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Original Research

Designing and Manufacturing of a Hexagonal Device to Assess the Reaction Time of Sitting Volleyball Athletes

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ABSTRACT

Sitting volleyball is one of the most popular Paralympic sports, which requires special movement and physical fitness factors according to the rules of the race. Reaction time is one of the most important physical fitness factors for players of sitting volleyball. Most of the devices and tests used to evaluate this factor are common among healthy athletes. However, in para athlete sports such as sitting volley, there are limited devices for evaluation and conditioning them. The specialization of physical fitness tests and devices for para athletes in each sport has an important role in the evaluating, preparing and success of the teams. In sitting volleyball, it is very important for athletes to move their body at different directions to reach the ball and have a suitable reaction. So, the aim of this study was to design and manufacture a system which could evaluate the reaction time of sitting volley players at 6 different directions. The hexagonal reaction time measuring system is a device that measures the reaction time by using six sensors located on the floor and a lamp panel in front of the athlete. When the lamp of each sensor turns on, the athlete should touch it in the shortest time by pushing himself at the given direction. This time period is measured and displayed as the reaction time.

Keywords**:** Sitting volleyball, Athlete, Hexagonal system, Reaction Time

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Introduction

Professional disabled sport has developed rapidly in the recent years. Sport is important to helping disabled individuals coming out of social isolation. Disabled individuals with a growing number include not only people born with disabilities, but also many victims of traffic accidents and war conflicts (1). Physical activities of the disabled individuals are not limited to the leisure time activities or rehabilitation that improves their physical fitness. Being a part of active rehabilitation, sport aims to restore self-confidence of the disabled people. Competitive sport is also a way of satisfying ambitions and presenting high abilities (1-4). Today, there are numerous sport branches adapted for the disabled individuals. Sitting volleyball is one of the Paralympic sports that the disabled can participate**.** As a high-level competitive sport, sitting volleyball appeared on the international scene comparatively late in 1980. That year, sitting volleyball became an official event for the first time at the Paralympic games in Arnhem, the Netherlands (6, 7). In sitting volley, for official tournaments a classification on minimum disability is required (1, 5, 7).

Sitting volleyball is a fast, high level competitive team sport, demanding physical fitness (6). There are significant relationships between sitting volley performance and field fitness of sitting volleyball players such as speed, endurance, strength, agility and reaction time (6, 8, 9). Since most sitting volley players have disability on their lower extremities, there is a main difference about displacement of players between sitting volleyball with other para sports, in which, sitting volley players use their hands to move and slide across the playing court instead of their feet, and their buttocks must remain on the floor while playing, serving, and blocking. At least one part of the player's buttocks should remain on the floor during passing, serving, attacking and blocking. For performing the skills of volleyball under these rules, the players should have high level of physical fitness (1, 5, 7, 10). Also, as everybody knows, different skills of volleyball are played by hands, which means that hands are used both to perform different skills and for moving to different directions to reach the ball in sitting volleyball. It highlights the crucial role of hand reaction in success of sitting volleyball players. Reaction time is the ability to respond quickly to a stimulus. It is important in many sports and daily living activities, though it is not often measured. Simple reaction time is the time taken between a stimulus and movement (e.g., sprint start) (11)**.**

Such simple reaction time depends on nerve connections and signal pathways, is 'hard wired' in our body composition and cannot be improved. Another type of reaction time, choice reaction time, is the time taken between stimulus and action which requires a choice. Choice reaction time can be improved by practice and training (12).

Performers receive stimuli from the eyes (position of other players, the ball etc), the ears (calling from players, the referee, even spectators), and kinesthetic sense (the performer's position, their options etc) (11). Skilled players reduce reaction time by selecting the most important information, and by anticipating other player's actions and the path of the ball quickly (12).

As with all sports fitness testing, specificity is very important, and if you want to measure an athlete's reaction time in a certain sport, you should select a test that is more specific to the visual cues and muscle reactions that are encountered during that sport.

