

Development of a Walking Game for the Elderly Using Controllers of Hand buttons and Foot boards

KyungSik Kim^{*}, Seong-Suk Oh^{*}, Jin-Ho Ahn^{**} and Sun-Hyung Lee^{***}

Dept. of Game Engineering^{*}, Dept. of Electronics Engineering^{**}, Dept. of Social Welfare for the Elderly^{***}

Hoseo University

Chungnam, Republic of Korea

kskim@hoseo.edu, oseong@hoseo.edu, jhahn@hoseo.edu, yisunh@hoseo.edu

Abstract—This paper proposes a serious game for the elderly that allows for the enjoyment of scenic views while walking in the room. The proposed game employs hand buttons and footboards based on a PC as controllers. The game is intended to provide the elderly with physical satisfaction through cooperation and competition, entertainment such as vital power, and opportunities to maintain mental functions through games. To test the efficacy of the game, we considered a sample of 309 elderly individuals who were more than 65 years old and resided in Cheonan City. The results indicated that 76.1% of the participants were fully satisfied with the game, rating it 4.13 out of 5. In addition, 89.4% were willing to play the game again. These results suggest that the intended permissiveness and coenesthesia of the game may be appealing to the elderly.

Keywords: *Serious Game, Game-Aided Human Life, Elderly, Walking Game, Entertainment*

I. INTRODUCTION

Various problems associated with a rapidly aging society have been a matter of increasing concern in Korea. Individuals over 65 years of age are expected to account for approximately 15% of the total population in Korea by 2020 [1]. Consequently, there has been growing social interest in entertainment and social welfare for the elderly.

This study proposes a walking game called “Paldokangsan”, a serious game that can provide the elderly with game-aided lifestyles and entertainment. The proposed game simulates walking in scenic areas by using hand buttons and footboards based on a PC as controllers. The game focuses on walking because those over 50 generally consider walking or hiking as one of the most preferred forms of entertainment [2].

Japan, which has one of the oldest populations in the world, has been developing serious games for the elderly since 2001. Famous games from Japan include “Taiko no Tatsujin” [3] and “Doki Doki Hevidachi” [4]. In comparison with these games, Paldokangsan is intended to provide the elderly with psychological satisfaction (e.g., making a journey to a scenic location and walking there) as well as physical satisfaction through cooperation and competition; entertainment such as vital power; and opportunities to maintain mental functions through games [5].

To test the efficacy of the proposed game, we considered a sample of 309 elderly individuals who were more than 65 years old and resided in Cheonan City, Korea, and evaluated their responses to Paldokangsan, including their interest in the game; the physical effects of the game on their body and emotions; and their satisfaction with the game interface (e.g., hand buttons and footboards). According to the results, 58% of the participants were satisfied with the interface, and 62% reported positive physical effects on their lower body. In addition, the participants rated the game 4.13 out of 5 in terms of their interest in the game.

Among the participants, 42 recorded their heart rates before and after the game, and we analyzed the correlations between several elements of physical effects and estimated effects.

II. DEVELOPMENT OF PALDOKANGSAN

A. Design Elements

In developing Paldokangsan, we focused on maintaining the interest of the elderly, including their upper and lower body actions as well as their attention to the screen.

The game is played by two individuals who cooperate as well as compete with each other. Their competition is not about walking fast but about herding sheep. For every 100 meters, the player (more specifically, his or her avatar) gets one more sheep to herd to the goal area. The total distance is approximately 700 meters (approximately 1,400 steps), which must be covered in approximately 7-10 minutes (Table 1).

TABLE I. OVERVIEW OF PALDOKANGSAN

Purpose	To provide the elderly with game-aided lifestyles and entertainment	
Controller	Hand buttons and footboards as game controllers	
Target User	<i>Main</i>	Elderly individuals wishing to walk
	<i>Other</i>	Individuals wishing to exercise with visual effects
Expected Effect	1. Vicarious satisfaction	
	2. Game therapy for the elderly	
Player	Two individuals (2 sets of controllers)	
Play Time	Approx. 7-10 minutes	

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B. Game Interface

We first designed the hand buttons to be installed on the armrest of a chair [6] but found that stepping on a footboard while sitting on a chair is a difficult task if it is done for more than two minutes [8]. Therefore, we designed the interface such that the player stands on a footboard while engaging in virtual walking (Fig. 1).

