnetic flux density on the surface increases. Here, in order to confirm the performance of the electromagnet, the absolute value of the magnetic flux density was measured when the value of the current supplied to the electromagnet was changed at the center of the surface of the electromagnet.The measurement result is,the absolute value of the magnetic flux density was minimum around -2.5 [A], and reached maximum175.3 [mT] at 3 [A].



(a) deal drawing (b) assembly drawing

Fig.1. Strucrure of gripper'sflexible fingertip

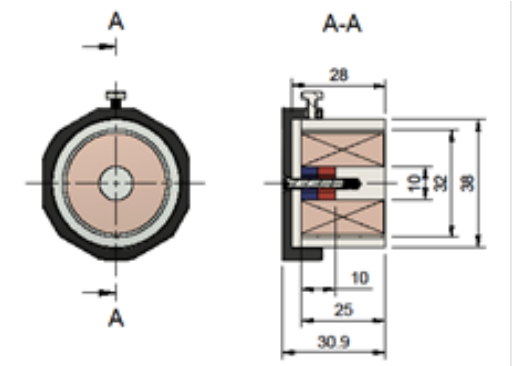
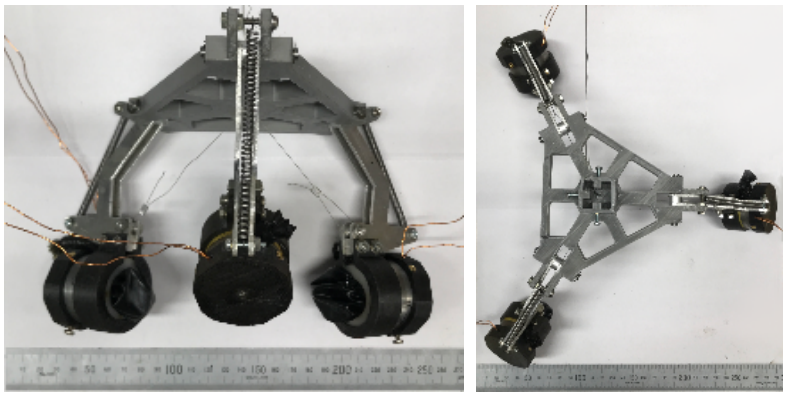


Fig.2. Structure of electromagnet

3. Experiment with robot hand using flexible fingertips

We made a 3-finger gripper using the created flexible fingers. The appearance is shown in Fig.3. An experiment was conducted to confirm whether the developed flexible fingertip cangraspobjects using this gripper. In order to confirm that objects of various shapes can be grasped, we performed gripping experiments of 10 types of objects summarized in Table 1. Fig.4 shows the overview of the experiment.

In this grasping experiment, first, a current of -2.5 [A] was supplied to the flexible fingertip to reduce the magnetic field applied to the flexible fingertip. In that state, it moved on the object and pulled a wire for opening and closing the gripper with a constant force by a motor. Next, after the gripper stopped moving further, the current was switched from -2.5 [A] to 2.5 [A]. Finally, the gripper was lifted, and if the object did not fall, the object was grasped successfully.



(a) Sideview (b) Topview

Fig.3. Gripperusing soft fingertips

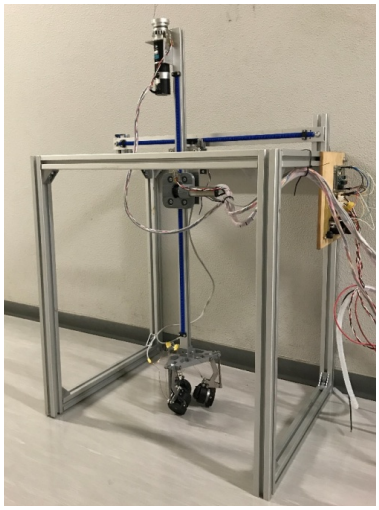


Fig.4. Overview of the experiment

Table 1 Objects gripped by robot hand

	Object Name	mass [g]	Use magnetic fluid	Use MR fluid
(a)	Hard tennis ball	57	○	○
(b)	Soft tennis ball	30	○	○
(c)	Empty plastic bottle	24	○	○
(d)	OPP tape	119	○	○
(e)	Paper cup	5	○	○
(f)	Resin spur gear	180	○	×
(g)	Raw egg	58	○	○
(h)	Strawberry	23	○	○
(i)	1/4 cut squish	280	○	○
(j)	Broccoli	248	×	×

Conclusion

In this research, we have successfully developed fingertips that used magnetic functional fluid.Then, the experiment to investigate the influence of the magnetic fluid and checked its performance by making grippers using those fingertips. It was confirmed that various objects can be lifted using the developed gripper.

References

[1] Brown E., et al. Universal robotic gripper based on the jamming of granular material, *PNAS,* Vol. 107 No. 44 (2010), pp. 18809-18814.

[2] Deimel R., Brock O.A. Compliant Hand Based on a Novel Pneumatic Actuator, 2013 IEEE International Conference on Robotics and Automation, (2013).