

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

Noboru Nakamichi, Yumiko Chiba, Konomi Kubo,
Naomi Mimura, Mikio Aoyama
Nanzan University
Aichi, Japan
nakamiti, 05mt007, 05mt056, 05mt064 @nanzan-u.ac.jp,
mikio.aoyama@nifty.com

Hidetake Uwano
Nara Institute of Science and Technology
Nara, Japan
hideta-u@is.naist.jp

Abstract— In this paper, we experimented for analyzing users' behavior on remote controller logs. We recorded the DVD recorder's signal data using IrRC-Logger can record Infrared signal (Ir-signal) from remote controller to the appliances. We focused on interval time between error/correct signal and previous signal, and analyzed a difference between error interval time and correct interval time. The results of t-test show that the mean of interval time data for the error cases is statistically different from that for the correct cases. There is a possibility that error operations are discovered by focusing long interval time from long recoded logs.

Keywords - usability; empirical; home network; Consumer Electronics;

I. INTRODUCTION

Usability of function-rich 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 problems. On the other hand, there is a problem that short-term usability testing neglects users' learning effect to the product. Users accustom themselves to the products for long-term (months or years) experiences. Long-Term Usability testing is necessity for measuring the actual conditions of utilization [2] [3]. However, enormous cost is required for applying typical techniques of usability-testing such as Interview, Video recording and think-aloud protocol [4].

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 [5]. 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 s. We focused interval time of remote controller signals and analyzed empirically.

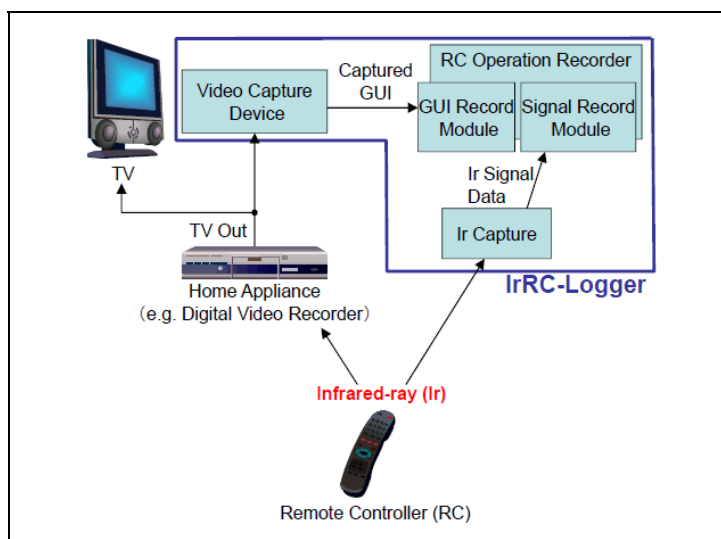


Figure 1. System Architecture of IrRC-Logger

II. IRRC-LOGGER

Fig. 1 describes the 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 the following three functions.

A. 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.

B. 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.

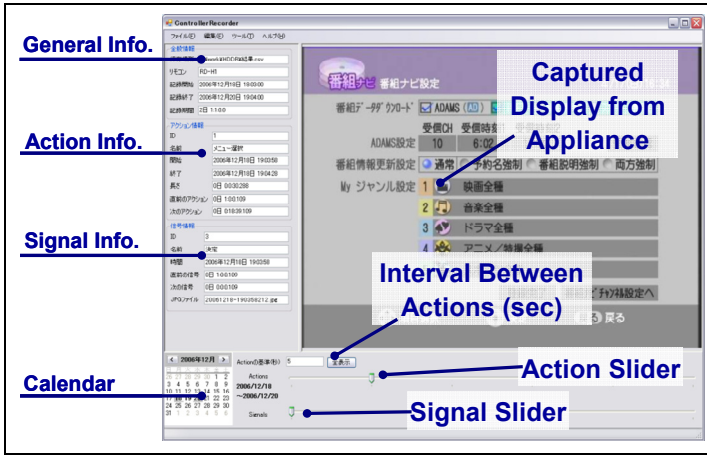


Figure 2. Replay of Ir Information and Captured Pictures



Figure 3. Remote controller of the DVD recorder.

C. 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.

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.

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.

