Development of Taekwondo Trainer System for Training on Electronic Protector with Hitting Target Indicator

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Summary
In this paper, we developed a digital taekwondo trainer system based on the electronic protector was authorized by the World Taekwondo Federation for the improvement of user's training effects and athletic performances. Our system consists of E-kick Bag with sensors for sensing hits, taekwondo trainer program and receiver for interconnection of E-kick Bag to program. Taekwondo trainer system also has an advantage to improve training effects and athletic performances such as hit-accuracy and reaction velocity by appointing a hitting target for users with 6 LED indicators. The taekwondo trainer program is a user interface to provide training courses such as progress training of response time and stamina, preparation training for real sparring by training scenario. It has also characteristics which are to strengthen and supplement user's pros and cons by analyzing hitting intensity and accuracy from training.
Key words:
Taekwondo Trainer system, Target Indicator and Electronic Protector

1. Introduction

After establishment of the World Taekwondo Federation (WTF) in 1972, Taekwondo, the representative culture content of Korea, made remarkable development, and got a title match from IOC in 1980, and it was adopted as a competitive sport in the Olympics. Also, about one hundred million people are training in 188 countries (41 countries in Asia, 49 countries in Europe, 42 countries in the American Continent, 43 countries in Africa and 13 countries in Oceania)[3,4]. While Taekwondo develops as a sport, it has pointed out its faults about the rule and result of the game. Especially, people who don't train Taekwondo look away owing to ambiguity of judgments. Therefore, in order to break down the ambiguity and distrust of referee's call, WTF pushed forward a development of the electronic protector for Scientific Movement and objectification of Taekwondo.

The electronic protector is an equipment to measure a hitting power with sensors and electro chips on head and body protection, and it displays by wireless what an attack was success. It also is one of the endeavors to make a regular event at the Olympics. WTF made a five-year contact about official approval and supply with the LaJust, Korea Sports Company, on September 11th, 2006. The paradigm of Taekwondo has changed to objectification, quantification and scientific movement. Because of official approval and supply, the training system was required in the same condition of using the electronic protector [5]. In other words, the training system demanded a development of hitting process and interface using the same or similar method of hitting sensing in the electronic protector. However, the existed training system just only measured a hitting intensity on pressure sensor, and figured an exact hit when over the regular hitting level.

Therefore, the purpose of this paper is development of Taekwondo training system which is able to increase a training effect and to train at the same condition as the electronic protector in the competition. The system is available to measure the absolute value of intensity and effective hits in each attack, based on standard hitting level on weight. In addition, it has the interface that the reaction velocity was checked time between indicating a target and hitting it, and it includes a function to improve the interest of training and hitting accuracy using the indicator on situations of training or competition. In this paper, we tested 10 people include national athletes and coaches who are different sex, age, and weight to judge an efficiency of system, and evaluated satisfaction and value of system through the survey.

2. Taekwondo Trainer System

Figure 1 shows the configuration of the Taekwondo Trainer System [1,2]. The trainer system consists of the E-kick Bag which includes six hitting sensors and LED indicators for target designation, Taekwondo Trainer Program (TTP) consists of communication part, DB, control & management part and GUI part, and the receiver for interconnection of E-kick Bag to TTP.
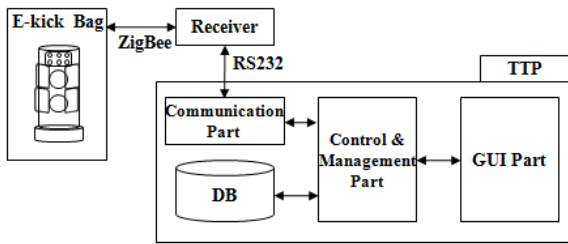
Fig. 1. Configuration of Taekwondo Trainer System

