IrRC-Logger: Statistical Analysis of Users Behavior on Remote Controller Log

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Abstract. In this paper, we analyzed remote controller log for users' operation on home appliances. We experimented for recording the DVD recorder's signal data of 20 subjects who imposed the task. The logs were recorded using IrRC-Logger records automatically Infrared signal (Ir-signal) from remote controller of the appliances and pictures of TV Output from the appliances simultaneously. We focused on interval time and analyzed a difference between error interval time and normal interval time. The results of the statistical tests show that the mean of interval time data for the error cases is statistically different from that for the normal cases. There is a useful possibility for the discovery of error operations by focusing on long interval time.

1   Introduction

Usability of rich-function home appliances such as Digital Video Recorder or DVD Player is an important factor to product selection. In many product development processes, usability testing is executed with short-term field trial of inexperienced users to extract usability problem. On the other hand, there is a problem that short-term usability testing neglects users' learning effect for the product. The users accustom themselves to the products for long-term (months or years) experiences. Authors consider Long-Term Usability testing is necessity for measuring the actual conditions of utilization [2]. However, enormous cost is required for applying typical techniques of usability-testing such as Interview, Video recording and think-aloud protocol [3].

Quantitative analysis of operation histories is required for consistency of evaluation results among the different evaluators. Some studies are conducted to evaluate usability of computer software quantitatively. Cook et. al. analyzed a operation log of text editor on the computer [4]. However, for most of home appliances, acquiring quantitative data is difficult because the appliances prepare no module of evaluation analysis and interfaces.

In this paper, we analyze empirically remote controller log of DVD recorder. The log was recorded using IrRC-Logger [1], a quantitative Ir-signal recording system for users' operation analysis. We focused interval time of remote controller signals and analyzed empirically.

2   IrRC-Logger

Fig. 1 describes architecture of IrRC-Logger. The system is composed of (a an Ir-Capture, (b a Video Capture, and (c a RC Operation Recorder to achieve following three functions.

2.1   Recording Ir-Signal

IrRC-Logger records Ir-signal acquired from the device, Ir Capture. Typically, remote controller of home appliance spreads the commands by Ir-signals. Capturing the signals by the device placed near of home appliance enables recording of the commands without particular interfaces or modification of the home appliance.

2.2   Recording GUI with Ir-Signal

A Video Capture acquires TV Out from the appliance as jpg file. Particular commands such as "Enter" or "Back" can be interpreted as several intentions from situation of use. Hence, recording TV Out which displays GUI of home appliances is necessary.
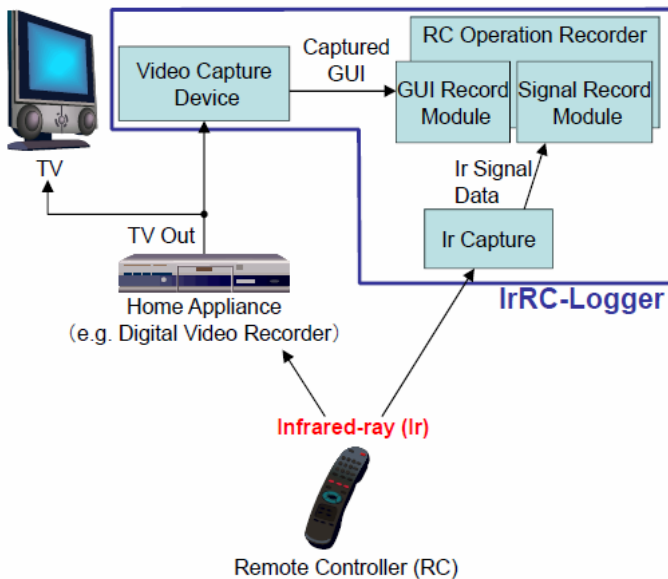

Fig. 1. System Architecture of IrRC-Logger

2.3   Time-Sequenced Recording

A software tool RC Operation Recorder documents the Ir signals, captured pictures and date of operations into a PC as time-sequenced information. The operations are recorded as csv format file, it can read and process as many analysis support tool. This may be sufficient number to record long term operations.

3 Operation Review Using Proposed System

Here, we show an example of operation review using the proposed system. RC Operation Recorder can display and play back the recorded Ir-Signals and captured pictures. Fig. 2 shows example of playing back by signal information and pictures. The system displays General Information (Start date and end date of Recording, csv file name, etc), Signal Information (Label, Date of operation, etc) and captured display from the appliance simultaneously. The analyst can traverse each signal using Signal Slider and Calendar.
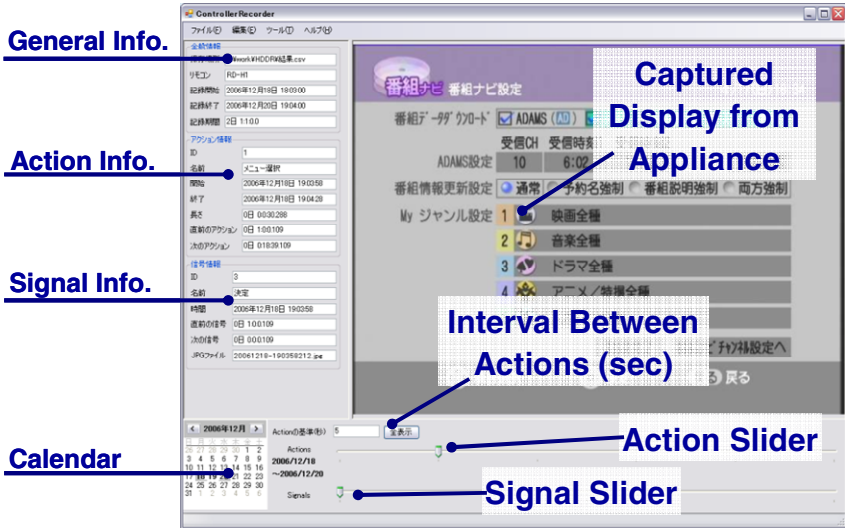

