



Original Research

Preliminary Design and Construction of Reaction Time Platform for Swimming Start Block

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ABSTRACT

The purpose of this exploratory descriptive study was to designing and producing a reaction time platform for swimming start block.

The participants consisted of 25 male swimmers had been training background at least three years, with mean age of 18.481 ± 2.32 years mean body mass 64.31 ± 7.65 mean height 174 ± 5.39 cm and mean body mass index 21.07 ± 1.97 kg/m²; participated in this study, randomly and voluntarily. This device can be installed on the swimming start block. Under the feet of the subject are 6 "batten sensors" that are placed on the front of the platform, and the timer starts to work with device startup bib and is stopped when the swimmer take off from the swimming start block and visible reaction time recorded on the LCD and saved on memory card. The device has two inputs, from the start button and sends data from sensors. The device has two outputs for shows the time and information and connect to the computer via the USB port and sends information to the computer after processing. The device software is written with the programming language C. From experts in swimming, coaches, referees, and swimmers opinions were used to evaluation the validity of device. The Pearson Correlation Coefficient was used to analyze the reliability of the data in two stages by SPSS version 23 statistical software. There was significant correlation coefficient ($P = 0.023$) between reaction time in the first and second times, There was significant correlation coefficient 47.2 ($P = 0.036$) between reaction time in the first and third times. There was significant correlation coefficient 65.9% ($P = 0.002$) between reaction time in the second and third times. Base on the result reaction time in swimming start, there was significant correlation between three times performances. This means with 95% confidence that this device has the reliability and validity required. It is recommended to coaches, referees and researchers use this device in training, competitions and future studies to improve the reaction time of swimmer, reduce the swimming record and referee's error during start.

Keyword: Design and Manufacturing, Reaction Time, Start Bock, Swimmers.

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INTRODUCTION

The swimming start has always been in continuous development that is more beneficial to swimmers find a suitable technique(1). A number of different block techniques have been used by swimmers over the years (2, 3). Training and laboratory equipment will help improve performance. The most recent exhibit development related to equipment emerged in 2009 when the International Swimming Federation FINA approved the new starting block with a back plate (FR 2.7 Starting Platforms in FINA's rules) that features an “adjustable, slanted footrest” (1). Memarbashi et al. designed and produced a mechanical starting block in track and field. Jast. Yuji Ohshima and et al (4). Ryu Nagahara et al. designed the new generation the starting block for biomechanical parameters in track and field (5). Jesus and et al. described the development and validation of a three-dimensional (six-degrees of freedom) instrumented block for swimming starts and turns (6). The new starting block by Omega firstly appeared in Beijing Olympic Games since the FINA amended the rule (OSB11, Corgémont, Switzerland). And this new start block gave rise to the researchers and academics focused more on the start techniques on this new start block (7).

In swimming, a fast start (time to 15 m) is important for competitive success, particularly in sprint events. This period of a race sequentially includes the block phase, flight phase, water entry, underwater streamlining, underwater propulsion, breakout, and some free-swimming. The block phase influences the performance in subsequent components of the start and, therefore, it is important for swimmers need to optimize their take-off parameters on the block (8). All athletes who are involved in team sports should have some advantages in their motor skills as well. These skills are to be improved by training. It is a fact that strength, agility, endurance, flexibility, and balance all of which are the factors used consecutively in aerobic and anaerobic systems which affect the performance of both team sports and individual sports (9). In order to be successful in sport events, an athlete must show a high performance with regard to physical and motor skills. One of the parameters that enables an athlete to have such performance is reaction time (10). Bloom et al. (1978) measured the reaction time as the time of the first visible movement after the starting signal but included a movement time, which was the time a swimmer's feet left the block (9). Havriluk and Ward (1979) measured a response time that was defined as the time from the starting signal until when the swimmer left the block, but also divided this into two separate phases - reaction time and movement time. Mills and Gehlson (1996) also measured flight time in their analysis of starts but did not define this phase (9). Highly skilled swim-starts are distinguished in terms of several factors: reaction time from the start signal to the impulse on the block, including the control and regulation of foot force and foot orientation during take-off; appropriate amount of glide time before leg kicking commences; effective transition from leg kicking to break-out of full swimming with arm stroking; overall maximal leg and arm propulsion and minimal water resistance; and minimized energy expenditure through streamlined body position (11). Reaction time was measured as the time between the “start” signal and the first movement of the participant using a reaction pad attached to the block (12). Start times were shown to consist of between 0.8% and 26.1% of the total race time depending on the event. The start time was then broken into various phases to determine the significance of each phase for the total start time. It was shown that the most significant variables in determining a quick start time were the underwater distance and time for both male and female events (9). In swimming competitions, especially 50 and 100 meters that the distance is short, the reaction time is very important to succeed. Therefore, measuring the reaction time is so important for decrease the final swimming time. Previous knowledge and history of invention device related to device can measure reaction time of hand fingers and legs that form visual and auditory stimuli are used.(1) In spring competitions, swimmers are not far apart in finish. Feedback on reaction time during start swimming with practice can be reduced the start and total time of swimming. The aim of this study is design and construction of reaction time for swimming start block.

