KIHECT©: Reliability of Hand-Eye Coordination among Rugby Players Using Consumer Depth Camera

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Abstract. Rugby is a growing sport in the whole world. For athletes who want to achieve a high level of potential, such as hand coordination skills and speed of reaction (sport) both are expected to be in good performance. The main problem in many sports is that there is no test for the reliability of the developed test tools. Thus, the aim of this study is to determine the reliability of the tests, so the research was conducted twice with an interval of 6-7 days (test-retest). A total of 33 rugby players (16-18 years of age) have participated in the study. The analysis includes one motor tasks performed only with the use of KIHECT©. Thus, this study was conducted on a differentiated time and score through two methods of evaluation test: automatically and manually in order to obtain the level of reliability of the tools. The hardware and software that were used in this research are Kinect camera 360, windows SDK and computer or monitor use by CPU systems. The average values of the resultant p-values (<0.005) showed that the instrument is reliable and practical to be used in research area. A test on KIHECT© displayed sufficient reliability to see the difference in score data using automatic method (evaluation score using KIHECT©) and manual method (evaluation score of the two observers). Therefore, it can be implemented as a tool to train the hand-eye coordination in rugby games.

Keywords: Hand-eye coordination, reliability, reaction time, KIHECT©

1 Introduction

Rugby union is a full contact team sport which is characterized by recurrent high-intensity dashes and a high grade of physical contact. Claimed rugby union is a high-intensity field based contact team sport which is considered as a New Zealand's national game [1]. Besides that, rugby is becoming a completely skilled sport in 1996, as the expectation from the society and media for the accomplishments of both the team and individual players has been equally overwhelming. Therefore, rugby games demand a high body performance and are definitely competitive, and a lot of research has been extended in rugby union [2].

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In rugby, physical characteristic is an important factor to the improvement of the overall performance. Clearly, the physical character of the player is crucial for the player`s performance, as it will be improved in the games. Specific criteria are expected in order to obtain success is highly dependent on the physical characteristic, particularly the role of a certain position in the rugby [3]. In particular, the essential physical characteristics to be successful will be primarily determined by the role of the specific player position. For instance, outside backs must be able to overcome the opponent's defensive attack in open play, hence are compulsory to be fast and agile [4, 5]. On the other hand, players who have good physical fitness are capable of accomplishing their tasks much more easily during the games. Hence, where the players that have advanced levels of physical fitness may have an edge in the performance of responsibilities in competition [6].

There are a few website providing a free online application for hand-eye coordination test; The Hand-Eye Coordination Test [7] Hand-Eye Coordination Testing [8], both are not using any real equipment's except computer mouse. Thus, there are a few devices blending both application (software) and hardware; Batax by Quotronics [9], The Visagraph II [10], The Wayne Saccadic Fixator [11], and The Acuvision 1000 [12]. Vision in game is paramount to settle on a decision making and reaction in every task. The basis of sport vision incorporates three handling stages comprised of recognition, decision making, and reaction which are the usage of development [13, 14]. In fact, four components are recognized and are perceived to have an incredible effect on an execution to all games are ability execution, fixation, reaction time and decision making [15].

However, vision in the context of this article actually refers to the real player's physical ability to make certain task inside the functionality of the eye as a muscle [16]. Thus, sport vision is one of the critical components in rugby because most of the trainings intend to improve and use the vision skill in terms of passing, catching, tackling, side stepping, player marking, and any other skills in rugby. Sports vision is indeed vital as it does not focus on an exact aspect of the body, but on the body as a whole [17].

2 Related Works

KIHECT© or the Kinect Hand Eye Coordination Trainer was created based on "Natural Interaction on Human Body Tracking for Low-Cost Motion Capture for Real-Time Computer Graphics Applications". KIHECT© is a tool that helps the human hand-eye coordination. The results of this study showed that KIHECT© helps in improving human concentration and agility. A number of constraints have been identified in KIHECT©. We use the method of markerless to automatically identify a human hand but the hand position is less accurate due to the noise from the camera and so on. Due to this situation, it should be improved in terms of accuracy in mapping the human hand because what the athletes need is a measure of agility. These things are taken into consideration in making KIHECT© prototype for athletes.

