Development of Automatic Trash System of Pet Litter Sheet

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Abstract: In recent years, the number of people owning pets has been increasing. Currently, many zoonotic diseases exist, and zoonotic infections can be contracted from pets. Since one of the routes of infection has been confirmed to be through excrement, we have developed a device that automatically folds pet sheets. This system consists of seven servomotors. The system folds the pet sheets along the creases and disposes of them in the trash. First, the left and right sides of the pet sheet are folded, then the top and bottom are folded. Finally, the pet sheet is carried to the trash can for disposal. This allows pet owners to dispose of their waste without touching the pet sheets, thus preventing zoonotic diseases. We conducted an experiment on the disposal of pet sheets containing urine and feces and found that the success rate was 96.7%.

Keywords: Zoonosis, Pet sheet, Animal excrement,

1. Introduction

In 2020, WHO declared COVID-19 pandemic and the number of infected and dead is increasing every day [1]. Human beings have been fighting against various infectious diseases, including SARS and Ebola, and there are more than 200 types of infectious diseases known by the WHO [2]~[4]. There is a high possibility that new animal-derived infections will occur in the future. According to the National Survey of Dog and Cat Breeding by the Pet Food Association of Japan, as of October 2020, the number of dogs raised was about 8.489 million and the number of cats raised was about 9.64 million, indicating that many animals live together [5]. Preventive measures are very important to prevent animal derived infections from spreading in these situations. There are several causes of infection, but we paid attention to the causes of infection when pathogens in excrement are blown up by the wind and inhaled [6]. To prevent infection, the Ministry of Health, Labour and Welfare recommends that excretion be disposed of promptly [7]. However, it is too burdensome to dispose of them every time they are excreted, and excreted. In addition, the method of defecation disposal for assistance dogs for the visually impaired and the elderly who need guide dogs or service dogs is difficult, as it requires the dogs to pick up the used pet sheets or to pull them up with a string attached to the pet sheets in advance. When excrement is disposed of in the above ways, feces may fall out when being picked up [8]. There, a product called brilliant pads that can automatically dispose of excrement is on sale [9]. As the product can be excreted by winding the roll every fixed time when excreted on a roll-like sheet, it is a very innovative product. However, excrement remains unwound until the roll is used, and large excrement cannot be handled, leaving a variety of problems,

Figure 1: Constitution of system.

such as the lack of excrement within a certain range of the sheet.

Therefore, we developed a system that automatically folds up pet sheets and throws them away when you press the button. The system folds pet sheets one by one and throws them away in the trash can, so once excreted, they can be disposed of in the trash can without remaining. Furthermore, since it is folded like a human being and disposed of, it can be disposed of wherever it is excreted.

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Figure 2: System movement.

2. Automatic Trash System of Pet Litter Sheet

Figure 1 shows configuration of the device in this study. Fig. 1(a) is a front view and Fig. 1(b) is a side view. In addition, movable part 1 to movable part 7 in Fig. 1 are parts operated by servo motors.

A user puts the pet sheet on the system as shown in Fig. 2(a), and when a start button is pressed, the pet sheet is automatically folded and thrown into the trash can. A pet sheet is folded according to the procedure shown in Fig. 2. The system fold pet sheet by folding movable part 1 about 140 degrees as shown in Fig. 2(b). After returning movable part 1, fold movable part 1 down to 90 degrees again to prevent the pet sheet from slipping. Fold the pet sheet over about 140 degrees as shown in Fig. 2(c). After restoring Movable part 2 to its original position, lower movable part 2 to 90 degrees again. To make it easier to fold, tilt Movable part 3 20 degrees as shown in Fig. 2(d). Folding of the cen-

ter is performed as follows. Fold movable part 4 about 145 degrees as shown in Fig. 2(e) and fold the pet sheet. A front view at that time is as shown in Fig. 2(f). Since the pet sheet absorbs and inflates urine, fold movable part 5 150 degrees instead of returning movable part 4 as shown in Fig. 2(g). A front view at that time is shown in Fig. 2(h). After holding the pet sheet in 5, put movable part 3 and movable part 4 back together. In order to throw away the pet sheets to movable part 6 of Fig. 2(i). In order to prevent the pet sheet from being shifted, stop it once at an angle where the pet sheet becomes vertical by pinching it between movable part 5 and movable part 7 as shown in Fig. 2(j). Then, move the pet sheet to movable part 6 as shown in Fig. 2(k). Tilt Movable part 6 outward as shown in Fig. 2(m) to prevent the pet sheet from falling. At that time, movable part 7 is returned to a vertical position so that the pet 6, return movable part 7 to its initial position. Move on to throwing away

Figure 3: Placement where shit falls.

pet sheets. As pet sheets need to be brought higher than the trash can, lift movable part 6 to a vertical position in movable part 3 as shown in Fig. 2(n). At that time, raise the angle of movable part 6 at the same time to prevent the pet sheet from falling. When lifted up to the vertical position, return the angle movable part 7 to the initial position as shown in Fig. 2(o) and throw the pet sheet away in the trash can. Finally, return movable part 3 to the initial position as shown in Fig. 2(p) and finish the operation.

However, when the feces are installed as shown in Fig. 3, feces may spill outside the device when the pet sheet is folded on both sides as shown in Fig. 2(b) and Fig. 2(c).

To prevent this, a fence is attached to prevent it from falling as shown A in Fig. 1(b). As with conventional pet sheets, toilet training is required for this device.