MATERIAL AND METHODS

An exploratory design was used for device efficiency evaluation. Convenience sampling was used to recruit community male participants between 18-24 years of age who were healthy students. The participants consisted of 25 male swimmers had been training background at least three years, with mean age of 18.481 ± 2.32 years mean body mass 64.31 ± 7.65 kg mean height 174 ± 5.39 cm and mean body mass index 21.07 ± 1.97 kg/m²; participated in this study, voluntarily. Inclusion criteria were persons with: Male swimmers with at least three years background training, no apparent musculoskeletal, postural or neurological ailment, healthy students, and age between 18-24 years. Exclusion criteria were person: A history of major musculoskeletal surgery at trunk and/or lower limbs, neuromuscular disorders, orthopedic related diseases,

limb length discrepancies of greater than 5 mm, if heavy physical tasks or exercises leading to fatigue were performed in the previous two days prior to the experimentation, reported history of psychiatric illness (13, 14), clotting disorder, infections and implanted internal devices (e.g., pacemakers)(15-17) and participants having them excluded from the study. Participants were asked again before signing the consent form to report if any of these conditions are present. Each volunteer who met the above criteria was invited to participate in the study. An orthopedic surgeon in a local clinic assessed all subjects prior to selection. All subjects gave their informed consent to participate in the study. To project a Sample size, a power analysis was calculated using G*Power software computer program (18). Using analysis of variance, with an α of .10, the size of sample was 20 participants (18). The actual sample size is 25 participants.

The overall view of the device illustrated in Figure 1. This device has two inputs, the first input is taken from the start button (part A) which is to get started and the second input is to send data from sensors (Part B). The device has two outputs which the first output is the display (Part D) which shows the time and information. The second output is to connect to the computer via the USB port (Part E) and sends information to the computer after processing. Furthermore, the device has the ability to save data on a Micro SD card with FAT32 format and shows the reaction time and the athlete's code on the LCD. There are 4 keys on the device plus a numeric keypad for determining the code for each athlete (Fig. F). The device software is written with the programming language C.

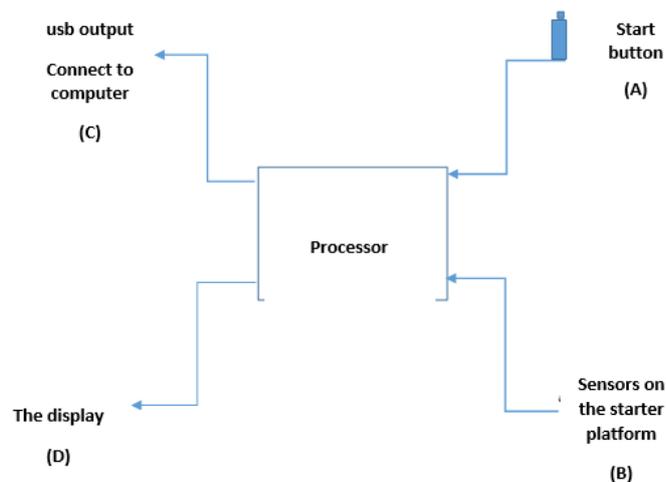


Figure 1: Inputs and outputs of the device

Based on the technical drawing of the device (Fig. 2), Sensors (Touch and Pressure Sensors) are located in the upper part of the platform plate (Part A) and the front end of the platform (Part B), which is used to send information from the under the feet of the swimmer to the device. Body of the device (part C) is located to fix the device on the swimming start block with dimensions of 40×60 cm. This device has a processor that receives sent data from the start command and bottom sensors. After processing, It saves on the memory card embedded in the device and can be transfer with a USB port to a computer. The name of the microcontroller used on this device is (ATMEL, USA) ATMEGA32.