These devices are widely used by researchers because of the reliability of the devices. Nonetheless, there are still disadvantages; heavy, needs an expert to operate and

calibrate the device, and high cost that only research center can afford to buy. Therefore, this study will develop a new innovation in technology-based device which is lightweight, can be operated by anybody, less time to calibrate, and low cost. The problems that were mentioned will be solved by the principle of human-computer interaction (HCI). The new way of HCI brought to us is a natural-user interface (NUI). For interaction of NUI, we call it natural interaction (NI) [18, 19] because this interaction is a new concept that goes back to the natural basis. NI is an emerging computer interaction methodology which focuses on human abilities such as touch, vision, voice, motion and higher cognitive functions such as expression, perception and recall. Previously, BATAK LITE was used to measure both hand-eye coordination and visual reaction skill.

Design innovation is known as an idea to a design or project to be developed for specific purposes according to the problems faced [20]. Thus, the advantages of technologies in sports research are acquired to improve skills in sport performance. Hence, the technological growths in notational study have unavoidably insulated those in the practical computing technology environment [21]. The function of the technologies in sport research is how the contribution of the research enhances performance.

BATAK LITE is still lacking in scientific of study to measure the hand-eye coordination skill and reaction time in research yet, because this tool is only for market commercialization while at the same time improving the hand-eye coordination and reaction time. Hence, it is important to investigate a new approach and create more reliable instruments to prove the new findings. Hence, stated that a reliable instrument for research would generate same data from the same subject [22]. Reliability is a measure of consistency over time and over the same samples [23]. Therefore KIHECT© was developed with the purpose that this new instrument is created based on sound research which did not happen in BATAK LITE. KIHECT© is the new tools designed to train the hand-eye coordination (HEC) and visual reaction time (VRT) while it would enhance the performance of athlete's skills. Innovation is known as an idea to a design or project to be developed for specific purposes according to the problems [20].

3 Data Acquisition

In this section, we will describe a method for 3D data acquisition from the camera to the data acquisition process and the type of face 3D camera utilized for face point cloud data and color images.

3.1 Input Device

In this study, we use the 3D camera that has several components that are included in the 3D camera. 3D camera is known as the Microsoft Kinect (Kinect). Kinect has 5 components: RGB camera (normal color camera), depth camera (3D camera), infrared (IR) laser projector, multi-array microphone and also motorized tilt. All components are shown in Figure 1. IR laser projector is used to emit infrared rays to the scene and

reflected back by objects on the beam to the 3D camera. Kinect reading speed is 30Hz or 30 times per second and Kinect is 640x480 pixels resolution for both RGB and 3D camera. Kinect has the ability to read a range of up to ± 9.9 m starting at a distance of ± 500 cm but with Kinect drivers supplied by Microsoft's own Kinect set can only be read between the ranges 1.2 - 3.5m. Kinect was used in this study because it is one of the 3D cameras that low-cost and able to afford by users.

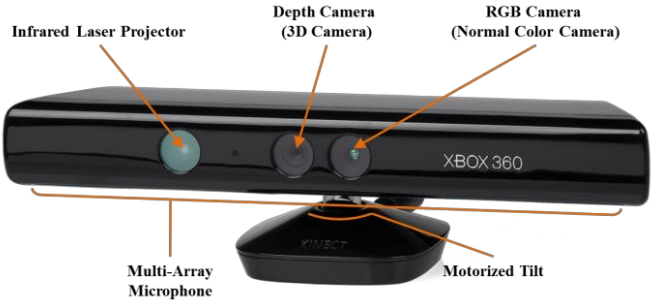

Fig. 1. Microsoft Kinect

3.2 RGB and Depth Data

For this study, the RGB data is very important to use to detect the human face as RGB color data contains information that can be used to get the current position of the face in the scene camera.

Depth data is also becoming an important element in getting the point cloud data for the process to form a human face avatar is to use the data. It is also important to position parallel with similar images in RGB camera.

Fig. 2 shows the images obtained from the RGB Kinect depth data and data from the same scene. RGB and depth data have no similarities in terms of pixel position due to its 3D camera and the RGB camera which has different position and it is repaired with a little calibration of both the camera.

Fig. 2. Depth data (left) and RGB data (right)

3.3 KIHECT©

KiHECT© is one of the products that use hand and eye coordination to interact with the application. Natural User Interface (NUI) that KiHECT© use enables user's full body involvement to respond with the developed application. The features of KIHECT© is shown in Table 1.

Table 1. KIHECT© Features

Hardware	Software
Camera mirrored both users' hands detection for the user-application interaction.	Able to set training time, movement pattern and difficulties level.
Voice recognition for Start and Stop procedure.	Automatically save training results, and can view personal records by data numbers and graphs.
Text to speech compatibility to give command and result.	Intelligent detection to recognize and records specific hand either left or right.
Motorized tilt setting for adjusting level of the camera.	Interactive and user friendly interface.