III. RECORDING EXPERIMENT

In the experiment, we recorded the HDD recorder’s signal data of the subject who imposed the task using IrRC-Logger.

A. Experimental Environment

The experiment environment used by this research is as follows.

- TV: SHARP LC-26P1
- HDD recorder: SHARP DV-AC82
- Video Camera: Panasonic HDC-SD1
- Remote Controller Logging Tool: IrRC-Logger
- Recording PC: FMV-E610

IrRC-Logger cannot record the interaction of voice. So we prepared Video camera with IrRC-Logger for recording a detailed interaction. Fig. 3 shows remote controller of the DVD recorder used by the experiment. It is designed in consideration of the usability. For example, the users can easily select the operation by holding the color buttons down in the center part of remote controller that synchronizes with the menu screen.

B. Subjects and Tasks

Subjects are 20 college students, 5 arts course male students, 5 arts course female students, 5 sciences course male students, and 5 sciences course female 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. Task’s limit time is 5 min.

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

C. Experimental Result

We recorded subjects’ remote controller logs using IrRC-Logger. From the logs, we show experimental result about task completion time in Table 1. Fig. 4 shows task completion time graph each subjects. From Task1 result, all of subjects could goal. And there is not variability among task completion time. From Task2 result, 7/10 arts course students couldn’t goal. But sciences course students could goal earlier.

TABLE I. TASK COMPLETION TIME

Task completion time	Task 1 (min)	Task 2 (min)		
		All	Goal	Not goal
Avg.	2.35	3.63	2.27	5.00
Max	5.00	5.00	4.83	5.00
Min	1.09	1.15	1.15	5.00
Standard Deviation	0.97	1.58	1.01	0

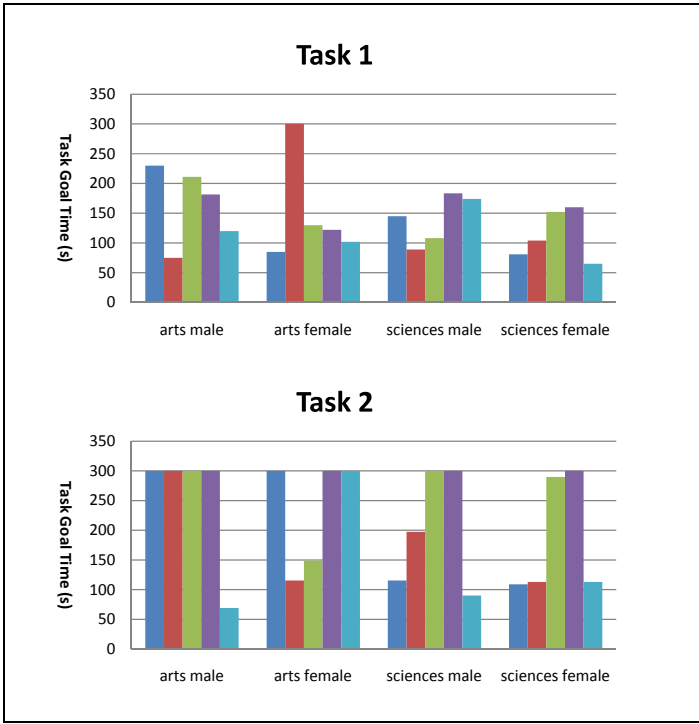


Figure 4. Histogram of Task Completion Time

IV. 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 buttons are the buttons which was pushed despite irrelevant to completion of the task, and Correct buttons is the buttons which is necessity for task completion.

A. Error buttons definition

The definition of the error buttons is different at each transition. Subjects can translate by buttons of remote controller. Next menu depends on current menu and buttons conditions. We should define the error buttons at each transition. Fig. 5 shows screen transition and Error buttons definition in Task1.

B. Hypotheses formulation

We form the following hypothesis as user's behavior which appears in signal interval time.

- Hypotheses 1: Error buttons signal interval time is longer than Correct buttons.
- Hypotheses 2: Waverer's signal interval time is long in the operation.
 - 2-1: Before menu transition, waverer's signal interval time is long in the operation.
 - 2-2: After menu transition, waverer's signal interval time is long in the operation.

