# Design of Two-sided Gripper for Bin Picking

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**Abstract**

This paper presents the gripper and system for Bin picking. We have designed a two-sided gripper, which can grab from the inside of the part, and it can also grab from the outside of the part. Our gripper can grab parts with holes by inserting the finers to the holes. This gripper has a wide range of applicability.

*Keywords*: Bin picking, Gripper, Double-sided grabbing, Grab from inside, Various parts.

## 1. Introduction

Bin picking is a core problem in industry automation. The goal is that a robot pick-up known objects with random poses out of a bin using a gripper. Progress of bin picking technology has the good effect in solving the current shortage of labor.

The current bin picking has the following problems. [1] It is common to use one gripper for one kind of part, which will increase the cost. To increase the use in the production of many parts, a gripper which is capable of handling many parts is in demand. This research is dedicated to designing and manufacturing a double-sided gripper that can be applicable to pick up many kinds of parts. This kind of gripper can grab not only from the inside of the part, but also from the outside of the part.

Different parts can be grasped by this new gripper. The gripper can grab objects with hole by inputting the fingertip into the holes. It is effective for pick up only one object from bin. It can grab object of various sizes.

Among the target objects of this experiment, the smallest inner diameter is 6mm, the minimum outer diameter is 9mm, the maximum outer diameter is 62mm. So the target object is all parts with an inner diameter of 6mm or more, or an outer diameter of 9mm-62mm.

The research repeats two phases, design and experiment. We redesign the gripper according to the experimental results. In this way, the problems of the previous design can be found and improved, so that the final design can meet the requirements as much as possible.

## 2. Related works

Several robotic hands have been developed. There are many soft robotic hands been designed.[2] There are also many grippers being manufactured. For example, parallel gripper, biologically inspired grippers, three finger grippers, compliant gripper.[3] The above-mentioned various grippers have a good effect on grasping the target object. Our gripper focuses the object with holes. The part with holes does not refer to a particular part, but a different part with holes. Our gripper has a wide range of applicability.

## 3. Design Gripper

The double-sided gripper is a gripper that can be grabbed from the inside of the finger and the outside of the finger, as shown in Figure 1.

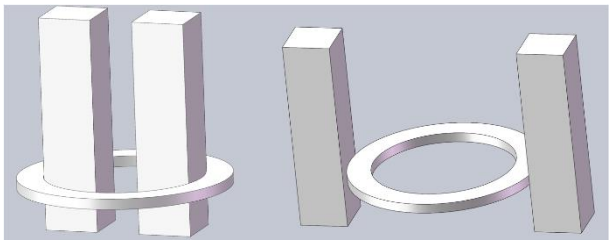

Fig.1. Schematic diagram of double-sided gripper

### 3.1. *Design*

In order to solve the problem of the gripper grabbing various parts, we consider adding the front end to the original shape of the gripper.[4] The design of the front end is for small parts with holes, and it has good performance for small parts. Because of the small design of the front end, it can enter the holes of parts and grab the parts from the inside to ensure that only one part can be grabbed at a time.

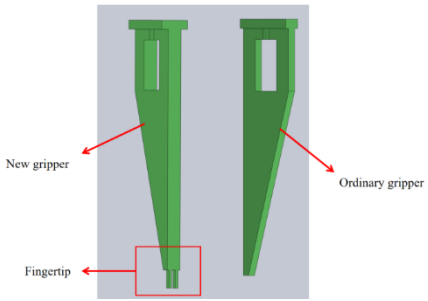


Fig.2. Gripper comparison

We design the structure shown in Figure 2. Compared with general grippers, there is an extra front-end design on the gripper. And the target parts of this research are mainly parts with small holes, so this gripper works well for small parts.
The front-end design has many parameters, such as front-end size, front-end material, front-end quantity, etc.[5,6]

## 4. Experiment

A total of 8 different parts were used in this research, as shown in Figure 3.

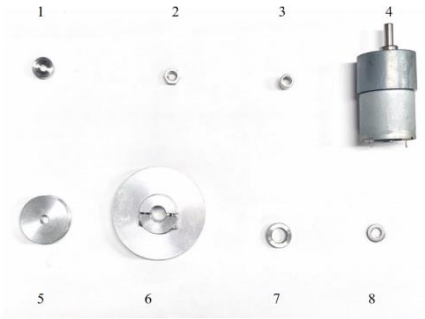


Fig.3. Parts

We tested the performance of 3 different front-ends. Then analyze and improve the design based on the results. Figure 4 is the three front-end models tested in this experiment. The difference between these three models is the size and angle. The front end of model A is 3mm in size. Models B and C are 2mm. Model A is a 60-degree triangular section, model B has no angle, and model C is a 60-degree quadrilateral section.

