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Performance Evaluation Methods of Mobile Household Robots

(IEC 62849:2016, IDT)

家用移动机器人性能评估方法

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Performance Evaluation Methods of Mobile Household Robots

1 Scope

This Standard specifies the performance test and evaluation methods for the common characteristics of mobile household robots.

This Standard applies to various mobile household robots.

This Standard does not address safety and performance requirements.

2 Normative References

The following documents are essential to the application of this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 34454-2017 Dry cleaning robots for household use - Methods of measuring performance (IEC 62929:2014, IDT)

ISO 554 Standard atmospheres for conditioning and/or testing – Specifications

ISO 2768-1:1989 General tolerances – Part 1: Tolerances for linear and angular dimensions without individual tolerance indications

IEC TS 62885-1 Surface cleaning appliances – Part 1: General requirements on test material and test equipment

3 Terms and Definitions

For the purposes of this Document, the following terms and definitions apply.

3.1 Household robot

Actuated mechanism with a degree of autonomy, operating within the household and similar environment, to perform intended tasks.

NOTE: Operating includes travel and/or robot body movement.

3.2 Mobile household robot

Household robot able to travel under its own control.

3.3 Capability of homing function

Capability of a mobile household robot to return to the charge station(s) for charging or after completion of the work task or called by user.

3.4 Pose

The combination of position and orientation.

3.5 Autonomous mode

Mode set by user where the robot travels horizontally with no user interaction.

3.6 Manual mode

Mode set by the user where the robot travels with intermittent or continuous user interaction.

4 General Conditions for Testing

4.1 Conditions prior to testing

The robot shall be completely assembled and fully operational in accordance with the manufacturer's instructions. All necessary leveling operations, alignment procedures and functional tests shall be satisfactorily completed.

Prior to conducting any series of tests, the age, condition, and history of the product shall be recorded.

NOTE: Condition information can include model number/name, software version, and accessories used, if available.

4.2 Operating and environmental conditions

4.2.1 General

The performance characteristics determined by the related test methods in this Standard are valid only under the environmental and normal operating conditions as stipulated by the manufacturer.

4.2.2 Operating conditions

All tests shall be carried out under conditions in which the mobile household robot is operated in normal use; the normal operating conditions used in the tests shall be in accordance with the

manufacturer's instructions.

Performance will be affected by the installed software. Therefore installed software shall not be modified or changed during a set of tests.

4.2.3 Atmospheric conditions

Unless otherwise specified, the test procedures and measurements shall be carried out under the following atmospheric conditions (in accordance with ISO 554):

Temperature: $(20 \pm 5) ^\circ\text{C}$

Air pressure: 86 kPa ~ 106 kPa

Temperature and humidity conditions if provided shall be aligned with manufacturer's instruction for good repeatability and reproducibility. Care should be taken to avoid changes during a test.

4.2.4 Lighting conditions

Unless otherwise specified, the test procedures and measurements shall be carried out under the following lighting conditions:

Intensity: (200 ± 50) lux

Color temperature: 2 000 K ~ 6 000 K

Measurement shall be made at the test surface.

4.3 Test equipment and materials

Measurements on carpets shall be carried out on a level floor consisting of a smooth untreated laminated pine tree plate or equivalent panel, at least 15 mm thick and of a size appropriate for the test.

Equipment and materials for measurements (devices, test carpets, test dust etc.) to be used in a test shall, prior to the test, be kept for at least 16 h at standard atmospheric conditions according to 4.2.3.

4.4 Number of samples

All measurements of performance shall be carried out on the same sample(s) of the robot with its attachments, if any.

Tests carried out to simulate stresses a robot may be exposed to during normal use, possibly causing impairment of the robot performance, may require additional samples of replaceable parts. Such tests shall be carried out at the end of a test programme.

This mode shall enable the robot to perform a repeatable test mode action in which it shall be driven forward 1 000 mm and turned 90 degrees 4 times in order to form a single loop. This test shall be carried out in clockwise and anticlockwise loop as shown in Figure 1. The precise nature of access to the test mode shall be clearly stated by the manufacturer and it should be simple to execute. Once the test mode operation is completed it should leave the machine in an idle state.

NOTE: Examples of access methods to the test mode could be to require the user to have a combination of buttons on the machine pressed when the robot is switched on, or for a combination of buttons to be held for a period of time which would not occur during normal robot operation. The only condition is that this access method is to be documented.