There are various tests to assess the reaction time of athletes, such as the ruler drop test and BATAK Pro reaction test (11). All tests used to assess reaction time are designed for healthy people. One of the important factors in choosing the type of test for athletes is the specificity of the test for that sport. Since sitting volleyball players receive the ball from any direction and must relay it by attack or defense to the next player, they need to quickly make decisions and move in different directions (8). Also, as mentioned above, while performing all movements of sitting volleyball, whole or part of the player's buttocks must be in contact with the floor and despite of this, the score is given to the rival

team. So, the exercises and tests should be done in sitting position in different directions. There is no device or tests which cover this scope of sitting volleyball (7, 10).

Furthermore, due to the fact that sitting volleyball athletes have to use their hands to move and reach the ball, and this factor affects the way they react, so based on the characteristics of this sport, it is necessary to design and build a suitable tool to measure the reaction time. So, the aim of this study was to design and manufacture a system which could evaluate the reaction time of sitting volley players at 6 different directions.

Technical Field of Invention

The technical field of the invention is sport testing.

Material and Methods

The device consists of three electronic parts connected to each other, which include: The sensors, Lamps panel and the Remote.

Figure 1: Complete design and setting of the device

1. **The sensors:** 6 touch sensitive sensors (20×10×5 cm) that are placed around the player on the floor and create a hexagon. These sensors are connected to each other and to the lamp panel via wires (Figure 2).

Figure 2: 6 touch sensitive sensors

2. **Lamps panel:** The screen has 6 lamps on it (one lamp for each sensor) and after each test shows the reaction time of the player (Figure 3).

Figure 3: The screen with 6 lamps on it

3. **Remote:** A device that commands to turn on the panel lamps. Due to the physical condition of the coaches and athletes of sitting volleyball, the remote is wireless (Figure 4).

Figure 4: The remote for turning on the panel lamps

Figure 5 shows the electronic map and table 1 shows the components used:

