

‘Paldokangsan 3’: a Walking Game for the Elderly Towards Good Memorization

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Abstract

Old people are prone to get weak in their physical bodies as well as their memorizations. We have developed a serious game for the elderly named ‘Paldokangsan 3’ which is a walking game strengthening the ability of memorization with the interface of motion capture using Kinect. The experiments were done with 25 old people of more than 65 years old in ‘Cheonan’ city in Korea. Its effect analysis has showed possibilities of the improvement of memorization as well as improvement of concentration and vitality through this game. Also the French version of ‘Paldokangsan 3’ has been tested for 20 old people of more than 65 years old in France. There was no cultural conflict in France even though the street and characters were Korean with sounds in Korean.

Keywords: Serious Game, Elder, Walking Game, Memorization, Kinect.

1. Introduction

The game has a specific feature of repeating something with fun. The serious game is a game with a special purpose such as education and training, not just for amusement [1].

The societies of the whole globe have increasing numbers of old people living longer with medical and scientific achievements. However old people are prone to get weaker in their muscle and power with their bodies receding, hence easy to get sick with less activities [2]. Also the ability of memorization is decaying with the ages. Therefore they need repetitive performance and trials to maintain their vitalities on their physical bodies as well as their mental activities.

This research is to utilize serious games to improve the life of the old people. We have developed a serious game ‘Paldokangsan 3’ recently which is a walking game to strengthen their bodies with memorizing to help their memorization abilities for that purpose.

The aim of this paper is to describe the latest development of ‘Paldokangsan 3’ about its design and its experimental results of its effect analysis. ‘Paldokangsan 3’ has features focusing on walking a shopping street with full attention of memorization to buy some designated items. It has the concept of mall walking which permits the player with visional fun as well as physical exercise. It is dealing with five common diseases of the elderly (Dementia, Depressions, Osteoporosis, Diabetes Mellitus, and Hypertensions). The mission of the game is to buy some good foods for the selected disease walking the shopping street. ‘Paldokangsan 3’ is using Kinect [3] as its interface of motion capturing of the player with intuitive gestures. The expected effect is improvement of memorization, concentration to find out something in the vision and mental health through entertainment.

The experiments were done with 25 volunteers of more than 65 years old in Cheonan in Korea in November in 2013. They tried the game in whole three levels once a day for ten days. They were all focused on the game to remember the mission and to make correct decision with the gestures walking inside a small area to be captured by Kinect.

The data were analyzed to show that the number of times of playing the game is positively correlated with the score with 99% of confidence, negatively correlated with the number of steps and duration time to finish it with 99% of confidence. Also we got the good results of adaptation and vicariousness, and self-esteem.

We have made agreement with the French team (Play Research Lab) to cooperate for the validation of this game to be effective for the general memorization like short-term memory. The French version of 'Paldokangsan 3' has been tested for 20 old people of more than 65 years old in France at May in 2014. They tried the game once to see its adaptation as a pre-test. Their responses were good enough to proceed for the next phase. There was no cultural conflict in France even though the street and characters were Korean with sounds in Korean.

In chapter 2, the related works are described for the serious games for the elderly. In chapter 3, development of 'Paldokangsan 3' is described with the concept of the game design, game play, game interface and the score of the game. In chapter 4, the experimental results are shown for correlation analysis to find the existence of one-dimensional relationships for the effects from the user responses. Finally we will conclude in chapter 5.

2. Related Works

Games for the elderly has been developed and utilized in Japan first where the ratio of old population of more than 65 years old is one of the biggest countries in the world. Their games are 'Taiko Drum Master' to move both arms following the music [4], 'Hebi Hebi' to strengthen the muscles of the leg for the elderly not to be fallen down [5], and recently 'Sit-up' by Kyushu rehabilitation center [6].

There have been several researches on games related to the old person's physical and mental problems: applications for entertainment and information retrieval could compensate for age-related physiological and cognitive shortcomings [7]. Serious games are not only useful for healthy behavior, but generally for cognitive learning (knowledge and skills), motor skills, affective learning (attitude change, motivation) and communicative learning [8].

