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Test and Evaluation for the Autonomous Multi-Zone Navigation Coverage Test in IEC 62885-7

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Abstract: The definition of a cleaning robot is an automatic floor cleaner that operates autonomously without human intervention in a defined area. The definition of a household cleaning robot is a cleaning robot that only removes non-liquid materials from the floor using methods other than using a solution or a liquid. Currently, IEC TC59 SC59F WG5 is working to establish standards for the performance evaluation of such household cleaning robots. And in 2014, IEC 62929, the standard for household cleaning robots, was released. IEC 62929 is a standard that includes a test item for evaluating the suction power and autonomous driving performance of a cleaning robot. IEC 62885-7 is the second edition of IEC 62929, with additional test items being discussed. In this paper, in order to evaluate the performance of home cleaning robots, I propose the test results and the method for improving the test performance of the autonomous evaluation items.

Keywords: Cleaning robot, IEC 62929, IEC 62885-7, Performance Evaluation

1. INTRODUCTION

In 2001, the cleaning robot was developed by Electrolux, a Swedish consumer electronics company, with the launch of Trilobite, the world's first cleaning robot. The first cleaning robot attracted attention as an innovative product that allows people to clean completely and automatically from obstacles without being manipulated. However, it was difficult to form a large market due to the high price, but since 2003, the market for cleaning robots has begun to expand rapidly. The need for a performance evaluation method for cleaning robots has been raised by the growth of these cleaning robots. IEC TC59 SC59F WG5 was enacted in 2009 by IEC 62929 ed.1.0, and official cleaning robot performance evaluation standard was established[1]. Currently, cleaning robot companies from all over the world are actively participating in the enactment of IEC 62885-7 ed.1.0, ed.2.0 version of IEC 62929. In this meeting, cleaning robot test items reflecting opinions of companies are being discussed, and one of them is Autonomous Multi-Zone Navigation Coverage Test. The evaluation items to be covered in this paper are not the items to be enacted in IEC 62885-7 ed.1.0, but they are expected to be discussed again since they are important items for evaluating the navigation performance of cleaning robots. From this point of view, research on this evaluation item is deemed necessary. In this paper, we propose test results and performance improvement methods for Autonomous Multi-Zone Navigation and Coverage Test evaluation items.

2. Navigation Performance test

In the existing IEC 62929 ed.1.0, an item for evaluating the self-propelled performance of the cleaning robot has been established in the Autonomous Navigation and Coverage Test item[2]. The Autonomous Multi-Zone Navigation and Coverage Test items are test methods for evaluating the reachability of a cleaning robot in a room with furniture, such as a table. This evaluation item can evaluate the autonomous running performance of the cleaning robot for one room, but the cleaning robot can not evaluate the performance or performance of the robot in several rooms. Therefore, IEC TC59 SC59F WG5 discussed the Autonomous Multi-Zone Navigation Coverage Test items which can evaluate the autonomous driving performance of cleaning robots by simulating the general home environment with doors and rooms. It seems likely to be included in IEC 62885-7 ed.2.0.

3. AUTONOMOUS MULTI-ZONE NAVIGATION COVERAGE TEST

3.1 Testbed

This test is a test item for measuring the autonomous driving performance and reaching rate of a cleaning robot moving between a room and a room in a general home environment with doors and a room.

Partition walls and curtains are installed in the test site of the existing IEC 62929 ed.1.0 Autonomous Multi-Zone Navigation and Coverage Test testbed and converted to multi-zone form to install the test site.

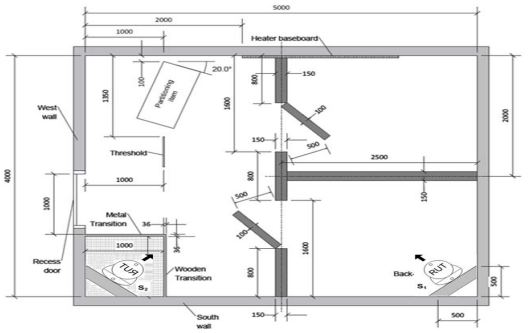

Fig. 1 Testbed

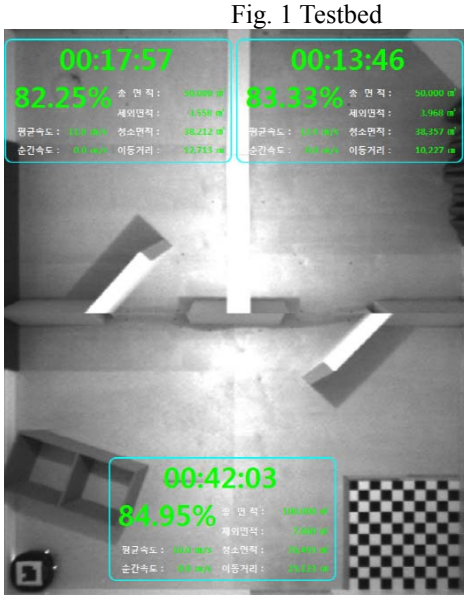

Fig. 2 VTS

3.2 Test procedure

First of all, clean the robot so that dust and dirt do not remain on the floor of the test area so that it does not interfere with the self-running of the robot. Then, at the start of the evaluation run, make sure that the cleaning robot is well aligned with the starting position. Tracks and records area ratios that the cleaning head has passed during the evaluation run time using VTS. The maximum test time is 120 minutes. Three evaluation runs are made at each starting point, and the average value is the result. Also, VTS stands for Visual tracking system to track robot position and direction.