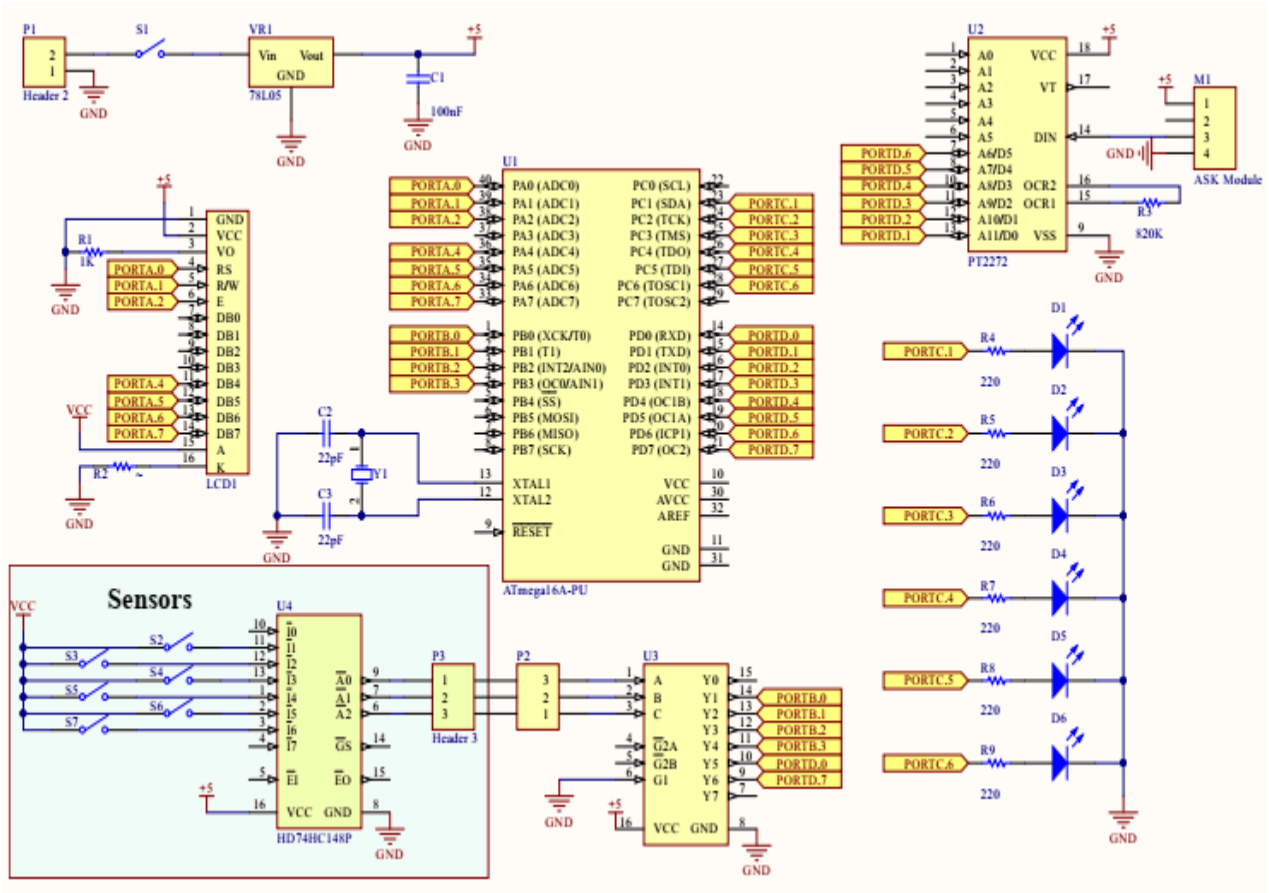

Figure 5: Electronic map of system

Table 1: The used components

Comment	Description	Designator	Footprint	LibRef	Quantity
Cap	Capacitor	C1, C2, C3	RAD-0.3	Cap	3
LED0	Typical INFRARED GaAs LED	D1, D2, D3, D4, D5, D6	LED-0	LED0	6
LCD 16X2	LCD 16X2 Character lcd	LCD1	My_LCD 16x2-A	LCD 16X2	1
ASK Module	Header, 4-Pin	M1	HDR1X4	Header 4	1
Header 2	Header, 2-Pin	P1	HDR1X2	Header 2	1
Header 3	Header, 3-Pin	P2, P3	HDR1X3	Header 3	2
Res1	Resistor	R1, R2, R3, R4, R5, R6, R7, R8, R9	AXIAL-0.3	Res1	9
SW-SPST	Single-Pole, Single-Throw Switch	S1, S2, S3, S4, S5, S6, S7	SPST-2	SW-SPST	7
ATmega16A-PU	8-bit AVR Microcontroller, 16KB Flash, 512 Bytes EEPROM, 1KB SRAM, 40-pin PDIP, Industrial Grade (-40°C to 85°C)	U1	40P6	ATmega16A-PU	1
PT2272		U2	DIP-18	PT2272	1
HD74HC238P	3-to-8 Line Decoder / Demultiplexer	U3	PRDP0016AE-B	HD74HC238P	1
HD74HC148P	8-to-3 Line Octal Priority Encoder	U4	PRDP0016AE-B	HD74HC148P	1
78L05	Voltage Regulator	VR1	D2PAK_N	Volt Reg	1
XTAL	Crystal Oscillator	Y1	R38	XTAL	1

Findings

Claim 1: The hexagonal device has six sensors that can evaluate the player's reaction time in six different directions (Figure 1).

Claim 2: The design of the sensors and their height are specialized for sitting volleyball players (Figure 2).

Claim 3: The lamp panel provides a visual stimulus that specialized for the nature of stimuli that occur in the game of sitting volleyball (Figure 3).

