Usability Improvement of the Automatic Washing-Drying Machine

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***Abstract*—The operation of an automatic washing machine has been in complex and difficult as much as the machines have many functions. This study aimed to improve the usability of the newly developed model of washing machine. The authors conducted the usability experiments at both planning and preproduction phase of SANYO AWD-AQ3000 prototype, the new model, comparing with the conventional model.**

I. Introduction

ABOUT 33 % of automatic washing machines sold in Japan in 2007 had built-in dryers [1]. The factors such as increase of working parents and pollen allergic measures must raise the sales of automatic washing-drying machines.

The operation has been complex and difficult as the machines have more functions. Manufactures provide more functions on automatic washing machines according to the change of family structures or the people's idea of personal hygiene. For example, futons and blankets, which have rarely been sent to the dry-cleaners, became frequently washable at homes by using the washing courses for heavy-laundry or wool of the washing machines. Residents of apartment houses want to use a quiet-washing course or a time switch.

In addition, Sanyo Electrics add a novel, waterless cleaning course to disinfects and deodorize items, such as leather-goods and stuffed toy animals, which have been difficult to be maintained at home.

In this way, as washing machines have more functions, the users require more simple way of using them. The interface has to help variety of users find the function they want in many functions and tune particular settings.

II. Usability Experiment on the Simulators

We attempted to examine the usability of the operation panel of the new model scince it was planed.

A. Settings

The objective operation panels were the conventional model, SANYO AWD-AQ2000 and the proposed one, AWD-AQ3000 prototype in which a control knob was newly employed in the modified layout. The both panels were implemented as simulator programs with a touch screen.

Seven women aged over 30 years who used to automatic washing machines participated the experiment.

The required tasks were categorized in following seven: turning on the power, switching the wash or wash-dry mode, changing the washing courses, tuning the wash settings, setting the time swich, setting water-saving mode, and setting the "air-washing" function. The instructions given to the participants were, for example, "set to wash the wool sweater and end (do not dry it in succession)" and "deodorize the leather shoes."

They were asked to set the designated washing tasks by using two simulator panels. Time and steps to completion for each task were counted, and irritating measure (5-point rating) was reported by the participants. Each operation steps were recorded on the video tape.

B. Results

The total irritating measure over all participants and tasks was found significantly reduced on the planning model comparing to the conventional one (df = 1, F = 9.0645, p = 0.0032). The completion times had no signifficant difference. Operation steps was reduced by using the control knob. This point was welcome by the participants, because they had not push buttons so many times.

Hierarchical task analysis was performed (Figure 2) to

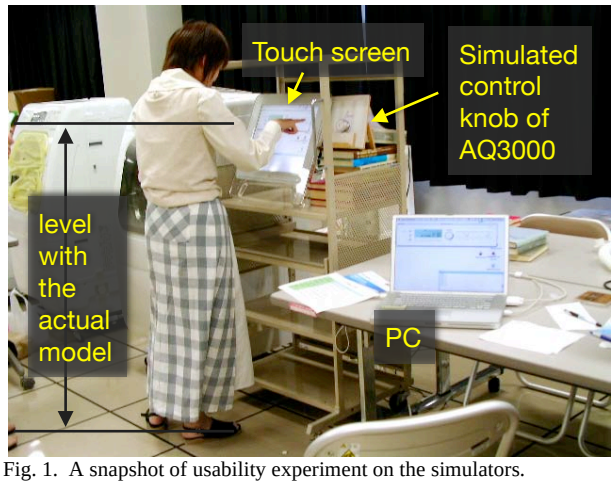

Fig. 1. A snapshot of usability experiment on the simulators.

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find the erroneous steps. We adapted the method of hiearchical task analysis [2] to the tasks we conducted. The current choices were layed out horizontally and followed the participants' actual operations vertically. Comparing to the intended operation sequence, we found the errornious point where our participants got lost.

According to those resuls, we adopted the control knob and to isolate the mode-selection buttons from other buttons. The location of the start button and control knob were also changed.