Recently domestic researches for the elderly are active for the improvement of physical movement and rehabilitation [9]. Some of them are the personal training system for exercise and rehabilitative training [10], game with Wii-mote to improve cognition with activities [11], and game by motion capturing with 3D depth camera to help exercise and rehabilitation [12].

Hoseo University has been supporting for the research of serious games for the elderly since 2009. We had analyzed the needs of middle and elder generation about serious games for the elderly, and got the result (1) elder generations prefer leisure activities such as mountain climbing, walking, yoga, golf and travel for health, interest, the development for oneself and relieving stress; (2) they don't prefer game activity for leisure, but prefer to use serious game for health, simulation, medical treatment and sports than middle generation [13]. We focused on the walking game that the original version 'Paldokangsan 1' was first developed in 2011 with wire connected interfaces [14, 15], and 'Paldokangsan 2' in 2012 with Bluetooth connected interfaces [16].

3. Development of 'Paldokangsan 3'

3.1 Concept of the Game Design

In human vision, the useful field of view (or UFOV) is the visual area over which information can be extracted at a brief glance without eye or head movements [17]. Generally UFOV size decreases with age most likely due to decreases in visual processing speed, reduced attentional resources, and less ability to ignore distracting

information [18]. UFOV performance is correlated with a number of important real-world functions including risk of an automobile crash. Performance can be improved by computer based training [19].

We focused on UFOV to make our new serious game for the elderly. By the repeated reaction on UFOV, we thought their bodies and mental abilities could be improved much better. We have decided to develop a walking game with vision giving the scene on the screen just as seen by the walker. So the movement of the scene should be adjusted with the steps of the player. Also to control the scene and the steps, we needed a useful and comfortable interface for the elderly.

‘Paldokangsan 3’ has the game concept of ‘mall walking’ to give walking action with visual pleasure as well as memorization. Walking to buy something in the mall or shopping area could help the player to concentrate on the game with little exhaust and longer play time. Its intention is to raise memorization, concentration, vitality by strengthening the UFOV. According to the player there should be several levels of difficulties. Also the game should give feedbacks to the player if the choice was right or wrong. We put different sound effect with color on every selection of the item in the game. And the final score with daily ranking and weekly ranking would show the accomplishment of the player [20].

3.2 Game Play

Figure 1 shows the game flow of ‘Paldokangsan 3’. The game starts with getting a mission that is to buy some items in the market, and walking the shopping street selecting those items following the remembering. The average time to finish the mission would be 5-10 minutes for one level. The player may forget what to buy: then a chance coin can be used to reshew the mission for five seconds in the screen [13].

The first screen of the game is to select one from five diseases (Figure 2). By hand motions the selection is done. After the selection, a mission is given to the player to buy those items in the market place. They are good foods for the selected disease (Figure 3). After confirming the mission, the walking starts in the screen of the market place with stores at both sides of the street. Each store shows a sign board of an item it’s selling. The player should decide to buy or not by raising hand of each side (Figure 4). At the end of each level, the player gets the score which is produced based on how correctly the player has collected and how fast the player has finished the mission (Figure 5).

The game has three levels. The first level is to remember three items with half round, and the second level is to remember four items with another half round. And the final level is to remember six items with another full round of the market place.