This microcontroller has been coded by the programming language C and converted to the hexadecimal file with help of the AVR Studio 4 compiler software. It was then saved and used by using microcontroller builder software and through serial port on microcontroller (9).

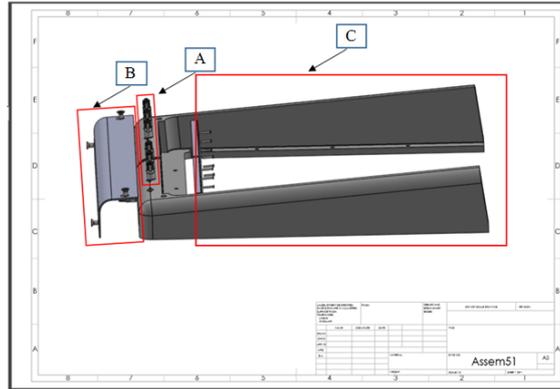


Figure 2: Technical Map of the swimming start block reaction time device



Figure 3: The apparent shape of the swimming start block reaction time device

Statistical analyses

The method of this study is exploratory descriptive and its purpose is to development. So after data collection, the Pearson Correlation Coefficient was used to analyze the reliability and validity of the data in two stages by SPSS version 23 statistical software.

RESULTS

Based on Figures (1) and (2), an overview of the device has been provided with its accessories and also the homepage of the designed software program. The operation of the device is in this way that, the referee presses the start button and notified with audio stimulator to the swimmer by the speaker. The timer starts to work with device startup. under the feet of the subject are 6 "batten sensors" that are placed on the front of the platform, and the timer is stopped when the swimmer take off from the swimming start block and visible reaction time recorded on the LCD and saved on memory card. From experts in swimming, coaches, referees, and swimmers opinions were used to evaluation the validity of device which was used in making the device. Statistical samples was performed the swimming start in three times for reliability of device. After data collection, all information transfer to computer. Pearson correlation coefficient between the two times performance were calculated with help of SPSS software. The results showed that, the Pearson correlation coefficient was tested for the reliability of the reaction time of the device in three times performance. The Pearson correlation coefficient was significant 50.7% ($P = 0.023$) reaction time in the first and second times, the Pearson correlation coefficient was significant 47.2 ($P = 0.036$) reaction time in the first and third times. The Pearson correlation coefficient was significant 65.9% ($P = 0.002$) reaction time in the second and third times.

Base on the result reaction time in swimming start, there was significant correlation between three times performances. This means with 95% confidence that the device records the same reaction times repeatedly for a swimmer with a same pattern. Overall, this device has the reliability and validity required.

Table 1. Reliability of reaction time for swimming start block in three times

Test	Mean ± SD	Test	Pearson coefficient	Sig
1	0/620±0.059	1 and 2	0.507	0.023
2	0/605±0.049	1 and 3	0.472	0.036
3	0/061±0.061	2 and 3	0.659	0.002

DISCUSSION

In order to be successful in swimming completion, a swimmer must show a high performance with regard to physical and motor skills. One of the parameters that enables an athlete to have such performance is reaction time (6). The result showed that, this device has the validity required. There were made samples of reaction time device for other sports such as football, martial arts in Iran but there are differences performance between these devices and produced devices. This device made for swimming pool and can be used to researches and reduce the reaction time of swimmers in swimming start. Jesus and et al. described the development and validation of a three-dimensional (six-degrees of freedom) instrumented block for swimming starts and turns (6). In this study, has been investigated more on the kinetics and kinematics of starts and turns, but the present study focuses on the reaction time of the swimming starts. Researchers have examined biomechanical comparisons of swimming starters technique in competitive swimming(19). Swimmers who are less expert at the swim start spend more time in this phase and would benefit from training designed to reduce: (i) the time between reaction to the start signal and impulse on the block, and (ii) the time in transition (between gliding and leg kicking, and between leg-kicking and full swimming). Key points swimmers meet two main constraints during the start movement: travelling more distance in the air (to get less resistance) and rotate to enter properly in the water (11). Due to present Federation International de Natation (FINA) starting block facility rule modifications, some researchers and coaches have invested in new technologies to measure the reaction time applied to the swimming starting block during different starting techniques (20, 21). In addition, researchers have also evolved their study purposes to separate the effective swimmers' time in deferent components (5), highlighting the crucial role of taking specific and accurate measurements by instrumented starting blocks. Swim start is a sum of compromises in all parts of it, and swim start expertise is distinct from swim stroke expertise corresponding to best ways to manage these compromises. Variability found is contextualized as having a functional role and operating across multiple levels of analysis (11). More researchers have summarized the current literature regarding the kinematics research progress of swimming start on Omega start block and find the proper swim-start to optimize the swimming performance (7). The current work aimed to describe the design and construction of a low-cost reaction time, as precursor of a swimming suitable device for decreasing time in different start techniques evaluation. The design of the platform can follow the laboratory reaction time device and that is very simple.