III. Association Between Control Knob and Display

A. Settings and results

Before starting the usability experiments, we conducted a study of association between operation and display on the control knob. The participants, 120 university students and teachers aged 20-61 were asked which course they expected to be focused in the display when they turn the knob clockwise. They answered their expected course on each of three type of display. The display types and number of responses are shown in Table 1. Display type A had two triangles pointing right and left, similar to station signs of railways. Curved arrows on the Type B also pointed the both side. Curved arrows on the Type C display were associated with rotation. As a result, the most participants agreed on the Type B display then we adopted this.

B. Comparison to other rotary controls

The compatibility of the association between rotate control and quantitative display is one of classic problems as described in [3], for example. Recently, wheel-type controls have been used on the new appliances such as Apple iPod and Sony HandyCam to choose one from the item list. In case of these two examples, the association is completely rotated clockwise in 90 degrees; the displayed items are listed in a column and the pointer moves up and down when the user rotates the control wheel counterclockwise and clockwise, respectively. In the case of our operation panel, its size and shape is constrained by the hardware. Then, the new association between control and display in a row had to be employed.

IV. Usability Experiment on the Test Models

A. Settings

Fifteen men and women washing machine users who were 30-61 years old, and 25 users who were around 20 years old participated in the usability experiment. As shown in Figure 3, they were asked to operate to actual devices of the conventional model and the improved test model for the designated six washing tasks as well as the first experiment, except for using water-saving mode. Time, operation steps and irritating measure were also recorded.

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B. Results

All measurements were improved at six tasks. The

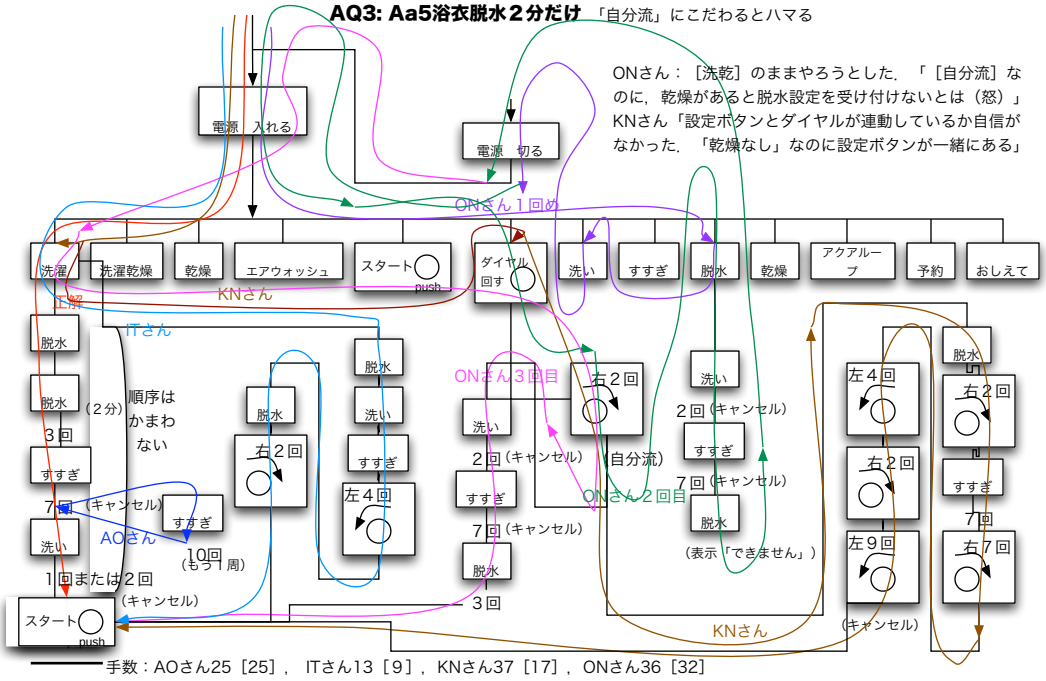

Fig. 2. An example diagram of hierarchical task analysis for the task “to spin-dry washed *yukata* (Japanese summer kimono) for two minutes.” The procedure starts with “turning on power” drawn on the top of the diagram. Choice buttons and control knobs are drawn as connected boxes. The designed procedure and the participant’s actually performed sequences were traced as lines with arrowheads.

Table 1. Compatibility between display and the rotary control knob.
Question given to the participants: The course “標準 (*hyoujun*; standard washing)” displayed at the center of LCD is now focused. When turning the control knob a division clockwise, which course do you expect to be focused next, “カビガード (*kabi-gaado*; keeping mold out)” or “おいそぎ (*oisogi*; quick washing)”?