2.1 E-kick Bag

Figure 2 shows the configuration of the E-kick Bag which is the hardware system of the Taekwondo trainer system [1]. E-kick Bag is designed detachable system for the purpose of using punching bag or water bag and it contains sensing module that is possible to measure of hitting intensity. In addition, E-kick Bag includes display panel for show the hitting intensity and whether a valid hit, and LED indicator for target pointing. Each of six LED in indicator provide improvement of training effects by appointing a hitting target such as central of head, head left, head right, central of body, body left and body right for users.
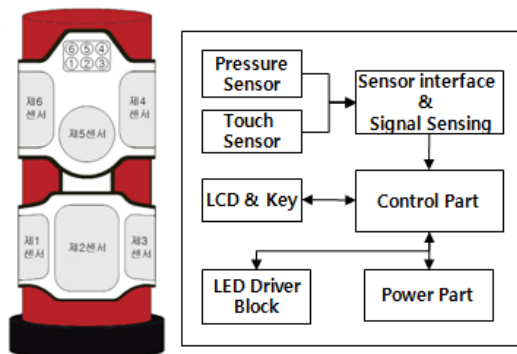

Fig. 2. Configuration of E-kick Bag

2.2 Taekwondo Trainer Program

TTP is a taekwondo training program that is available to analyze the hitting pattern such as accuracy and reaction velocity for hitting training, and setting, management, and control of E-kick Bag which is mentioned at 2.1 [2]. TTP is an monitor interface of target-destination, hitting intensity and target-accuracy using a visual indicator, LED, to increase the interest of training and target-accuracy. The menu consists of management of player registration, hitting intensity training, scenario training, result analysis

and system setting. The user is able to train by TTP, refer to Table 1. Target-Destination training measures a hitting intensity on target in given time after appointing the target, and Target-Free measures a hitting intensity on each target after hitting the target in free on E-kick Bag. Pre-defined scenario training measures a hitting intensity and reaction velocity as the indicator instructed in fixed training scenario. User-defined scenario training is a mode for setting a training scenario to fit in user's purpose.

Table 1: Training lists of TTP

Training Name	Detailed Name
Hitting Intensity Training	Target-Destination
	Target-Free
Scenario Training	Pre-defined
	User-defined

Figure 3 is the training flow chart of TTP. There are detail training processes below.

① Step of log-in process for users. When confirm the past statistics, go to ⑦.
② Step of training select.
③ Select the Target-Destination or Target-Free training in Hitting Intensity Training.
④ Select the Pre-defined or User-defined training in Scenario Training
⑤ Analyze the result in real time from the training start.
⑥ Save and analyze the training result.
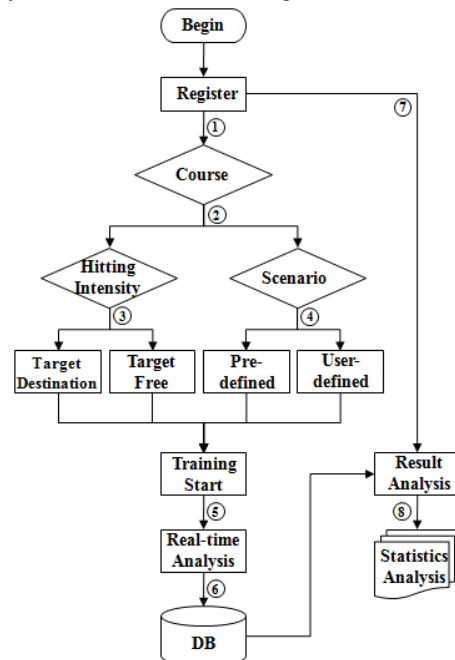⑧ Analyze the statistics of training result.

Fig. 3. Flow chart of Taekwondo Training Program

3. Experiments and Evaluation

3.1 Subjects of Experiments

In this paper, we implemented a test targeting eight taekwondo players on the playing list include a member of the Korea national team as shown in the table 2, and two coaches from municipal taekwondo team in order to evaluate the utility of our system. The player participated experiments consist of active-players with various ages, sex and weight classes. The test participants implemented three times of the hitting intensity training and two times of the scenario training as shown in the table 3. Each player checked own analysis of training results after finishing their training. After all tests, we conducted a survey for evaluating of satisfaction of the taekwondo trainer system.