Fig. 2. Replay of Ir Information and Captured Pictures

The system combines continuous signals as *Action*, which represents a task of users such as "item selection of playing back" or "recording reservation." In current version of the system, we use interval time between actions to split the signals. Action Information (Start date and end date of action, length of action, etc) is also displayed by Action Slider.

4 Recording Experiment

In the experiment, we recorded the DVD recorder's signal data of the subject who imposed the task using IrRC-Logger. Subjects are 20 college students, 10 arts course student and 10 sciences course students. They have never touched the DVD recorder used in the experiment. We requested the subject to following 2 tasks using DVD recorder's remote controller.

- Task1: Schedule a TV program broadcasted three days after.
- Task2: Split a 10-minute portion of TV program from a recorded program.

As an Experiment result, all subjects goal at task1. But 10 of 20 subjects couldn't goal at task2. We set execution time to 300 seconds when subjects couldn't goal. Average of task time is 179.5 seconds.

5   Signal Interval Time Analysis

We focused on signal interval time for analyzing subjects' behavior. We hypothesized the interval time of the signals become long when users operate incorrectly for their misunderstanding or wavering. We analyzed following four kinds of interval time. Here, Error button is the button which was pushed despite irrelevant to completion of the task, and Normal button is the button which is necessity for task completion.

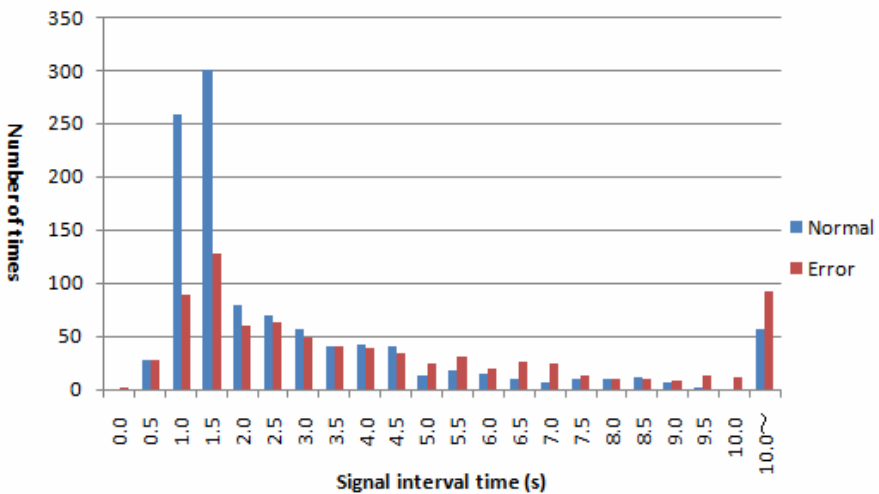**Table 1.** Comparison of Average Interval Time

	Signal interval Time			t-test
	Average (sec)	*SD*	*Sample #*	**p-value**
ALL	3.74	4.75	1902	
Pre-Normal	2.86	3.31	1090	p < 0.000
Pre-Error	4.91	5.98	812	
Post-Normal	2.87	3.38	1093	p < 0.000
Post-Error	4.90	5.94	809	

Pre-Normal: Interval time between a Normal button signal and a signal before the Normal button
Pre-Error: Interval time between a Error button signal and a signal before the Error button
Post-Normal: Interval time between a Normal button signal and a signal after the Normal button
Post-Error: Interval time between a Error button signal and a signal after the Error button

Fig. 3. Histogram of pre-signal interval time

Analysis result of average interval time is showed in Table 1. The difference was seen between Error and Normal. Before and after the error, interval time is long. But the difference was hardly seen between Pre-Button (Pre-Normal and Pre-Error) and Post-Button (Post-Normal and Post-Error). We consider continuousness of error button as a cause. The difference between Pre-Normal and Pre-Error is a little longer than the difference between Post-Normal and Post-Error. Histogram of Pre-Normal and Pre-Error interval time is showed in Fig. 3 54% of all samples are up to two seconds. There is a possibility that a series of user's operation can be clarified by using interval time. More than two seconds error ratio rises. The result suggests that the error button can be clarified from interval time.

6   Conclusion and Future Work

In this paper, we experimented for recording remote controller's signal log using IrRC-Logger. As a result, interval time of Error button was longer than Normal button. 54% of all interval time samples are up to two seconds.

As a future work, we are planning to conduct experiments of long term recording of users' operations with IrRC-Logger. Long term recording of user operation with displayed GUI allows us empirical analysis of users' intent among the actual situation. Evaluation of Action-wise analysis is also an interesting topic to establish an efficient analysis method. To divide using particular type of signals which suggest a beginning of consecutive operation is useful for analysis support.

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