The Applicability of Gesture Commands on PDA as Remote Controllers

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Abstract: This study explored the applicability of gesture commands in a PDA to the operation of DVD players, video tape players and TVs. Firstly, 58 subjects were asked to write the appropriate gesture commands for each of the 11 pre-selected commonly used operations in controlling video equipments. From this set of written gesture commands as well as the gesture commands used in the PalmRemote for Palm OS, five commands were screened for each operation by experts with the consideration on frequency been written, compliance with the one stroke writing rule and ease of writing. Another 50 subjects then were recruited to select the most appropriate command from the set of five commands for each of operation. With minor adjustment, a most appropriate set of gesture commands for the 11 operations was summarized. In the second phase of this study, three tasks were designed to simulated the commonly operations on video equipments. Eighteen subjects were asked to execute the three tasks by using conventional remote controller, remote control keypads on Sony CLIE PDA, and the devised gesture commands on Sony CLIE PDA in random sequence. Time and error rate on execution these tasks with three different operation approaches were compared and analyzed. Due to our familiarity with conventional remote controllers, it can be most effectively used to operate video devises. However, gesture commands can be performed more effective than control keypads, if we want to use a PDA to replace a remote controller in operating video equipments.

Keywords: gesture commands, PDA, remote controller, use evaluation

1. Introduction

A Product of Personal Digital Assistant (PDA) is like a digitalized notebook that cans assistant people to manage their daily schedules and trivial matters. Furthermore, by connecting to a PC, a PDA cannot only process information, but serves as a platform for playing games, listening to music, browsing Internet, or even watching videos. Now, most of the PDA products are equipped with an infrared (IR) unit of emitter and receiving port to transmitting message and data with other devices with IR unit, such as other PDAs, notebook computers or cell phones. Since the function of the IR unit in a PDA as well its portable size are similar to those of a remote controller of audio/video devices, it is natural to expand the usage of PDA to remotely control A/V devices. For example, the CLIE remote commander ver.1.10 software developed by Sony can be applied in Sony's CLIE PDAs to remotely control A/V devices, such as TV, VHS, and DVD players, of most popular brands. By hitting the touch button on the PDA screen, a specific command will be sent through the IR unit to control the aimed device. The PalmRemote for Palm OS, on the other hand, can be incorporated into almost every brand of PDAs to remotely control various A/V devices of varied brands. There are two alternatives to operate this "remote controller: to send commands by pointing the on screen keypad; or to send commands by drawing the established gesture commands on the screen. The gesture command library can be further expanded by users.

Gesture, to write or draw a symbol by a pen, is the most feasible way for inputting data or commands in a miniature information device, such as a PDA. Gesture input includes hand-written character data input and hand-drawn icon input for non-character data or command. Unistroke and Graffiti are the two most commonly used gesture input systems now. Gesture commands are generally the hand-drawn iconic commands to instruct the device to do the assigned operation. (Kurtenbach et al., 1994)

The most frequently implemented functions in a PDA are: taking notes, scheduling, managing address or telephone information, reminding things to be done, dealing with e-mails, drawing in order. These activities involve inputting or inquiring information of small pieces, not typing a large amount of text information. Therefore, conventional keyboard with a certain size is not good for this kind of information device. Buxton (1986) pointed out that the performance of gesture interface of using a pen is better than mouse in selecting an object on a screen. Rubin (1991) revealed the convenience of using a gesture command to correspond an identical object, command, or region. Thus gesture commands are easy to learn and memorize. (Wolf, 1988) The researches of Wolf (1988) and Kurtenbach et al. (1994) have concluded that gesture commands are easier to learn and operate by naives than common keyboard or mouse commands. The questionnaire survey on PDA of Long et al. (1997) indicated that most of users appreciated the advantage of gesture commands in the aspects of power, efficiency, convenience, and ease for learning and operating. This survey also revealed that further applications of gesture commands, especially of self-defined commands, were expected.