Notwithstanding the relevance of present data, some study's limitations should be considered. Despite the above mentioned advantages of this device, this is suitable for reaction time measurements during start swimming. In addition, the environment of the swimming pool demands waterproof sensors (as the bonding process is hygroscopic and may be damaged). Finally it is expectable to have a regular instrumented block complying with FINA's FR 2.7 and 2.10, rules designing the loci and anchorage of the necessary set of platforms. Future studies should take into account of such feature and try to mitigate its effect.

CONCLUSION

Reaction time device for swimming start block has the validity required. Swimming start block can be equipped with help of this device that swimmer and coaches can record the reaction time of swimmers and it can be used in competitions and researches. It is recommended to coaches, referees and researchers use this device in training, competitions and future studies to improve the reaction time of swimmer, reduce the swimming record and referee's error during start.

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طراحی و ساخت تخته زمان عکس‌العمل در استارت شنا

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مقدمه و اهداف: هدف از پژوهش اکتشافی-توصیفی، طراحی و تولید یک تخته زمان عکس‌العمل در استارت شنا بود. شرکت کنندگان این پژوهش ۲۵ مرد شناگر با حداقل سه سال سابقه ورزشی با میانگین سنی، قد، وزن و شاخص توده بدنی (به ترتیب $18/48 \pm 2/32$ سال، $174 \pm 5/39$ سانتی متر، $7/65 \pm 64/31$ کیلوگرم و $21/07 \pm 1/97$ کیلوگرم بر متر مربع)، را به عنوان به طور کاملاً تصادفی و داوطلبانه در این پژوهش شرکت کردند. این دستگاه بر روی سکوی استارت نصب می‌شود. در زیر پای‌های آزمودنی ۶ دکمه سنسور که در قسمت جلویی سکوی استارت قرار دارند. زمان عکس‌العمل با بوق استارت شنا شروع به کار می‌کند و هنگام کنده شدن پای‌های آزمودنی از سکوی زمان‌سنج قطع می‌گردد. و زمان واکنش بر روی صفحه نمایشگر قابل مشاهده است و در کارت حافظه ذخیره می‌شود. نرم افزار دستگاه با زبان برنامه نویسی C نوشته شده است. برای ارزیابی روایی از نظر متخصصان شنا، داوران، مربیان و شناگران استفاده شد. برای تجزیه و تحلیل پایایی از ضریب همبستگی پیرسون با کمک نرم افزار SPSS نسخه ۲۳ استفاده شد. نتایج نشان داد: پایایی دستگاه زمان واکنش در مرحله اول و دوم دارای همبستگی معنی‌دار بود ($P=0/023$). پایایی دستگاه زمان واکنش در مرحله اول و سوم دارای همبستگی معنی‌دار بود ($P=0/036$). پایایی دستگاه زمان واکنش در مرحله دوم و سوم دارای همبستگی معنی‌دار بود ($P=0/002$). با اطمینان ۹۵ درصد می‌توان بیان کرد که این دستگاه از پایایی و روایی لازم برخوردار است. به مربیان، داوران و پژوهشگران توصیه می‌شود از این دستگاه در تمرینات، مسابقات و پژوهش‌های آینده برای بهبود زمان عکس‌العمل شناگران، کاهش رکورد و خطاهای داوری استفاده کنند.

واژه‌های کلیدی: طراحی و ساخت، زمان واکنش، سکوی استارت، شناگران