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USING ARTIFICIAL INTELLIGENCE TO DETERMINE THE MOST IMPORTANT BIO-KINEMATIC VARIABLES FOR THE HITTING PHASE AND CHANGING THE TRAJECTORY OF THE BALL TO PRECISION AREAS WHEN PERFORMING THE HIGH CRUSHING SKILL IN VOLLEYBALL

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Abstract
The importance of the research is evident in that it sheds light on the most important things that lead to improving this skill, including the aspects of the ability to achieve accuracy and stay away from areas where there are usually defenders, that is, the performance from a biomechanical standpoint, and which variables are usually most important in achieving a change of direction, directing the ball, and knowing These bio-kinematic variables, according to their importance, provide an opportunity for the coach or player to practice on them. As for the research problem, and through the field experience and personal observation of the researcher in the game, he noted that this The skill, despite its importance, is modest in its performance if there is a blocking wall in front of it and a strong defense of the court. The reason for this is that the player cannot quickly shift his attention and overcome the blocking wall and thus direct the ball accurately to the opponent's court floor and score the point. The study aimed to identify the most important skills. Biomechanical variables for the hitting phase and changing the trajectory of the ball to the accuracy areas when performing the high crushing skill of volleyball using artificial intelligence.
The researcher hypothesized that there are biomechanical variables that are more important for accuracy than others when performing the skill of hitting a high smash in volleyball.
The researcher used the descriptive method using the survey method to suit the research objectives. The most important conclusions were that the height of the ball at the moment of hitting achieved the highest degree of importance in accuracy. As for the most important recommendations that the researcher recommended, the emphasis on the ball height variable is the factor that most influences accuracy.

Keywords: artificial intelligence, biomechanical variables, overwhelming multiplication, accuracy.

Introduction

The game of volleyball is one of the games that has witnessed great and rapid development in recent years and in all aspects related to it, which led to a change in the character of the game and its character of precision and speed of performance, as it began to advance very quickly in its various physical, motor and tactical indicators, and since the skill of striking is an offensive skill. For the task, it is necessary to monitor its development among the players, which must be mastered correctly from the beginning of learning it, and to modify the errors that accompany it on an ongoing basis, because of this skill's specificity in performance. From the above, the importance of research is evident in shedding light on the most important things that lead to improvement this skill is one of the aspects of the ability to achieve accuracy and stay away from areas where there are usually defenders, that is, the performance is from a biomechanical perspective, and which variables are usually more important in achieving a change of direction and directing the ball to the areas where there are defenders or the blocking wall, which is estimated in fractions of a second and by knowing those Biokinetic variables, according to their importance, provide an opportunity for the coach or player to practice them.

Through the field experience and personal observation of the researcher in the game, he noticed that this skill, despite its importance, is modest in its performance if there is a blocking wall in front of it and a strong defense of the court. The reason for this is that the player cannot quickly shift his attention when executing a high smash and overcoming the blocking wall. The opposing team defends the field and thus directs the ball accurately to the opponent's court and scores the point. Determining the most important biokinematic variables is usually either statistical or according to the experience of the person performing the operation, and it may vary.

This is based on the results of the study, which may have relied on the players' performance for a certain number of attempts and according to the number of the sample, and this is one of the traditional methods. Also, the speed of performance sometimes and the difference in the performance style of each player may cause the emergence of variables that are not considered important in changing the direction, and this is what prompted the researcher to study this problem. .

The objective of the study :

1- Identifying the most important bio-kinematic variables for the hitting phase and changing the trajectory of the ball to the accuracy areas when performing the skill of hitting the high smash in volleyball using artificial intelligence.

Methods and structure of the study

Expermental approach to the problem

The nature of the problem studied by the researcher is often what determines the research method, as the researcher used the descriptive method using the survey method as it is the most appropriate method to solve the research problem.