6.3 Test method

The fully charged robot with test mode shall be placed at the starting position as shown in Figure 1. The body center of robot shall be on top of the starting point, and the robot body shall be aligned along the direction of travel. Clockwise and anti-clockwise operation commands shall be given to robot to follow the commanded paths individually as shown in Figure 1.

After the operation has been performed, the deviation (position and orientation) between actual pose and the commanded pose of the robot shall be measured. A single test for each operation (clockwise or anticlockwise) consists of three runs.

The floor material used shall be reported in the test report.

NOTE: If the test mode which is to generate the motion required for the test is not readily available in the robot the test can be skipped.

The average deviation of the position dP for the trial shall be calculated from the three runs, see Formula (1):

$$dP = \frac{1}{3} \sum_{n=1}^3 dP_n \quad \dots\dots\dots (1)$$

Where:

dP_n - is the deviation of position from the n th run, $n= 1,2,3$

dP - is defined as the distance between body centre and starting position after run.

The average deviation of the orientation dA for the trial shall be calculated from the three runs, see Formula (2):

$$dA = \frac{1}{3} \sum_{n=1}^3 dA_n \quad \dots\dots\dots (2)$$

Where:

operation time as t_{work} and the chosen operation mode.

The robot shall be fully recharged according to the manufacturer's instruction. The corresponding a.c. energy consumption shall be recorded as E_{work} .

The operation time per single charge is calculated as per Formula (5):

$$T_{\text{max}} = (E_{\text{max}} / E_{\text{work}}) \times t_{\text{work}} \dots\dots\dots (5)$$

Where:

T_{max} - is operation time per single charge;

E_{max} - is the corresponding a.c. energy consumption for robot from completely discharged to fully charged;

E_{work} - is the corresponding a.c. energy consumption for robot from fully charged to completely discharged after each run;

t_{work} - is the total operation time for each run.

Three runs shall be carried out, and the average shall be considered as the result of the operation time per single charge.

NOTE 2: This calculation is based on assumption of linear relationships for charging behavior.

NOTE 3: Although this test method is only defined as single test, the tester, may perform more than 1 test.

NOTE 4: Due to tolerances of the measurement if $E_{\text{work}} > E_{\text{max}}$, then set $T_{\text{max}} = t_{\text{work}}$.

9 Managing a Single Step

9.1 General

The purpose of the test is to determine the robot's management of a single step whilst moving during activities. The mobile robot shall be moving throughout the test time and it is permitted to restart the robot to encourage movement when terminated because of its function. Other possible tasks (e.g., air purifying without movement) are not understood as movement and the time for these tasks are not included to the overall test time.

NOTE: The tester is allowed to restart the robot to encourage movement if necessary.

9.2 Test bed

The test bed is shown as in Figure 4. The test bed consists of the base and the step. The base

Case 2: Robot collides with obstacle

The test shall be terminated if the robot collides with the obstacle.

The maximum force shall be recorded.

The average force of collision with the obstacle shall be calculated as per Formula (7):

$$\bar{F} = \frac{\sum_{i=1}^n F}{n} \dots\dots\dots (7)$$

Where:

F - is the maximum force of colliding the obstacle after i^{th} collision case;

N - is the number of collisions with the obstacles;

$\bar{F}$ - is the average force of collision with the obstacle.

11 Cable Traversing Behavior

11.1 General

This test measures the impact of the mobile household robot has on a cable when the robot tries to cross it. By having the cable attached to a pendulum it is possible to measure the pendulum swinging distance. The swinging distance corresponds to the pulse transferred to the cable.

NOTE: This is a comparative test within a single lab and absolute values may not be repeatable in different laboratories.

11.2 Test bed

11.2.1 General

The length and width of the test bed shall be at least 2 000 mm × 1 150 mm. Only the obstacle under test shall be placed in the test bed area. A scale, similar to a dartboard, shall be put on the floor where there is a free space, in order to ensure that there is no impact from the surroundings on the product. A carbon fiber pendulum hanging freely from the ceiling with its bottom end freely movable in its X and Y-axes, with Z defined in the direction of the pendulum, and coordinate system fixed at the center of the pendulum. The pendulum shall be mounted in such a way as the bottom edge sits 15 mm above the floor level. Insert an eyelet into the bottom of the tube through which the wire should be run so that it does not lose contact with the stick as shown in Figure 8.

The length of the carbon fiber tube shall be 2.5 m ± 0.2 m and 20 mm to 40 mm outside diameter. It is important that the pendulum is as stiff and lightweight as possible to get a stable and

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