Claim 4: Using the remote helps the trainer and player to perform the test remotely without the need for movement (Figure 4).

Discussion

Physical fitness is one of the most important aspects of any sport that the implementation of most sports skills and success depends on this factor (13). Each sport has its own physical fitness needs, for example, the fitness needs required in volleyball are different from football. Also, the fitness needs of a sport are different for healthy people than the people with disabilities (12, 14-16).

Sitting volleyball is one of the sports where reaction time is very important for success in it (1). Athlete’s reaction is defined by the time between stimuli and the athlete's response to it (11). In sitting volleyball, predicting the path of the ball sent from the opposing team players, moving toward it and choosing a proper hit to the ball indicating the importance of reaction for para volley players. The faster reaction of the player to receive, defend and control the ball, the more likely chance for success and getting scores. Due to the conditions and nature of this sport and the lack of a suitable device to

evaluate the player's reaction time, we designed a hexagonal device to assess the reaction time of sitting volleyball athletes and eliminate the existing defects. In this device, the use of ground sensors brings the test performance conditions closer to the actual conditions of sitting volleyball match. Due to the breadth and variety of positions for a sitting volleyball player during the game, the hexagonal device can evaluate the player's reaction in 6 different directions. On the other hand, most of the coaches and staff of the team also have disabilities, using the remote makes it easy for them to perform tests and trainings. Finally, the hexagonal device of sitting volleyball player's reaction time is a device that was specialized to the needs of this sport.

Conclusion

Sports for the disabled are an area that needs more attention. Specialization of training and testing tools for this group of athletes can increase their performance. The main purpose of this device is to make the reaction time test, specific for sitting volleyball players.

Acknowledgment

This device has been registered with patent number of 100454, in the Office of Industrial Property, Center for Intellectual Property dated 2020 February 23.

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چکیده فارسی

طراحی و ساخت دستگاه شش ضلعی جهت ارزیابی زمان عکس العمل ورزشکاران والیبال نشسته

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والیبال نشسته یکی از ورزش های محبوب در پاراالمپیک می باشد که بر اساس پست های بازی به فاکتورهای حرکتی و آمادگی جسمانی ویژه ای نیاز دارد. زمان عکس العمل یکی از عوامل مهم آمادگی جسمانی برای بازیکنان این رشته می باشد. بیشتر دستگاه ها و تست های مورد استفاده برای ارزیابی این عامل در ورزشکاران سالم کاربرد بیشتری دارد. با این حال، در ورزشهای معلولان مثل والیبال نشسته، دستگاههای ارزیابی و بهبود فاکتورهای آمادگی جسمانی بسیار محدود می باشند. تخصصی سازی تست های آمادگی جسمانی برای ورزشکاران در هر ورزش نقش بسیار مهمی در ارزیابی و آماده سازی و موفقیت تیم ها دارد. در والیبال نشسته، حرکت بدن در جهات مختلف برای رسیدن به توپ و عکس العمل مناسب به آن نقش مهمی در کسب نتیجه مطلوب دارد. بنابراین هدف از مطالعه حاضر، طراحی و ساخت دستگاهی است که بتواند زمان عکس العمل بازیکنان والیبال نشسته را در ۶ جهت مختلف مورد ارزیابی قرار دهد. دستگاه سنجش زمان واکنش شش ضلعی وسیله ای است که با استفاده از شش سنسور مستقر در کف زمین و یک پانل لامپ در جلوی ورزشکار ، زمان واکنش را اندازه گیری می کند. هنگامی که لامپ مربوط به هر سنسور روشن شود، ورزشکار باید در کمترین زمان ممکن آن را لمس نماید. این دوره زمانی به عنوان زمان واکنش اندازه گیری شده و نمایش داده می شود.

کلمات کلیدی: والیبال نشسته، ورزشکار، دستگاه شش ضلعی ، زمان عکس العمل