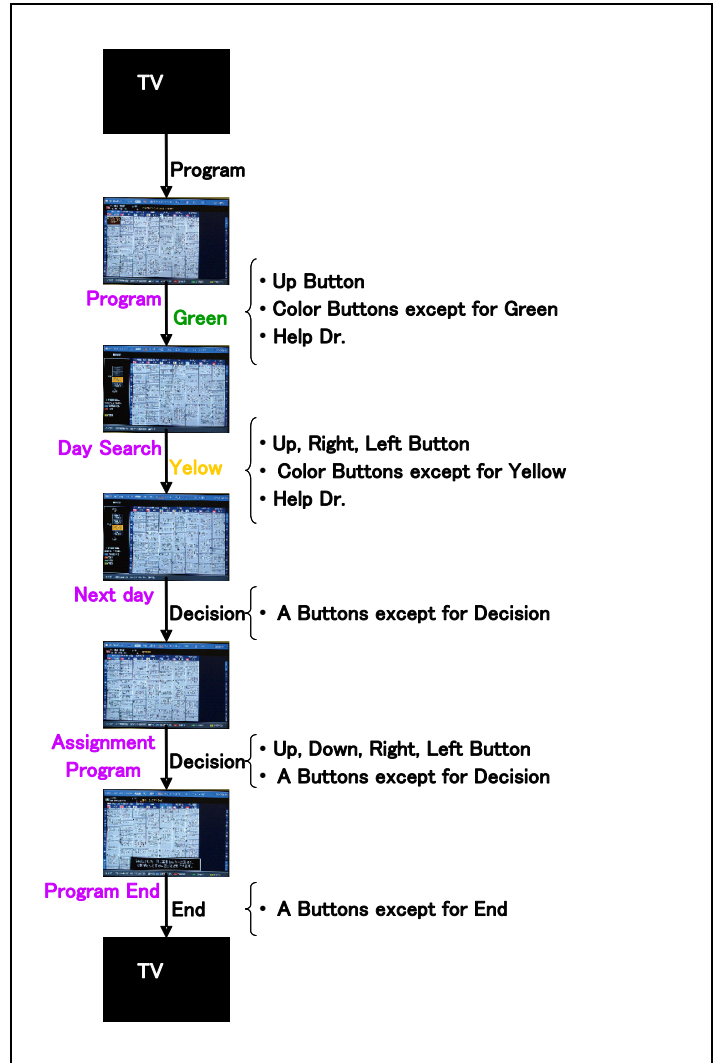


Figure 5. Error buttons definition

C. Analysis result

Analysis result of average interval time is showed in Table 2. The difference was seen between Error and Correct. Before and after the error, interval time is long. But the difference was hardly seen between Pre-Buttons (Pre-Correct and Pre-Error) and Post-Buttons (Post-Correct and Post-Error). We consider continuousness of error buttons as a cause. The difference between Pre-Correct and Pre-Error is a little longer than the difference between Post-Correct and Post-Error.

Histogram of Pre-Correct and Pre-Error interval time is showed in Fig. 6. 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 buttons can be clarified from interval time.

TABLE I. COMPARISON OF AVERAGE INTERVAL TIME

	Signal interval Time			
	Average (sec)	standard deviation	number of sample	t-test p-value
ALL	3.74	4.75	1902	
Pre-Correct	2.86	3.31	1090	p < 0.000
Pre-Error	4.91	5.98	812	
Post-Correct	2.87	3.38	1093	p < 0.000
Post-Error	4.90	5.94	809	

Pre-Correct: Interval time between a Correct buttons signal and a signal before the Correct buttons
 Pre-Error: Interval time between a Error buttons signal and a signal before the Error buttons
 Post-Correct: Interval time between a Correct buttons signal and a signal after the Correct buttons
 Post-Error: Interval time between a Error buttons signal and a signal after the Error buttons