Regarding to the design of gesture input, one-stroke gestures are preferred with the advantages of small writing area needed, eye-free, low wrist strain, no worry about from which stroke to start the recognition by considering the stroke order and pause time between strokes. (Mackenzic and Zhang, 1997) Most gestures used in both Unistroke and Graffiti gesture input systems are one-stroke gestures. As Graffiti gestures are similar to their corresponding Roman characters, it is easier to learn and memorize. Thus, at present, the use of Graffiti system is more popular than that of Unistroke system. (Masliah, 2001) Masliah (2001) has also revealed that one-stroke gesture input is especially suitable for mobile devices, because it can not only be used for rapid input but it can free the restraint of eyes while on inputting. Furthermore, it is pointed that the use of one-stroke gesture input can enhance the rate of input recognition. (Rubine, 1991) Few investigations have explored the design of gesture commands, so far. However, Liu and Chuang (2001) have concluded some guidelines for designing gesture commands

2. Method

A questionnaire survey was conducted, firstly, in this study to find out the most commonly used operations in general audio/video devices. Corresponding gesture commands of these operations were designed and their applicability was verified through simulated tasks.

2.1 Designing gesture commands for commonly used operations

Through a questionnaire survey to 60 subjects, the 11 most commonly used operations in TV, VCR, and DVD players, power (on/off), jump, volume, mute, up/down (channel), TV/VCR, play, stop, fast, rec., and pause, were summarized.

Fifty-eight designers as well as users with experience of using gesture commands then were recruited to design an appropriate 'one-stroke' gesture command for each of the 11 operations. These designed gesture commands as well as the established gesture commands of the PalmRemote for Palm OS (as shown in Table 1) were screened

by the researchers according to the design principle of gesture commands developed by Liu and Chuang (2001). As a result, 5 candidate gesture commands for each of the 11 operations were sampled.

Table 1. Established gesture commands of the PalmRemote for Palm OS

Device	Operation	Gesture command
TV	power	
	volume	
	up/down (channel)	
VCR/ DVD player	play	
	stop	
	fast	

Another 50 subjects were asked to select the most suitable gesture from the set of 5 candidate gesture commands for every operation. According to the frequency of each candidate been selected, a most appropriate gesture command was decided for each of the 11 operations. However, since the gesture command of volume operation was identical to that of VCR/TV switch operation in this elected set of gesture commands, the gesture command of VCR/TV was assigned to the second frequently selected candidate. In a pilot test, it was revealed that the most frequently selected gesture command of 'fast' operation was not well recognized, thus, it yielded its position to the second one, too. After these adjustments, the final set of 11 most appropriate gesture commands were derived, as shown in Table 2.

Table 2. Appropriate set of gesture commands

Device	Operation	Gesture command
TV	power	
	jump	
	volume	
	mute	
	Up/down (channel)	
	TV/VCR	
VCR/ DVD player	play	
	stop	
	fast	
	Rec.	
	pause	

2.2 Verifying the applicability of gesture commands

In this verification phase of study, the derived set of the 11 most appropriate gesture commands from the last phase were firstly established and appended into the Gesture Command Library of the PalmRemote for Palm OS. As regulated by the design of the PalmRemote for Palm OS, a precedent gesture command should be added before inputting a user-defined gesture command. Thus, the recorded operation time in the later experiment would include the time of inputting the precedent gesture command. The time of inputting the precedent gesture command was estimated and excluded in the analysis.

Three tasks, which included the 11 operations to simulate three common operation procedure for A/V devices (as shown in Fig. 1), were designed for verification experiment. Task 1 was a basic TV operation procedure; whereas Task 2 was to control the playing program of a DVD player on TV screen and Task 3 was the operation procedure for playing VCR program on TV screen.

Figure 1. Three tasks for verification experiment

Eighteen subjects were recruited in this verification experiment. They were asked to complete the three tasked by using a conventional remote controller, a Sony CLIE PDA as a keypad remote controller, and a PDA gesture command remote controller, respectively. The 18 possible orders for balancing the sequence of conducting operations among these three devices were equally and randomly assigned to the subjects. Figure 2 showed the interface of gesture commands on a PDA used in this experiment; while Fig. 3 was the keypad interface on a Sony CLIE PDA.