3. Prototype

This section describes the prototype that realizes the system described in Chapter 2. Figure 4 shows an overall picture of the manufactured system. The size of this system is approximately $400\text{W} \times 300\text{D} \times 70\text{H}$ (mm). This system consists of servomotors in Success rate of soft stools movable part 1 to 7. Movable part 3 uses S777FCG/6BB from GWS. For others, S03T2BBMG from GWS was used. Details of each are shown below. A servo motor is arranged as shown in Fig. 5(a). A range of movement of the servo motor is set to 0-140 degrees so that the aluminum plate moves toward the center. As shown in Fig. 5(b), movable part 1 is inverted left and right, and movable part 3 is arranged with servo motors as shown in Fig. 5(c). An arm of about 300 mm is attached and a servomotor is installed at the tip in order to assume the function of putting the pet sheet in the trash can. A moving range of the servo motor is set to 0-90 degrees. Because a load is applied to the servo motor, a servo motor having a large torque is used. Figure 5 Shows the way Movable part 4 is positioned in the servo motor. A range of movement of the servo motor is set from 0 degrees to 145 degrees so that the aluminum plate moves toward movable part 7. In movable part 5 and movable part 6, servo motors were installed as shown in Fig. 5(e). In movable part 5, the range of movement of the servomotor is set from 0 degrees to 150 degrees so that the arm moves toward movable part 7. In

Figure 4: Prototype unit.

Fig. 2(l), the range of movement of the servo motor is set from 0 degrees to 155 degrees. A servo motor is arranged as shown in Fig. 5(f). A range of movement of the servo motor is set from 0 degrees to 150 degrees so that the aluminum plate moves toward movable part 6.

Operation of this prototype machine is shown in Fig. 6.

First, a pet sheet is placed as shown in Fig. 6(a). The pet sheets were wet by yellow water in place of urine. At the start of the operation, the left side of the pet sheet is folded as shown in Fig. 6(b) and the right side as shown in Fig. 6(c).

A pet sheet is inclined as shown in Fig. 6(d), the front side of the pet sheet is folded as shown in Fig. 6(e), and the back side is collapsed as shown in Fig. 6(f) and folded. A pet sheet is moved to the back as shown in Fig. 6(g), and the pet sheet is held as shown in Fig. 6(h). Lift the pet sheet to the vertical position as shown in Fig. 6(i). Then throw the pet sheets away in the trash can. The pet sheet in the trash can is shown in Fig. 6(j).

4. Experiment

Practicality of this system was confirmed through experiments. Because excrement contains urine and feces, the following two experiments were conducted.

Further, success or failure is judged by whether or not the pet sheet is put in the trash can properly.

4.1 Urine Healthy dogs urinate 24-41 ml per kilogram per day, and adult dogs urinate 3-4 times per day [10][11]. The prototype was designed for small dogs, so if the weight of the small dog is calculated as 5 kg, the amount of urination at a time is approximately 40 ml. Thus, as shown in Fig. 7, in order to take into account, the change in urine volume, we conducted experiments with three patterns: small volume, moderate volume, and large volume. A small amount of urine is 20 ml, a moderate amount is 40 ml, and a large amount is 60 ml, which were reproduced using colored water. As shown in Fig. 8, the pet sheet is divided into nine equal parts, colored water in place of urine is applied to each position, and the sheet is folded five times at each position by the above device. Table 1 shows the suc-

Figure 5: Servo layout.

cess rate at each position when the urine volume is 20 ml, Table 2 shows the success rate at each position when the urine volume is 40 ml, and Table 3 shows the success rate at each position when the urine volume is 60 ml. All urine experiments were successful.

4.2 Wastes As a result of investigating the shape of feces, it can be classified into three types: bale, stick, and soft feces.

Thus, we conducted an experiment using clay and slime to reproduce the above three patterns as shown in the Fig. 9.

Feces can be excreted in all areas of the pet sheet as well as urine. Taking into account the possibility of feces being caught in the folds of the pet sheet, we established a pattern in which feces were defecated in 25 locations, as shown in the Fig. 10 below, and conducted a total of 300 experiments, 4 times each. Since feces from a pleasant defecation could be directed in various directions, the experiment was divided into four directions and conducted once in each direction as shown in the Fig. 11. Table 4 shows the success rate at each position for bale shaped feces, Table 5 shows the success rate at each position for stick shaped feces, and Table 6 shows the success rate at each position for soft feces. According to Table 4, bale shaped feces was 96% successful; according to Table 5, stick shaped feces was 94% successful; and according to Table 6, soft feces was 100% successful. Thus, the overall success rate of feces is 96.7%.

5. Consideration

According to Table 1 to Table 3, the success rate of treating pet sheets containing urine was 100%, which is sufficient for practical use. Also, according to Tables 4 to 5, the success rate for feces is 96.7%, which is considered to be sufficient for practical use. The breakdown of failures for bale droppings was 3% for falling pet sheets and 1% for dropping feces. The failure rate of stick-shaped feces was 3% for dropping pet sheets and 3% for dropping feces. Of these, the dropping of feces was due to the recoil of the impact caused by the distortion of the body due to excessive use of the device.

As shown in Fig. 12, depending on the position of the feces, it could not be folded neatly.

The time required for each operation was 45 seconds, indicating that the process can be performed quickly.

6. Conclusion

In this study, an automatic folding system for pet sheets was developed. In the developed robot, the operation from folding the pet sheet to disposal is automatically performed by pressing a switch. Consequently, since a user can discard the pet sheet without touching the pet sheet, the risk of infection to an infectious disease originating from an animal can be greatly reduced.

From now on, we aim to add functions such as automatically detecting and folding excrement using a camera, automatically installing pet sheets, taking pictures of excrement

Figure 6: Movement was completed.

with a camera installed to check the condition of excrement,

Figure 7: Each volume of urine.

Figure 8: Position of feces.

Figure 9: Feces shape.

Figure 10: Position of feces.

and attaching them to emails.

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Figure 11: Direction of feces.

Figure 12: Defective pattern.

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