3.3 Determination of performance

The factor that determines the autonomous performance of cleaning robot is coverage. The penetration rate is determined by the ratio of the area passed through the cleaning head of the robot at least once to the area of the test site excluding furniture and partitioning wall, and the unit is percentage. The coverage is calculated with below equation.

$$C(\text{Coverage}) = \{A(t) / A\} \times 100$$

where C is coverage, A is area of testbed, A is area of testbed, and A(t) is the area that cleaning robot pass through in the testbed.

4. TEST RESULTS

4.1 Coverage results

The values shown in Table 1 show the results of the autonomous test run.

In fact, the driving algorithm is of course the most important factor for evaluating the self-propelled performance of a cleaning robot.

	S1	S2	Average
A	85.78	87.81	86.79
B	83.76	83.75	83.75
C	73.60	75.14	74.37
D	71.30	77.89	74.59
E	80.62	79.65	80.13
F	74.68	68.29	71.48
G	85.78	92.58	89.18
H	71.67	2.05	36.86
I	74.45	72.76	73.60
J	81.21	80.66	80.93

Table 1 Results of the tests

4.2 Finding

The point of analysis in this test result is to focus on the suction port of the cleaning robot. The cleaning robot equipped with the largest suction port is the product of company A, but the reach rate is the second among all products. On the contrary, the cleaning robot of G company having the second largest suction port showed the first reaching rate. These results suggest that the size of the product inlet does not simply determine the coverage to determine autonomous driving performance. In short, the performance of the Autonomous Multi-Zone Navigation and Coverage Test of the cleaning robot is evaluated as an important factor affecting not only the autonomous driving performance but also the size of the intake port.

(unit : mm^2)

	A	B	C	D	E
Area	11470	6498	4577	9975	5800
	F	G	H	I	J
Area	7200	10471	5964	720	5208

Table 2 Area of cleaning head

4.2 Analysis

I want to analyze why the products of company G show better results than those of company A. First, the difference in size of the suction port of the cleaning robot is about 91% of that of the A company. The suction port of the cleaning robot of company A is

located at the center, while the inlet of the company G is located at the left side of the cleaning robot, and the clearance (x) between the outside of the product and the outside of the inlet is close. For this reason, it seems that the cleaning robot of Company G is superior to the cleaning robot of Company A. Currently, the decision of IEC TC59 SC59F WG5 is that Autonomous has agreed that the area of the cleaning robot intake, not the size of the entire cleaning robot, is a factor that determines the reachability performance of the cleaning robot in order to evaluate the reachability of the cleaning robot. In this paper, prior to this test, A company's products had the largest inlet size and expected to show the best test results, but the results showed the highest G results. As mentioned earlier, when the suction port of the cleaning robot is measured at the penetration rate, G will actually have a shorter x than A's x, so that the edge, wall, partition wall, access. Of the 10 products actually tested, nine are located at the center of the product, while the left product is the only product. For these reasons, G products seem to have the best results.

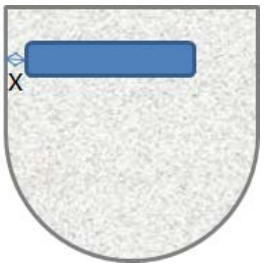

Fig. 3 Distance between cleaning head and outside

4. CONCLUSIONS

It is clear that the autonomous navigation algorithm of the cleaning robot is the most important factor that determines the coverage performance. However, through this experiment, it was found through analysis that not only the self - running algorithm of the cleaning robot but also the size of the intake port of the cleaning robot and furthermore, the position of the intake port of the cleaning robot is an important factor showing the achievement rate. As we have analyzed in this paper, it is important to improve the efficient algorithm of the cleaning robot to improve the reaching performance of the cleaning robot, but it is helpful to consider the size and position of the intake port proposed in this paper.

REFERENCES

[1] S. Moon, S. Rhim, et. Al., “Summary of recent standardization activities in the field of robotics,” Vol. 31, No. 2, pp. 217-224, 2013.

[2] IEC 62929 ed 1.0, Cleaning robots for household use – Dry cleaning : Methods of measuring performance, July 2014