Control knob

Shape of arrows	Display on LCD		
Type A	カビガード ◀ 標準 ▶ おいそぎ		N.A.
Number of answers	21 (17.5 %)	96 (80.0 %)	3
Type B	カビガード ◤ 標準 ◥ おいそぎ		N.A.
Number of answers	13 (10.8 %)	105 (87.5 %)	2
Type C	カビガード ◤ 標準 ◥ おいそぎ		N.A.
Number of answers	61 (50.8 %)	56 (46.7 %)	3

overall performance on each measurement for all participants and all tasks are described in Table 2. Total completion times had no significant difference between two models, while total steps and total irritating measure were significantly reduced for the new model. We tested the difference in the measurements between the models by Wilcoxon matched-pair signed-rank test, because we found all of the distributions were not recognized normal.

Then, we focused on the performance of the participants 30 years or older, because they are similar to our target purchaser. We found that all measurements were significantly reduced for the new model.

Especially, layout change and control knob was found contributed to the task using ‘Air-wash’ function (disinfects and deodorize through using air (ozone) instead of water), whose averaged completion time became 34.5 % of the conventional model.

From the result of hierarchical task analysis for 15 participants aged 30 or more years, there remained a little problems on washing course-selection task on the test model. Six participants missed to set wash/dry mode first, yet it was better than that in case of conventional model.

Some participants near push the power button instead of the start button. The participants who find to rotate the control knob for selecting washing course and settings performed the tasks smoothly.

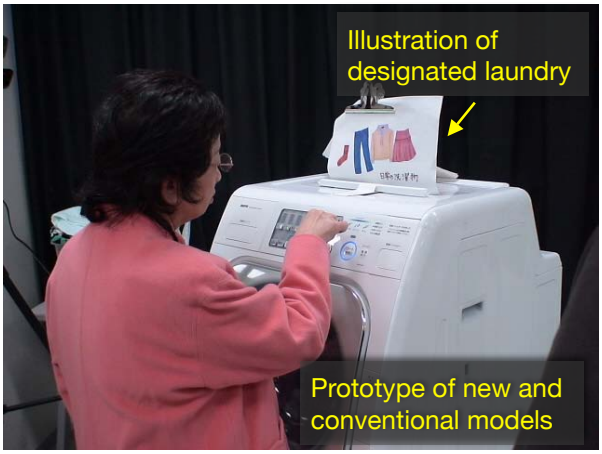

Fig. 3. A snapshot of usability experiment on the prototype models.

Table 2. Comparison between new and conventional models with average measures over all tasks for all 40 participants.

Measures / Models	Average completion time	Average steps**	Average irritating measure*
AQ3000 (new prototype)	28.3 sec	11.8	1.9
AQ2000 (conventional)	31.1 sec	16.4	2.0

(*$p < 0.05$, **$p < 0.01$)

Table 3. Comparison between new and conventional models with average measures over all tasks for 15 participants who were 30-61 years old.

Measures / Models	Average completion time **	Average steps**	Average irritating measure**
AQ3000 (new prototype)	26.3 sec	11.2	1.8
AQ2000 (conventional)	34.9 sec	18.2	2.2

(*$p < 0.05$, **$p < 0.01$)

Table 4. Comparison between new and conventional models on the task of the appealing function “Air-wash.” The measures were averaged over 15 participants who were 30-61 years old.

Measures / Models	Average completion time **	Average steps**	Average irritating measure*
AQ3000 (new prototype)	12.5 sec	3.6	1.3
AQ2000 (conventional)	36.2 sec	11.5	2.3

(*$p < 0.05$, **$p < 0.01$)

(a) Body of the new model.

(b) Improved operation panel and the printings.

Fig. 4. Released model of SANYO AQUA AWD-AQ3000.

V. Additional Improvement

Small problems found at the experiment were fixed on the final production model. The colored line on the start button was changed so that it should be easily discriminated from the power button. Rounded squares were added in the menu illustration on the operation panel to suggest the user rotating the control knob. The final design is shown in Figure 4. The improved new model was released on February 2008.

References

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