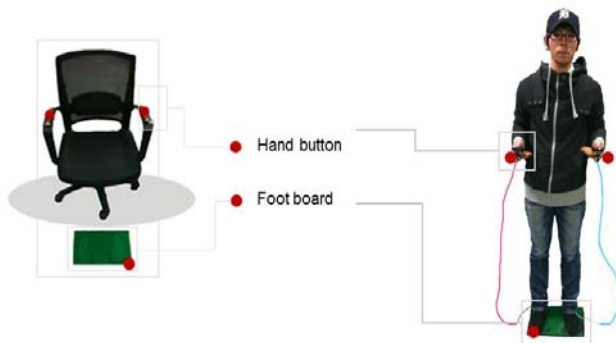


Figure 1. Hand Buttons and Footboards

C. Game Play

Although the game can be played by one person, it is intended to be played by two individuals. Each player controls his or her avatar by using two hand buttons for the left and right arms and a footboard for the left and right legs. The camera follows the avatars from the third-person point of view, and Jeju Island (Korea) is the background (Fig. 2).

When a player stands on the footboard and steps on it as if he or she is walking, the avatar walks by reflecting the player's steps and arm motion (based on hand buttons).



Figure 2. A Screenshot of Paldokangsan

The game uses sheep to reward players for walking; sustain their interest in the game; and improve their cognitive ability by helping them to focus their attention on keeping their sheep alive through the use of hand buttons.

A sheep dies and disappears when it deviates from the path through random movements. Therefore, players must use hand buttons to move their arms to keep their sheep on the path.

In addition, the game employs a sound system to guide players in terms of what they should do next and provide them with the announcement of the physical effects for psychological relief as well as with status reports.

III. ANALYSIS OF EFFECTS

A. Testing

We tested the efficacy of the game by considering a sample of 309 elderly individuals who were more than 65 years old. The test site was located at the Cheonan City Community Center for the Elderly (near Hoseo University). We invited these individuals to play the game and provide their opinions. For each participant, the test lasted 5-10 minutes. In addition, we examined 42 participants in terms of the effects of the game of their heart rates.

Questionnaire Items:

- What is the appropriate length of the game?
- What are the effects of the game on your upper body, lower body, and emotional refreshment?
- How do you rate your interest in the game (out of 5)?
- How do you rate the convenience of hand buttons, footboards, and the game in general?

B. Results

The average age of the participants was 75.1, and men accounted for 22.5% of the sample, although they accounted for 30% of the elderly population in Korea as of 2010 [1].

On average, the participants reported 7.6 minutes as the appropriate length of the game, but 89.4% answered 5 minutes.

The effects of the game on bodies and emotion for men and women are shown in Table II.

TABLE II. FREQUENCY OF ACTIVITY EFFECTS BY GENDER

		Very High	High	Normal	Low	Very Low
Lower body	Total	21	42	33	3	1
	Male	24	28	43	3	1.5
	Female	20	47	30	3	0.4
Upper body	Total	10	35	37	15	3
	Male	9	30	36	20	5
	Female	10	36	38	14	3
Emotional Refreshment	Total	36	48	14	2	0
	Male	35	43	18	5	0
	Female	36	50	13	1	0

(unit: %)

In addition, the results for the activity effects according to their self-reported health status indicate that unhealthy participants were more likely to report physical effects (Table III).

TABLE III. FREQUENCY OF ACTIVITY EFFECTS BY HEALTH STATUS

		Very High	High	Normal	Low	Very Low
Lower body	Total	21	42	33	3	1
	Healthy	19	42	33	4	1
	Normal	18	44	36	3	0
	Unhealthy	31	40	25	4	0
Upper body	Total	10	35	37	15	3
	Healthy	10	34	38	17	2
	Normal	8	31	41	17	3
	Unhealthy	17	44	28	4	7
Emotional refreshment	Total	36	48	14	2	0
	Healthy	33	52	14	1	0
	Normal	40	43	15	3	0
	Unhealthy	36	51	11	2	0

(unit: %)

In terms of availability, 52% of the participants responded positively to the footboard (males: 40%; females: 56%). The participants suggested making some correction for the position and sensitivity of the foot.