Participants

The research sample was chosen intentionally to achieve and employ the objectives of the research, as Wajih Mahjoub states that the intentional sample "is the sample that the researcher intends to choose in order to generalize the results of this sample to everyone" (Wajih Mahjoub: 2001:165), as the research population included national volleyball team players. The number of players is (14) for the year 2023, and the research sample included some players, numbering (5), who are players who specialize in high smashing in position (4).

In order to verify the homogeneity of the measured sample, the researcher conducted measurements of the sample members regarding the variables (height, mass, age, arm length, leg length) that may affect the experiment. It was found that the sample was homogeneous in the values of those variables, and Table No. (1) shows this. Marwan points out Abdel Majeed: The sample is homogeneous if the value of the coefficient of variation is 30 or less (Marwan Abdel Majeed: 241:2000)

Table (1) It shows the arithmetic means, standard deviations, and coefficient of variation for some variables in the research sample

coefficient of variation %	standard deviation	Arithmetic mean	Research sample variables	Sequence
1.93	3.72	191.8	Length (cm)	1
6.73	5.66	84	Mass (kg)	2
19.62	5.81	29.6	Age (years)	3
1.17	0.88	75.05	Arm length(cm)	4
1.14	1.205	104.81	Leg length (cm)	5

Procedure

1 - Arab and foreign sources and references 2- Tests and measurement 3- Observation- 1 (4) legal volleyballs - 2 (2) video cameras, type (Sony HDR-XR520V) with frequency speed (100 images/second) 3 - Video cameras (numbers) 1) Sony type with frequency speed and (200 images/second) 4 - tripod number (4). 5 - A medical scale for measuring weight 6 - A LENOVO g8 computer: Core – i5) 7 - DVD type CDs. 8 - Measuring tape (10) m 9 - Adhesive tape 5 cm wide 10 - LED lighting with a power of 300 watts

The researchers used (3) video cameras, two of which were (Sony) with a frequency speed of (100 images/second), while the third was (Casio) with a speed of (200 images/second)

with a tripod (3) in both. The two exploratory and main experiments for the high smashing skill. The horizontal distance between the camera lens and the performance location was (8) meters and the height of the lens point from the ground was (1.40 meters), as shown in Figure (4).

Random selection device

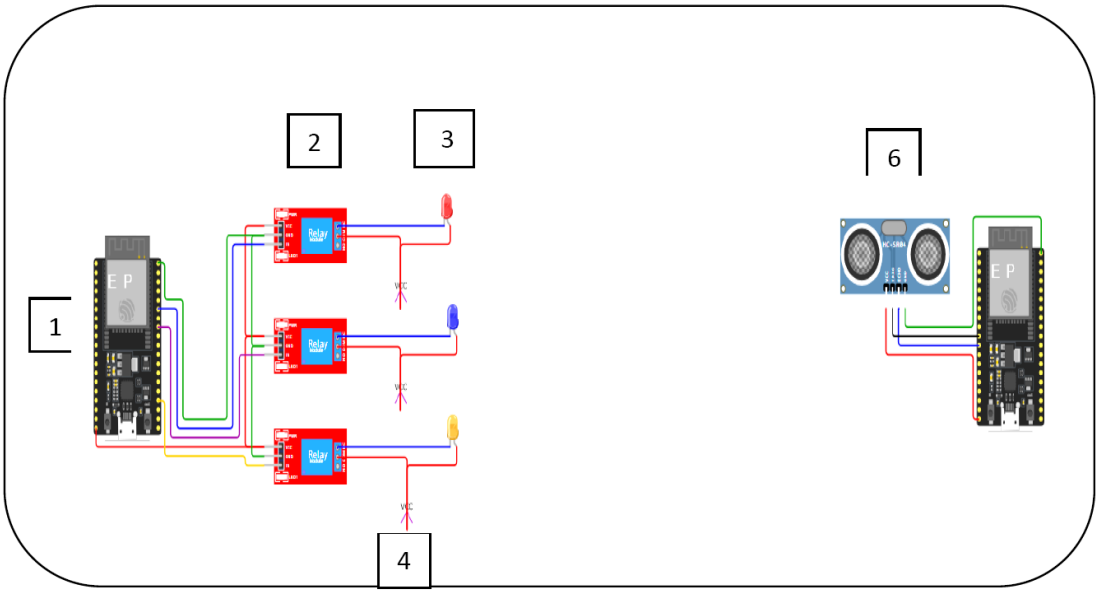

Figure (1)