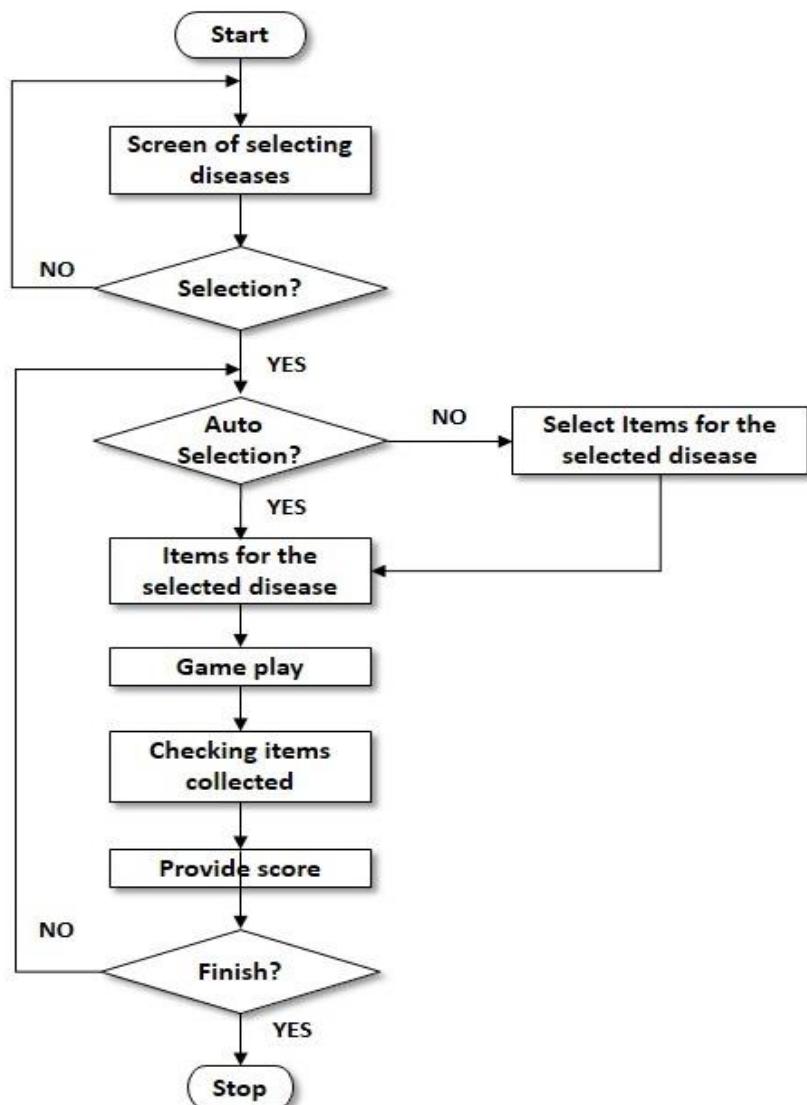


Figure 1. Game Flow [13]



Figure 2. First Screen to Select a Disease



Figure 3. Screen of Game Mission



Figure 4. Screen of Main Game



Figure 5. Screen of the Score of the Game

3.3 Game interface – Kinect

Using Kinect [9], it becomes easy to control the game with just a gesture. We have asked the old to walk in a small circle to count the steps, to use right hand to traverse in the menus, and to use left hand for selection and confirmation. Also we have added a gesture of remembering the mission and gesture of discarding a wrong item for the usage of the coin in the game.

One of the biggest benefits of using the Kinect interface is the business model. If the player has the Kinect and PC with big monitor or TV which can be connected to PC, he or she can download the software online to use them in the own environment.

3.4 Score of the Game

The score is an important factor for the player to get feedback from the game. When the player has finished each level of the game, the score would be given at the end for at least 10 seconds (Figure 5):

$$\begin{aligned} \text{Score} = & (\text{no. of correct items}) * K_1 - (\text{no. of wrong items}) * K_2 + (\text{no. of coins}) * K_3 \\ & + (\text{standard time} - \text{duration time}) * K_4 \end{aligned}$$

Where $K_1 \sim K_4$: constant numbers, time unit: sec

4. Experiments

4.1 Environment of Play Test

We have collected 25 volunteers of the game in Cheonan senior center in Chungnam in Korea to play the game once a day for total of 10 days since 8th Nov. 2013 (Table 1. General reviews) [13].

Table 1. General Reviews of the Players (N=25)

Area	Element		Average	Percentage(%)
Population and social variables	Sex	Female	20	80.0
		Male	5	20.0
	Age(66~83 years old)		76.0	4.4
	Height(141~168cm)		153.4	7.5
	Weight(40~75kg)		59.8	8.3
	Education	No school	5	20.0
		Elementary school	15	60.0
		Over Middle school	4	16.0
		No reply	1	4.0
	Subjective Health	Healthy	7	28.0
		Normal	11	44.0
		Unhealthy	5	20.0
		No reply	2	8.0
Interests on telecommunication devices	No interests		9	36.0
	Little interests		2	8.0
	Normal		8	32.0
	Large interests		2	8.0
	Very large interests		1	4.0
	No reply		3	12.0

In the experiment, two trained assistants worked: one for helping the game play with the scoring, the other for the questionnaire after the game. We recorded their scores in the game every time with the duration time and number of steps to check their adaptation. And we compared the values of the first finished day of level 3 which was 3rd or 4th day for each player, with the values of the last day.