We tested the heart rate before and after the game for 42 participants to determine the intensity of the physical action required by the game (Table IV).

TABLE IV. STATISTICAL SUMMARY FOR VARIABLES

Variable	No	Min	Max	Mean	SD
Health status (self-reported)	42	1	3	1.92	.74
Age	42	69	94	76.14	5.20
Physical effect (lower body)	42	2	5	4.19	.80
Physical effect (upper body)	42	1	5	3.71	.86
Physical effect (emotional refreshment)	41	3	5	4.31	.61
Game interest	42	3	5	4.40	.73
Intention to replay	42	1	2	1.09	.29
Heart rate (before)	42	42	84	68.35	8.98
Heart rate (after)	42	62	120	79.45	12.77
Estimated max. heart rate*	42	126.	151	143.85	5.21
Increase in the heart rate	42	-8.6	27.4	7.72	7.23
Estimated effect of physical activity	42	42.9	82.1	55.28	8.96

* Estimated maximum heart rate = 220 – age [7]

As shown in Table V, the self-reported physical effect on the lower body was significantly correlated with that on the upper body, the level of game interest, the increase in the heart rate, and the estimated effect of physical activity.

In addition, the average heart rate for the unhealthy group was higher than that for the healthy group.

TABLE V. CORRELATIONS BETWEEN VARIABLES

	①	②	③	④	⑤	⑥	⑦
① Health status (self-reported)	1	.058	.005	.020	.124	.267	.005
② Physical effect (lower body)	-.058	1	.608 (**)	.244	.527 (**)	.358 (*)	.379 (*)
③ Physical effect (upper body)	.005	.608 (**)	1	.460 (**)	.494 (**)	.251	.238
④ Physical effect (emotional refreshment)	-.020	.244	.460 (**)	1	.607 (**)	.190	.149
⑤ Game interest	-.124	.527 (**)	.494 (**)	.607 (**)	1	.303	.227
⑥ Increase in the heart rate	.267	.358 (*)	.251	.190	.303	1	.719 (**)
⑦ Estimated effect of physical activity	-.005	.379 (*)	.238	.149	.227	.719 (**)	1

* p < 0.05, ** P < 0.01.

IV. CONCLUSION

We developed a walking game called “Paldokangsan,” a serious game for the elderly that uses hand buttons and footboards as controllers. We tested the efficacy of the game by using a questionnaire with items for the level of interest in the game, game satisfaction, and activity effects.

Most participants (89.4%) reported their intention to play the game again, rating their interest in the game 4.13 out of 5. In particular, they reported physical effects on their lower body and changes in their emotions.

Future research should enhance the game interface by employing advanced technologies such as Bluetooth connections to PCs as well as better arm support mechanisms for weaker individuals. In addition, cognitive ability may be incorporated into simulated walking.

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KyungSik Kim

1982 B.S. from Seoul National University
 1984 M.S. from Eng. of Seoul National University
 1990 Ph.D. from Seoul National University
 1984~1991 Senior Researcher in ETRI
 1991~present Professor in Hoseo University
 2005~2007 Chairman of Korea Game Society
 Interests : Serious Game, Design Pattern, Game Education



Seong-Suk Oh

1992 B.A. Degree in Hong Ik University
 1999 M.A. Degree in Savannah College Art & Design
 1994~2002 Microsoft, NCSOFT, Acclaim, GT
 2009~present Professor in Hoseo University
 Interests: Serious Game, Game Design, Game Art



Jin-Ho Ahn

1995 B.S. degree in EE from Yonsei University
 1997 M.S. degree in EE from Yonsei University
 2002 Research Engineer at LG Electronics
 2006 Ph.D. degree in EE from Yonsei University
 2007~present Professor of EE, Hoseo University
 Interests: VLSI Design and Testing



Sun-Hyung Lee

1993 Korea University, Home Economics Education(Bachelor)
 1995 Korea University, Home Economics Education(Master)
 2001 Korea University, Home Economics Education(Doctor)
 2008 Kangnam University, Social Work (Doctor)
 2008~present Professor in Hoseo University
 Interests: Elderly Economics, Strong Family Support, Serious Game for the Elderly