Speedup of System to Fold T-shirt in the State of Hanging

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Abstract

In this paper, we describe the automatic folding system of T-shirt that was developed and improved. This system, take out the T-shirt on the hanger rack in automatically, and it will detect whether the T-shirt is dry or not. After that, the T-shirt is removed from the hanger, and fold. So, we can fold the T-shirt without removing hanger. We just hang T-shirt that state took on the hanger. After the T-shirt has been folded, it will be put away, and the hanger will be recovered. We improved the speed of operation of system in this time. So, system was able to fold T-shirt more quickly. With this system, it will be able to alleviate some of the burden of housework.

Keywords: folding the laundry, folding system, motor

1. Introduction

Housework is one of tough jobs. Not only that, we must do it every day. We can't live comfortably without doing housework. In the case of a single life, you have to do that as well as your work. On the other hand, if you have a large family, amount of housework become enormous. There are a great number of household tasks such as cleaning the room, washing the dishes, and doing the washing ⁽¹⁾ ⁽²⁾. Previously, housework has been done manually. However, as a result of appearance of Dishwasher, Vacuum cleaner, and Washing machine, we can conveniently save trouble. Nevertheless, the machine which folds the laundry automatically has not prevailed among the ordinary homes. Even today, folding the laundry is a manual labor.

There are several items to fold the T-shirt⁽³⁾. For instance, Quick-Press sold by Daisaku Shoji Ltd. is item which make folding T-shirt easier. Although folding T-shirt

became easier, it is manual procedure all the same. The folding machine which works automatically exist, however, it is not automatic completely because it needs to put a T-shirt on it manually. There are two machines with function to fold T-shirt. However, one of them needs specific hanger which is expensive and complicated as many as the number of T-shirt. Another can fold a T-shirt hung on a hanger. However, owing to its mechanism to fold, some T-shirt can't be folded by this machine. Besides, these machines does not detect whether T-shirt is dry or not. Consequently, they needs some help by human to start folding.

So, we developed a system which folds the laundry automatically before. Furthermore, it can detect whether the T-shirt is dry or not, while the T-shirt is hung on a hanger. The system can fold T-shirt precisely because it places the T-shirt on the table when it folds the T-shirt. All things that user have to do is only hanging washed T-shirt on a hanger.

This time, we have improved the speed of the system. The concept of the system, it is possible to separate the work while the system is folding T-shirt. For that reason, folding speed might seem so as not to worry too much. But it takes 2 minutes and 30 seconds in folding of a T-shirt before. So, it was too time-consuming. For example, when another work was finished, folding may not be finished. So, we must confirm each time whether folding was finished. There is a difference between free time left no tasks and free time left works.

Even looking at the operation of the system, there is no problem to operate some mechanism at the same time, and it can be expected to the speed improve by changing the parts. We improvement based in those point. As a result, system has be able to fold T-shirt more quickly and more efficiently.

Fig. 1. Overall view of the system.

Fig. 2. System operation procedure.

2. System to Fold T-shirt Automatically

2.1 System overall view and the operating procedure

The overall view of the system after improvement is shown in Fig. 1. In Fig.1, the right side is rotary hanger rack part, and the left side is folding T-shirt robot part. The user hangs T-shirt on the rotary hanger rack. This system operates in the procedure as shown in Fig. 2. This

Table 1. Relationship between the operation procedure and the improved mechanism

Operation of the system	Improved mechanism with relationship
Remove the hanger from the rotary hanger rack	Rotary hanger rack
Move the hanger into a single hanger rack of the robot body	Take out hanger mechanism
Check if T-shirt is dry	Hanger mobile device, Lifting and lowering device
Put a T-shirt on the folding apparatus	Hanger mobile device, Lifting and lowering device
Remove the hanger from the T-shirt	Hanger mobile device, Lifting and lowering device
Fold the T-shirt	Lifting and lowering device, Folding device
Post-processing	H-bot ⁽⁴⁾

procedure is not changed from the previous. As shown Table 1, the relationship between the operating procedures and the mechanism that we have improved the system. From here, along with the operation procedure shown in Figure 2 and Table 1, we will describe improvements.

2.2 Improvement of rotary hanger rack part

We describe about improvement of rotary hanger rack part that is the right side of the system. So, related mechanisms are rotary hanger rack and take out hanger mechanism.

In rotary hanger rack, we have changed motor driver which controlling to rotation of the DC motor. We have changed motor driver “TA7291P” to “VNH2SP30”. As a result, current can flow to the motor driver have become 14A. So, the rotational speed of the DC motor and hanger rack is raised.

The mechanism that takes out the hanger on a rotary hanger rack, and carrying the hangers to be folding mechanism was changed pulley for winding the wire. By increasing the diameter of the pulley, it can be moved faster mechanism. The pulley was made sandwiching pillars in aluminum plate as shown Fig. 3. The diameter of the pulley is about 105mm. The diameter of the previous pulley was about 75mm. So, the size of the pulley became about 1.5 times.

(a) The fabricated pulley.

(b) The difference between the diameter

Fig. 3. The attached pulley.

2.3 Improvements in the T-shirt folding robot part

We describe about improvement of folding T-shirt robot part that is the left side of the system. So, related mechanisms are hanger mobile device, lifting and lowering device, folding device, and H-bot⁽⁴⁾.

In hanger mobile device, it changed waiting position to near the hanger. By this, it shortened the time to catch the hanger.

In lifting and lowering device, we have changed motor driver “TA7291P” to “VNH2SP30”. It because motors move some of the weight, it needs a large current. So, we changed motor driver as shown Fig.4.

The operation of their mechanism, in previously, when

(a) TA7291P

(b) VNH2SP30

Fig. 4. Changed motor driver.

remove the hanger, the lifting and lowering device and hanger mobile device were separately driven. In this improvement, the folding device can rise while the hanger mobile device is driving. The hanger was removing while folding device is rising.

Similarly, when folding the T-shirt, the folding device and lifting and lowering device were separately driven. So, we rewrite the program of the control microcomputer. T-shirt was folded at the time of lowering the folding device.

In H-bot, it had pulled the rope using pulleys for move the folding device in the horizontal direction. But the rope was pulled at friction with the pulleys. In this time, as shown Fig.5, the wire was fixed instead of rope. Additionally, we have changed the parts to the pulley of

(a) Wound wire

(b) The difference between the diameter

Fig. 5. The changed pulley and wire.

larger the diameter. In terms of actual size, the diameter of the pulley has become 75 mm from 50mm. As a result, folding device can be moved more quickly.

Separate from the speed improvement, however, we changed servo motor of using folding system to have larger torque. By this change, the folding system can fold things somewhat heavy.

3. Experiment

We checked the performance of the system. We measured the time that takes to fold. The measurement was start when the lift detected the hanger on the rotary hanger rack. The measurement was end when the system returns to the initial state after finishing folding the T-shirt.

4. Result of the experiment

As a result of the experiment, the time takes about 2 minute and 30 second in previous, became about 1 minute and 20 seconds to fold one T-shirt. In other words, the time for folding T-shirt became about half. So, we can fold the T-shirt at twice the speed.

5. Conclusions

We have improved the system speed of operation. As a result, the system can fold many of the T-shirt in a short time. So, efficiency of the system has become better and practicality has increased.

However, problem is still left. From now on, we will improve the system to it can fold the many types of laundry. For that, we will improve the mechanism for removing the hanger from the laundry and folding mechanism for the laundry other than T-shirts.

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