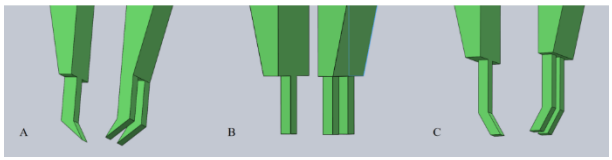


Fig.4. Fingertip model

The real Bin Picking process is tested in the experiment. We put many parts in a messy box and conduct a grasping experiment. As shown in Figure 5.

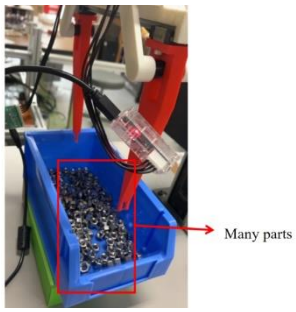


Fig.5. Actual experiment

The experimental results are shown in Figure 6. Four parts are grabbed from outside. The part1 is grabbed by the model C from inside. The other models cannot grab object from inside because the front end is too large to go

deep into the hole. Each part carried out 10 grasping experiments, and the number of grasping was recorded. Success here refers to picking up parts, no matter how many. The average is the total number of crawls divided by the number of times. We analyze the data, take part 1 as an example. The success rate of models A and C is higher than that of model B, and the probability of picking one of model C is higher than that of model A, so for part 1, model C is the optimal model. After analyzing all data, it can be concluded that model C is the best model of them. It should be noted that the best model mentioned here is only a conclusion drawn based on the experimental data, not the final conclusion. Among the experimental results, model B has never succeeded in grabbing part 4, and it can be seen that the angle of front end is important. Because if the finger surface is straight, the part will fall off very easily due to lack of supporting force.

| Model | Parts | Success rate | Average | Grabbed only 1 rate |
|---|---|---|---|---|
| Model A | 1 | 70% | 1.2 | 30% |
| | 2 | 100% | 2.2 | 40% |
| | 3 | 80% | 1.1 | 50% |
| | 4 | 10% | 0.1 | 10% |
| Model B | 1 | 20% | 0.2 | 20% |
| | 2 | 100% | 2.4 | 40% |
| | 3 | 50% | 0.8 | 30% |
| | 4 | 0% | 0 | 0% |
| Model C | 1 | 70% | 0.9 | 60% |
| | 2 | 90% | 1.4 | 50% |
| | 3 | 60% | 0.6 | 60% |
| | 4 | 50% | 0.5 | 50% |
| | 1 (inside) | 50% | 0.5 | 50% |

Fig.6. Actual experiment date

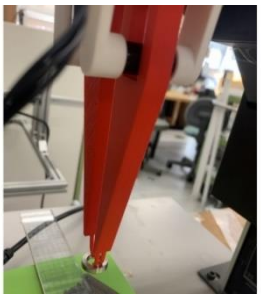

Fig.7. Grab from the inside

The size of the front end was too large, which prevented it from extending into the holes of many parts. Because the gripper is made of resin, the model below 2mm cannot be manufactured, so the experiment of grasping from the inside only tested the No. 1 part. Grabbing from the inside is shown in Figure 7.

### 4.1. *Improved front end*

Through experiments and improvements, We solved the problems that appeared before and designed a model as shown in Figure 8. In order to make a smaller front end and ensure strength, we changed the material. The material of the metal is SUS303. The size of the front end is 2mm, 2mm, 1mm. The size of the front end also has a gradient reduction, and the smallest place is 1mm. This way even the smallest hole with an inner diameter of 6mm can be entered. And there is enough contact area when grabbing large parts. Quadrilateral with an angle of 60 in section. The smallest positions are rounded on the outside of the front end. This helps to secure the parts.

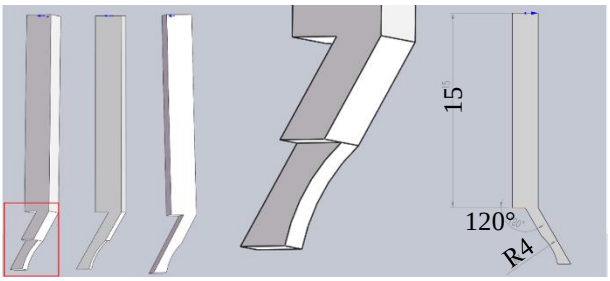


Fig.8. Fingertip design

This new model can grab all parts from the outside and all parts with holes from the inside. And the comprehensive success rate can reach 80%. Success here means grabbing 1 part. As shown in Figure 9, it shows how this model grabs the smallest part from the inside and the heaviest part from the outside.

Fig.9. Gripper grabs parts

## 5. Conclusion

In this research, we designed a gripper that can hold various objects. This gripper can be gripped inside and outside the gripper. This gripper can grab small parts.

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## Authors Introduction


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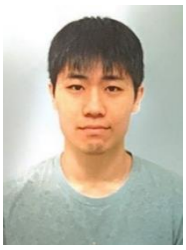

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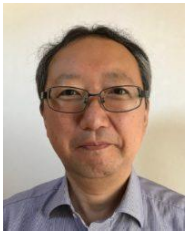

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