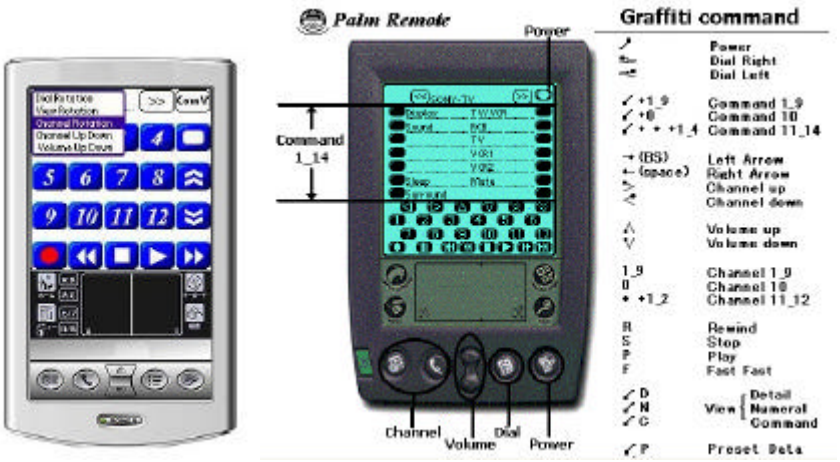

Figure 2. The gesture command interface in the PDA for verification experiment

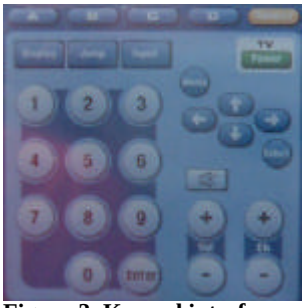

Figure 3. Keypad interface on the Sony CLIE PDA for verification experiment

Before the formal experiment, the subjects were provided with the set of 11 gesture commands and were asked to memorize them and to familiarize their implementation on PDA through practicing for 3 minutes. A brief examination conducted to each subject to ensure his familiarity with applying these gesture commands on PDA. Each subject then was asked to execute the 3 tasks in sequence by using the three remote controllers with the assigner order. The elapse time for executing each task as well as for each gesture command was recorded. Furthermore, the memorization rate of gesture commands in the experiment was counted.

3. Result and discussion

The data of the experiment was analyzed to reveal the relative performance among the three approaches of remote controller tested. The ease of memorization of each gesture command and the confusion of recognition among gesture commands were explored and discussed.

3.1 Performance among different approaches of remote controller

Performance of a remote controller was evaluated with the elapse time and error rate it was used to complete the assigned tasks in this study. Table 3 summarized the elapse time by adopting the three different ‘remote controllers’ to execute the three assigned tasks in the experiment. As expected, the total elapse time of using conventional remote controller is the shortest, because we all had sufficient experience of using it in our daily life. Using this time as an anchor point to justify the applicability of the ‘gesture command remote controller,’ the statistical test supported the applicability. The total elapse time of using conventional remote controller is not significantly (α= 0.05) shorter than that of using ‘gesture command remote controller,’ but both of them are significantly shorter than that of using ‘Sony Clie keypad remote controller.’ It was observed that, although the concept of operating Sony Clie keypad was similar to that of conventional remote controller, but users had to spend time for finding the position of a specific key and for pinpointing this key, as a result, the operation time was increased.

Table 3. The elapse time for executing the 3 tasks

Approach	Task1	Task2	Task3	Total
Gesture command	682	763	585	2030
Sony Clie keypad	723	1198	591	2512
Conventional remote controller	484	982	442	1908

Further statistical test of paired comparison among the three ‘remote controllers’ in each of the 3 tasks was conducted. The result of significant differences (α= 0.05) was summarized in Table 4. In task 1 and task 2, using conventional remote controller is significantly more efficient than using ‘PDA remote controllers.’ However, in task 2, gesture command showed its superiority in controlling DVD players. This may due to the fact that DVD players are relative new products to users; therefore a conventional remote controller has no advantage of use

experience to operate them. It may lead to conclude that gesture command can be efficiently implemented on a PDA for remote controlling some new developed A/V devices, although further researches will be needed to confirm this conclusion. Regarding to the error rate of operating gesture commands, the rate due to the gesture command miss recognition or memorization is low in general. Most of the errors occurred at inaccurately aiming the target of IR receiving port. Some subjects made errors due to their unfamiliarity to one-stoke gesture commands.

Table 4. The significant differences of paired comparison in the 3 tasks

Task	Compared pair	Significance
Task 1	Gesture command vs. conventional	0.009
	Sony CLIE keypad vs. conventional	0.001
Task 2	Sony CLIE keypad vs. Gesture command	0.000
Task 3	Gesture command vs. conventional	0.022
	Sony CLIE keypad vs. conventional	0.005

3.2 The memorization rate of gesture commands

The memorization rate of each command in the 3 tasks was summarized in Table 5. Except for the command of power on operation to DVD player, TV/Video switching and channel-up tuning, the memorization rates of other commands were exceeded to 60%. Three of the 4 times of power on operation appeared in the whole procedure of experiment were executed with the memorization rate higher than 94%, but that of the second time operation to power on the DVD player was only 39%, the lowest at all. In real world, we might use separate remote controllers to operate TV and DVD, respectively. In our experiment situation, however, subjects were instructed to use same command on the same PDA remote controller to control different devices. Thus, they were confused and hesitate to respond when they were firstly encountered this situation, and made mistakes consequently. But this can be learned immediately, as revealed by the following two high memorization rate operations. Another command with difficulty of memorization is the TV/Video switching operation. As mentioned above, this command selected for the experiment is not the most acceptable one, but is the second one, because that the best one is identical to that of volume-up operation. This gesture command, therefore, may not match with the mental model of this operation.