The data was analyzed statistically to find correlation between several factors using SPSS with T-test.

4.2 Analysis

The number of times of playing the game is found to be deeply correlated to most factors with the confidence of 95% as in the Table 1(by **). The score was increased while the duration time was decreased with the number of times of the play. That meant the most player could memorize better, and finish the mission faster as the number of play increased.

The graphs of the variation of the factors according to the number of the times of the play are shown in Figure 6 ~ Figure 9 with different color for each level. Their average values were decreasing with the repetition.

Table 2. Correlations of Factors of 25 Players

		No. times	Score			Avg. score	Avg. duration time	Avg. no. step	Avg. no.step /sec
			Level 1	Level 2	Level 3				
No. times		1							
Score	Level 1	0.461**	1						
	Level 2	0.439**	0.519**	1					
	Level 3	0.309**	0.276**	0.494**	1				
Average score		0.623**	0.721**	0.793**	0.787**	1			
Duration time	Level 1	-0.664**	-0.626**	-0.524**	-0.313**	-0.692**			
	Level 2	-0.244**	-0.214**	-0.167**	-0.101	-0.270**			
	Level 3	-0.207**	-0.188	-0.013	0.005	-0.060			
Avg. dur. time		-0.531**	-0.537**	-0.431**	-0.186*	-0.552**	1		
No. steps	Level 1	-0.692**	-0.453**	-0.420	-0.168*	-0.601**	0.563**		
	Level 2	-0.651**	-0.437**	-0.484**	-0.237**	-0.614**	0.547**		
	Level 3	0.098	0.099	0.031	0.260**	0.187*	0.379**		
Avg. no. steps		-0.203**	-0.118	-0.142*	0.089	-0.096	0.417**	1	
No. steps/sec	Level 1	0.511**	0.577**	0.433**	0.240**	0.576**	-0.756**	0.005	
	Level 2	0.504**	0.411**	0.439**	0.263**	0.504**	-0.720**	0.82	
	Level 3	0.387**	0.260**	0.048	0.306**	0.268**	-0.737**	0.087	
Avg. no. steps/sec		0.554**	0.546**	0.434**	0.311**	0.590**	-0.818**	0.016	1

(number of times of the game, score of each level with average, duration time of each level with average, number of steps of each level with average, and number of steps per second with average) **: confidence of 95%.