Table 2: List of participants

PLAYER	WEIGHT	AGE	SEX	FEATURE
P1	Bantam	21	Male	Korea Classification - Top 16
P2	Middle	19	Male	Korea Classification - Top 16
P3	Heavy	27	Female	2010 Korea National Team Member
P4	Light	20	Female	2008 Korea Junior Team Member
P5	Bantam	25	Male	2007 Ministry of National Defense Champion
P6	Heavy	23	Male	2009 Ministry of National Defense Champion
P7	Pin	17	Male	-
P8	Middle	17	Male	Korea Classification - Top 8

Table 3: List of experiments

MODE	TRAINING-NAME	TIME(sec)	CONTENTS
Hitting Intensity Training	One step Kick	90	Training to measure the hitting times and intensity by hit on the designated target(right-footed : 3rd sensor, left-footed : 1st sensor) during 90 seconds
	Rotation Kick	90	Training to measure the hitting times and intensity by hit on the 1st and 3rd sensor on a rotation during 90 seconds
	Free Training	90	Training to measure the hitting times and intensity by hit on each target of the E-kick Bag freely during 90 seconds
Scenario Training	Scenario 1	90	Training to measure the hitting intensity and response time by hit on the directed target from indicator through the scenario
	Scenario 2	90	

Fig. 4. Example of result-analysis in TTP

3.2 Experimental Results

Taekwondo trainer system shows user's training results in the form of graph as shown in the figure 4. Player is available to measure own the average of hitting intensity, hitting times and average of reaction velocity per hitting position. It means the analyzed results can be used for improvement to training effects through the grasp of hitting patterns. Figure 5 shows the analysis of rotation kick training per each player. Moreover, for evaluating the correlation of strength and response time between same gender and same weight, we analyzed the variation of strength and response time using f-test, and analyzed the average using t-test. As a result of f-test, for male subjects in bantam-weight class P1, P5, in all of the position excepting 6th in strength data and 3th in response time data, variation ($f>0.05$) was significantly same. And as a result of t-test, strength data indicate the significantly different average in all of the position excepting 6th, and average of response time was significantly different excepting 2nd and 3rd position($p<0.05$) as shown in the figure 6(a). And male subjects in middle-weight class P2, P8 showed same variation excepting 2nd in strength and 3rd in response time ($f>0.05$), same average excepting 3rd and 4th in strength ($p<0.05$) as shown in the figure 6(b). These results