Table 5. The memorization rate of each command in the 3 tasks

Command	Task1	Task2	Task3
Power On	100%	39%	94%
			100%
Ch ↑	59%		
Ch ↓	100%		
Vol ↑	83%		
Vol ↓	100%		
Mute On	72%		
Mute Off	100%		
Jump	61%		
TV/Video		44%	
Play		76%	89%
		83%	
Fast		67%	83%
Pause		67%	
Stop		78%	61%
			72%
Rec.			72%

The memorization rates of the channel-up operation (59%) and jump operation (61%) are also not quite satisfied. These low rates may be due to the fact that the concepts of the operations are too abstract to allow simple gestures to present them. Further designing more suitable gesture commands for these abstract operations may be required. It is worth to notice that the memorization rates of the second operation in a paired operation, such as in channel-down, volume-down and mute-off operation, all approached 100%. This may prove the possibility of learning gesture commands.

3.3 Confusion among gesture commands

In this experiment, some gesture commands were found to be easily confused with others. The most obvious confusion occurred between the gesture command of 'stop' and 'pause.' However, the confusion was asymmetric. There were 10 times to input 'pause' gesture command (●) when 'stop' command was required; but only 4 times to mistakenly input 'stop' gesture command (S) for 'pause' command. Actually, since the meanings of these two operations are quite similar, the cause of confusion between them is understandable. However, in this situation, the 'pause' gesture command (●), which was based on using abstract symbol for representing meaning, seemed to be more suitable for interpreting the concept of interrupting operation than the 'stop' gesture command (S), which was derived from the first character of word for the operation 'stop.' It may be not a good idea to use different conceptual systems in establishing gesture commands with concepts. Therefore, same conceptual symbol system is suggested to be implemented for redesigning two distinctive gesture commands to clearly interpret and distinguish the meaning of 'pause' (temporary interruption) and that of 'stop' (permanent interruption).

4. Conclusion

As at present most PDAs are equipped with IR components for wireless remote operation or data transmission, it is quite reasonable to expand the function of a PDA to be a remote controller for A/V devices. Gesture commands are the most natural interfaced to be implemented in PDA products. Thus, this study explored the applicability of gesture commands in a PDA to remotely control A/V devices. Firstly, 11 most commonly used operations in controlling video equipments were decided. Subjects of designers and users were asked to design and select the appropriate gesture commands for each of the 11operations. The most appropriate set of gesture commands for the 11 operations then was evaluated and compared to the conventional remote controller and the Sony CLIE PDA keypad remote control on the performance of being a remote controller for A/V devices. Eighteen subjects were asked to execute the three tasks, which were designed to simulated the commonly operations on video equipments, by using the three different approach of remote control. Time and error rate on execution these tasks with three different operation approaches were compared and analyzed.

Regarding to the executing time, due to our familiarity with conventional remote controllers, it was found to be most effectively used to operate video devises. However, gesture commands was proved to be performed more effective than control keypads, if we want to use a PDA to replace a remote controller in operating video equipments. The ease of recognition, memorization and learning of most of the gesture commands designed in the present study were confirmed in the verification experiment, although those of TV/Video switching, channel-up tuning and jump operation might be further improved through thoughtful redesign. The confusion of concept and gesture command between pause and stop operation should be resolved by implementing the same conceptual idea in redesign.

Conclusively, the applicability of implementing gesture commands on PDA products as remote controllers for A/V devices were verified in this study. However, the verification tasks employed in this study included only

simple operating procedures. More complicated procedures, such as program reserved recording or time control may be needed for comprehensive verification. PDA remote controllers are not necessary to be limited to control A/V devices only, but may be used as unified remote controllers to control all the appliances at home. A more complete set of gesture commands should be appropriately designed and verified for the unified remote controller in further studies.

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