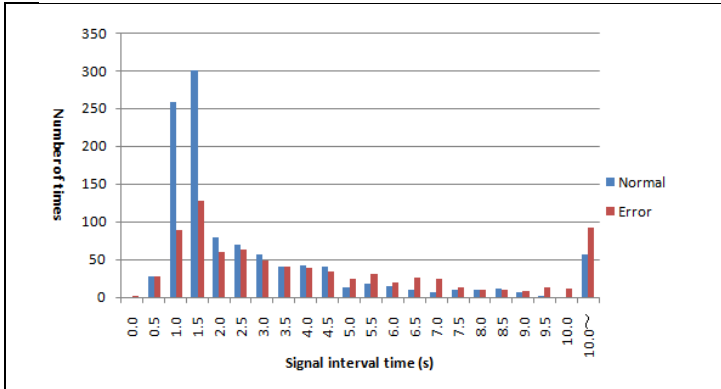


Figure 6. Histogram of pre-signal interval time

Start	2008/11/5 15:54		
2008/11/05/15:54:59.015		2008-11-05-155459.015.jpg	Program
2008/11/05/15:55:09.406		2008-11-05-155509.406.jpg	Record list /Top menu
2008/11/05/15:55:24.140		2008-11-05-155524.140.jpg	Program
2008/11/05/15:55:27.828		2008-11-05-155527.828.jpg	Right
2008/11/05/15:55:34.421		2008-11-05-155534.421.jpg	Up
2008/11/05/15:55:39.468		2008-11-05-155539.468.jpg	8
2008/11/05/15:55:41.906		2008-11-05-155541.906.jpg	Program
2008/11/05/15:55:45.296		2008-11-05-155545.296.jpg	Right
2008/11/05/15:55:46.421		2008-11-05-155546.421.jpg	Up
2008/11/05/15:55:48.312		2008-11-05-155548.312.jpg	Right
2008/11/05/15:55:49.515		2008-11-05-155549.515.jpg	Right
2008/11/05/15:56:07.343		2008-11-05-155607.343.jpg	Right
2008/11/05/15:56:08.781		2008-11-05-155608.781.jpg	Up

Figure 7. An example of a part of subject's log

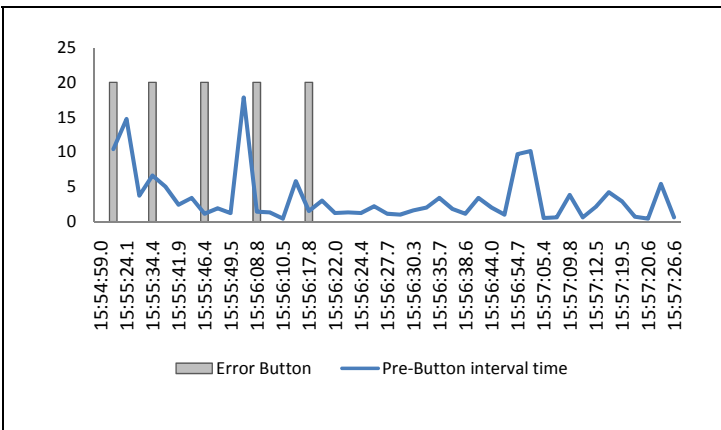


Figure 8. Transition of Pre-Buttons interval time

D. Analysis from subjects' log

We analyzed subjects' remote controller log for examining signal interval time of subjects' behavior. Fig.7 shows an example of subjects' log. Yellow parts of log are Error buttons timing. Fig. 8 shows transition of Pre-Buttons interval time. From Fig.8, we could confirm pre-buttons interval time is long when the subject presses an error buttons.

V. 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 buttons was longer than Correct buttons. 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.

REFERENCES

- [1] H. Uwano, M. Ando, N. Nakamichi, and M. Kurosu, "IrRC-Logger: A Logging System for IR Remote Control Signal to Analyze Intension of Users' Operation," the 12th International Conference on Human-Computer Interaction (HCI International 2007) Proceeding, CD-ROM, 2007.
- [2] M. Ando, M. Kurosu, and H. Takahashi, "The Importance of Long Term Usability," Correspondences on Human Interface, Vol.7, No.4, pp47-50, 2005.
- [3] M. Ando, M. Kurosu, and H. Takahashi, "Concept Framework for the Long Term Usability and Its Measures, Association Annual Conference Proceeding 2006, CD-ROM, 2006.
- [4] K.A. Ericsson and H.A. Simon, "Protocol analysis: Verbal reports as data," MIT Press, Cambridge, MA, USA, 1984.
- [5] Ronny Cook, Judy Kay, Greg Rayan, and Richard C Thomas, "A toolkit for appraising the long term usability of a text editor," Software Quality Journal, Vol.4, 2, pp 131-154, 1995.