KIHECT©'s original idea came out from the problem of sport science fields that concentrate to enhance athlete's performance for specific parts of the body (hand-eye coordination) for training purpose. It is developed for specific population, i.e.: elite athletes, rehabilitation centers, training centers etc. KIHECT© also uses fewer raw materials as components such as steel, plastic, rubber and others.

Benefits of KIHECT© are listed below:

- Non reflective body marker technology that detects both hands.
- Solving contemporary product issues: high cost product, high maintenance cost, durability issues, bulky, heavy and time consuming for calibration.
- Improving drivers focus, alertness and efficiency for high speed driving and casual driving (i.e.: Formula 1 drivers, daily commuters).
- Enhancing hand-eye coordination for racquet sports athletes.
- Enhancing children cognitive developments in reading ability.
- As treatment method to overcome dyslexia among kids.
- As tools in rehabilitation program for users who are losing an ability to move and coordination between their hands and eyes.

All players were informed about how the power 2000 New Test device works and how the measurements be made. In order to measure learning, test measurements were conducted on all of the members or study group. Measurement environment was quiet, airy and there were no distracters. During tests, players successfully carried out the test's directives and were encouraged to have the maximum attention. Hence, the reliability test was done in one week.

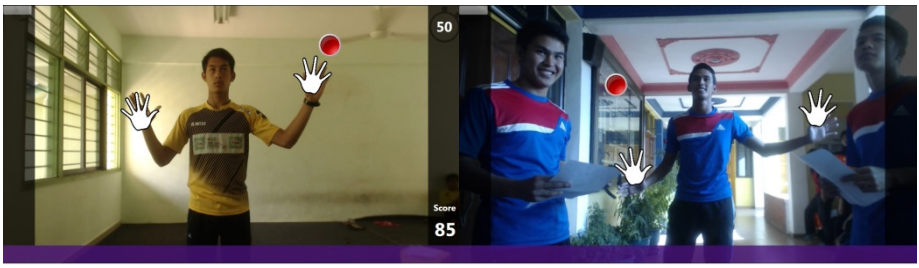

Fig. 3. KIHECT© using automatic system (left) and KIHECT© using manual system and helped by other 2 players (right)

4 Results

In this study, the participants were recruited from the Sekolah Sukan Tunku Mahkota Ismail (SSTMI) to measure the reliability test. 33 rugby players participated in this experiment to test the consistency of hand eye coordination using KIHECT©. Furthermore, KIHECT© developed by combining the hardware and software technology such as consumer depth camera, KIHECT© system and display system.

The validity of the motor task 1 was determined on the comparison between manual and automatic test score (KIHECT©). The test-retest procedures are to prove the reliability of KIHECT©. Reliability test indicates methods of two routines: for manual system is by evaluating left and right hand scores while programmed system is to survey score from left and right hands. In this device, the red dot as stimulus will appear randomly on the software and subject must react with a good hand-eye coordination to complete the task. The investigational and review models of research, this would mean that if a test and then a retest were conducted within an appropriate time span, the parallel results would be obtained [22].

In fact, hand-eye coordination is important to track the movement of the hands with the eyes, hence enabling the eyes to send the compulsory signals to the brain about hand movement while poor hand-eye coordination can greatly compromise the ability to exercise or even move, which may also affect the everyday basic tasks such as writing [24]. Hence, the score forms were provided to all players to fulfill the requirement accordingly. This study consists of one task only and the reliability study on the BATAK LITE has all 6 motor tasks [25]. Technically, in this study task 1 has been used to measure and train the weakness of hand-eye coordination among sport school athletes. Thus, condition 1 (automatic count) the time given is 30 seconds for the subject to complete the task by touching the red dot as a stimulus randomly, after that it will evaluate the total score of both hands during the test.

In addition to that, the automatic test recorded in the system that was completed in 30 seconds should measure the reaction speed with good hand-eye coordination depending on the total right and left hand touches. After the task is completed, the system will illustrate/demonstrate the result which indicates how many touches of the right hand, left hand and both hands. The data will then be recorded in the score forms

(see Fig. 3 (left)). Meanwhile, for condition 2 (manual count) the total number of touches by the right hand and left hand, the time and the total number of both hand touches are required to be counted manually by 2 observers. One observer counts the right-hand touches and another one counts left-hand touches. After the specific time has completed, the sum of the total of both hand touches is then recorded in the score forms (see Fig. 3 (right)).

Data of this research are analyzed with SPSS 16.0. Comparison of the research sampling in terms of reaction hand-eye coordination, reaction times, perception speed and decision making according to gender and variables is made with paired sample t-tests analysis and significant level is determined to be 0.005.