mean that the average of the strength and response is significantly different although gender and weight is same. For this reason, it will be possible to make the exercise scenario and focus to exercise based on this result.
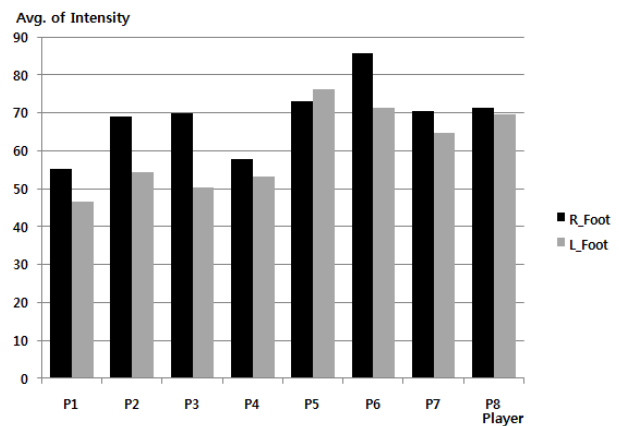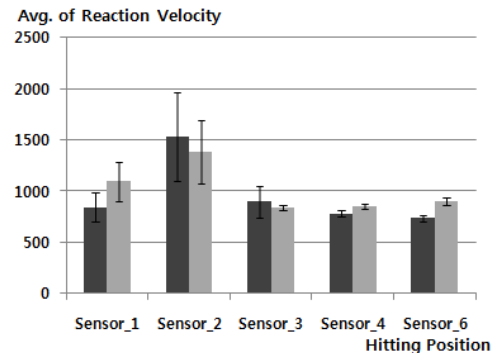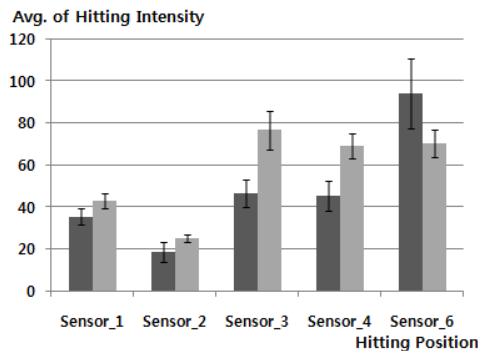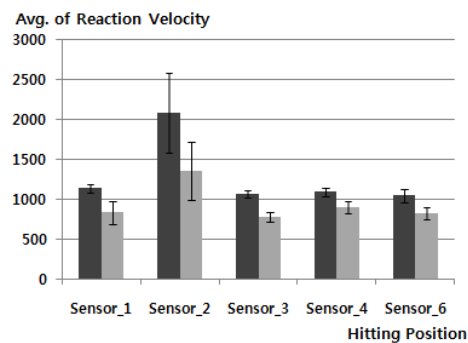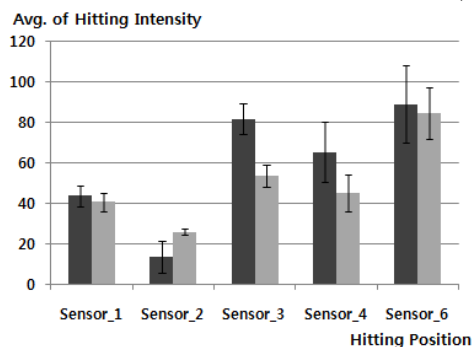

Fig. 5. Result of rotation kick training

(a) Results of P1 and P5

(b) Result of P2 and P8

Fig. 6. Results of f-test and t-test for evaluating the correlation of intensity and reaction velocity

3.3 Evaluations

In this paper, we conducted a survey for evaluating of effectiveness and user's satisfaction of the taekwondo trainer system. The survey consists of 10 questions include the similarity with existing electronic protector, satisfaction of intensity and scenario training course as shown in the table 4. The result of survey shows in the table 5.

Table 4: Contents of Survey

	Question
Q1	Similarity with existing protector
Q2	Accuracy of hit measurement
Q3	Sensitivity of hit
Q4	Satisfaction of reaction velocity measurement method
Q5	Contribution of training effects from intensity training
Q6	Contribution of training effects from scenario training
Q7	Contribution of training effects from reaction velocity measurement method
Q8	Satisfaction of scenario training
Q9	Satisfaction of user defined scenario training
Q10	Overall satisfaction of system

Table 5: Results of Survey

	Result (person)					
	Very good (5)	Good (4)	Normal (3)	Bad (2)	Very Bad (1)	Avg. score
Q1	3	6		1		4.1
Q2	3	5	2			4.1
Q3	3	4	3			4
Q4	2	5	3			3.9
Q5	3	5	2			4.1
Q6	2	6	2			4
Q7	3	6	1			4.2
Q8	1	3	5	1		3.4
Q9	4	5	1			4.3
Q10	4	3	3			4.1
Average						4.02

4. Conclusion

In this paper, we developed the taekwondo trainer system for training on electronic protector with hitting target indicator. The system consists of E-kick Bag with sensors for sensing hits, taekwondo trainer program and receiver for interconnection of E-kick Bag to TTP. The system is available to measure the absolute value of intensity and effective hits in each attack, and reaction velocity by appointing a hitting target for users with 6 LED indicators. For evaluating of effectiveness and user's satisfaction of the taekwondo trainer system, we tested 10 people include national athletes and coaches who are different sex, age, and weight. Participants of experiments gave a good grade more than 4 out of 5points as a result. Therefore, we think the system is of use to improve training effects.

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