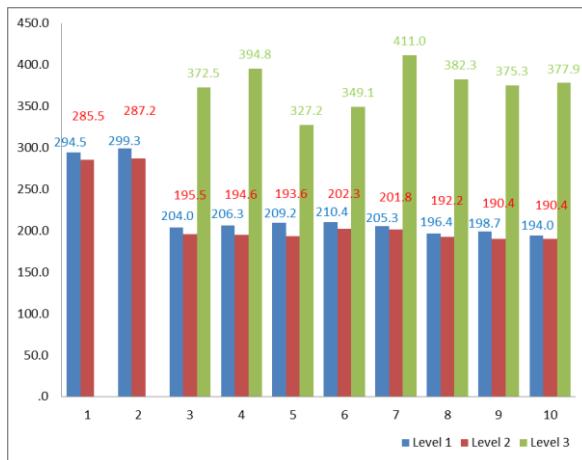


Figure 6. Average Number of Steps Variation for the Repetition

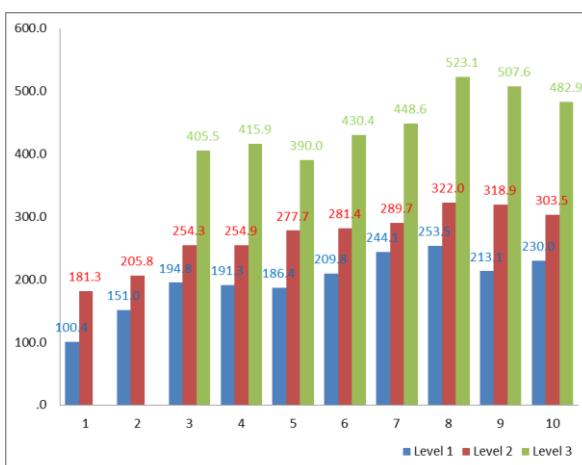


Figure 7. Average Score Variation for the Repetition

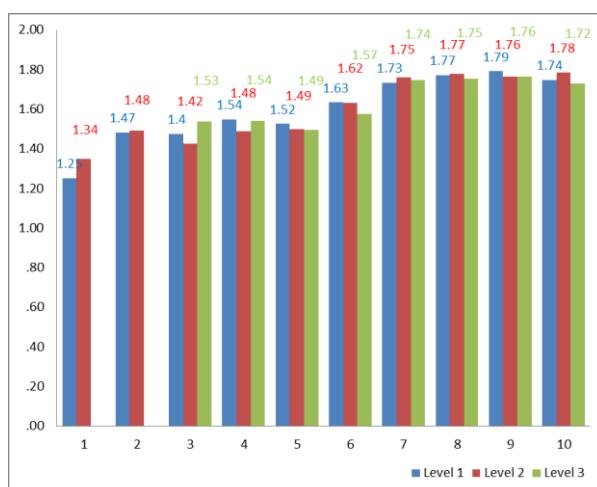


Figure 8. Average Number of Steps per Second Variation for the Repetition

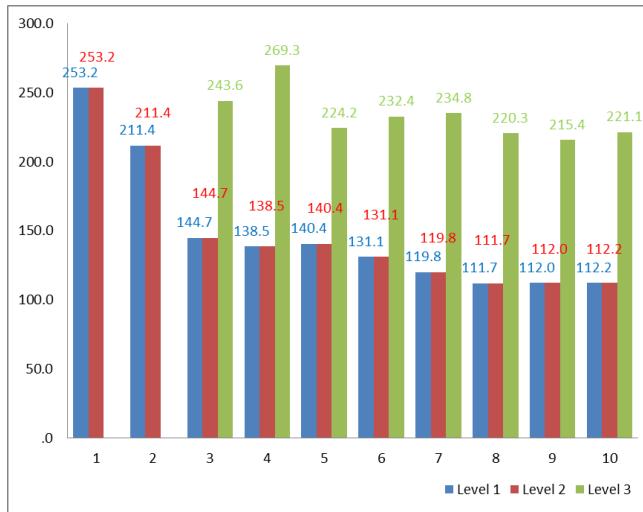


Figure 9. Average Time Variation for the Repetition

That means that the more repetition, the more correct and faster accomplishment.

In the previous work [13], the adaptation of the game and vicariousness for the avatar improved correspondingly through the game with the confidence of 99% and 95% respectively. And memorization of good foods for some diseases increased with confidence of 95% but for the general memorization of the player was not proved to have the confidential relationship. The analysis showed also the self-esteem has been increased after the game with the confidence of 99% [13].

For the French experiments, the PRL team gathered 20 old French people to pre-test the game ‘Paldokangsan 3’. The objective of the pre-test is to look its usability with appreciation survey for the game. Most of them enjoyed the game without complaining different cultural background while ‘Paldokangsan 3’ French version was just modified for the letters and words without changing sounds with Korean voices.

5. Conclusion

In this research, we have developed a serious game for the elderly that is a walking game plus memorization with motion capture interface using Kinect. And the game has been tested for its efficiency to 25 old people of more than 65 years old.

The statistical analysis of the results showed that the number of times of playing the game is deeply correlated to scores and duration time with the confidence of 99% that means better memorization with fast accomplishment.

To get regression analysis with R square and B for more precise analysis, it is necessary to have various control groups to analyze causal relationships between the independent variable and dependent variables among the factors of players. But we didn’t have such control groups in the last experiment that the experimental results have the meaning of basic correlation analysis to find the existence of one-dimensional relationships.

We are planning our future research to verify the effect of the game to be valid on normal memorization abilities of the elderly by adding factors to improve the short-term memory with better regression analysis with R square and B.

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