Table 2. Comparison paired sample T-test between the total for auto test and retest of left/ right hand scores to measure the hand eye-coordination

Variable	N	Mean	Standard Deviation	t	df	Significance
Total test auto (left/right hand)	33	32.97	5.187	-13.457	32	.000
Total retest auto (left/right hand)	33	39.55	3.930	-13.457	32	.000

The results of paired sample t-test, as depicted in table 2, indicate that the comparison between auto (KIHECT©) test and retest evaluated by left/right hands touches scores. The p value at 0.000 which is lower than t value at -13.457 at the 0.005 level of significance established. This is means, the mean and standard deviation auto test shows (32.97±39.55) and it is clearly significance. This conclude that using the paired sample t-test using innovation devices as a KIHECT© test score by left/right is reliable to use as a training tools and able to measure the hand eye coordination.

Table 3. Paired Samples Correlations for test-retest auto (KIHECT©) and manual (count by Manual)

		N	Correlation	Sig.
Pair 1	test_auto & retest_auto	33	.839*	.000
Pair 1	test_manual & retest_manual	33	.587	.000

As shown at the Table 2, the comparison correlation between test-retest using auto method (KIHECT©) and manual (count by manual). Hence, the auto (KIHECT©) test-retest show the highest reliability was observed in pair 1, where the correlation coefficient was r = 0.83, while the lowest reliability was noticed in pair 2, where r = 0.58. This is meant the KIHECT© was reliable to use as a training tools.

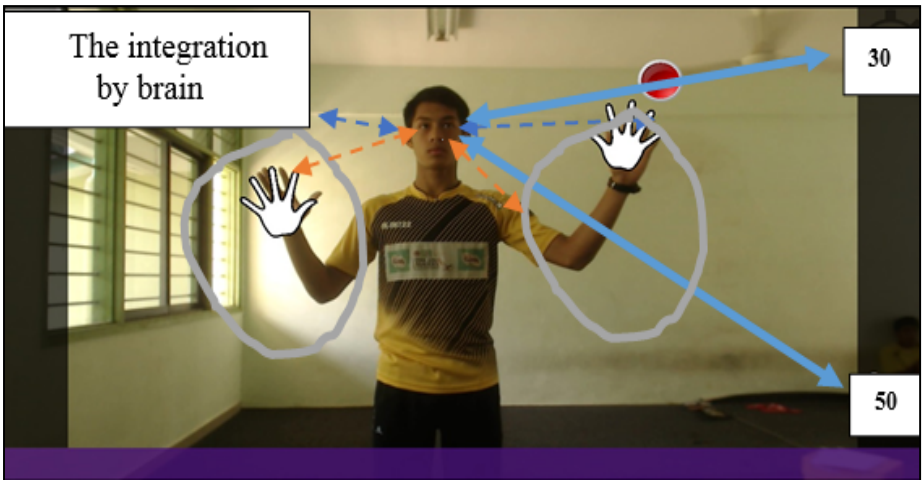

Fig. 4. Descriptive in term sport science and the process of Hand-Eye Coordination (HEC) and Reaction Time Speed

5 Conclusions and Discussions

KIHECT© developed is intended for use in testing and training will be able to measure and train the hand-eye coordination (HEC) and visual reaction speed (VRS). In addition, tests were performed on these tools by using experimental methods in test-retest. KIHECT© as training tools using high technology is to test the level of hand-eye coordination as well as to assess the level of visual reaction speed. Furthermore, in terms of sports science view, HEC is included the physical fitness component of sport vision. Hence, visual skill is one of the important components to give info to the info for hand to complete the task. In fact, visual is a learned skill that implies an appropriate interpretation of what is seen and interpreted [26]. So, KIHECT© is reliable to be a training tool to improve the visual skill while it is enhance the hand-eye coordination in sport performance. Refer to the figure 5 below; this is how the system and the test initiated.

Refer to the figure above, the skill showed by the subject to test the hand-eye coordination in which it tried to touch stimuli to react as soon as possible. This means that, based on the picture above shows the movement of the subject or skill points to make air visual contact of the stimulus and it is shown that the good combination between eye and hand to touch it. Based on the paired sample t-test, indicate that the mean or the average of the auto (KIHECT©) test is sufficiently better.

This is because; in a given time is 30 seconds, to touch the red dot as a stimulus as much as quickly as possible to get that many in a short time. Motor task 1 from BATAK LITE were applied the test in 30 seconds to touch the stimuli randomly as much as possible [25]. Moreover, KIHECT© usefulness to improve and training for vision in pass and catch technique.

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