Random selection device

1 - Arduino chip type ESP32: 2 - Relay: 3 - LED lamps 4 - Alternating current source 5 - Power source 6 - Ultrasonic distance sensor

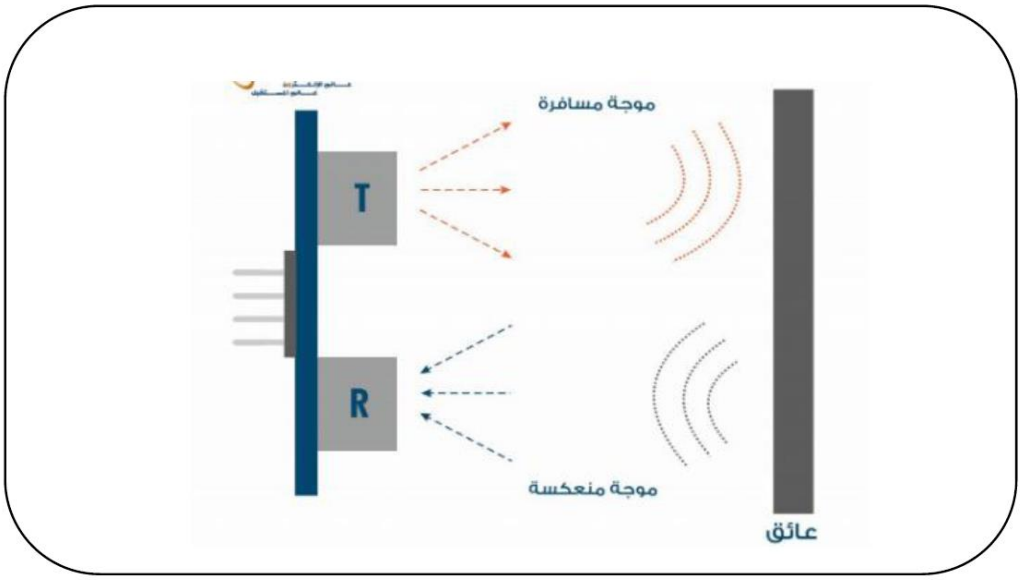

Figure (2) Arduino chip

Circuit working principle:

The first part: The part connected to the distance sensor. If the circuit is turned on, the distance sensor continues to send ultrasound waves within the specified range by converting

electrical pulses into ultrasound waves. When the sensor senses the presence of an obstacle or object within the distance, the waves are reflected to the bending part of it, which is the recipient that In turn, it converts the ultrasound waves and returns them into an electrical pulse that is transmitted to a chip

1. Arduino via wires. The Arduino chip has its terminals connected to both the sending and receiving end programmed so that when an electrical pulse is received directly from the receiving end of the sensor, the Arduino chip sends a wave via Wi-Fi through a pre-determined channel between the first (sending) chip and the second (sending) chip. Received) which is connected to the lamps.

1. The second part: The second Arduino chip, which is connected to the lamps, receives the signal via Wi-Fi from the first transmitting chip. The waves in the Arduino chip are transformed from a Wi-Fi wave into an electrical pulse that controls the closing or opening of the relay circuit, which in turn controls turning on and off the lamps.

2. Through the programming code of the second chip, it is possible to control the time for closing the relay circuit and the time for opening its circuit to obtain the best condition for the lamps (in this experiment, the transition time from closing/opening the relay circuit was delay (1000MS).

Measures

For the purpose of achieving the goal of manufacturing the device and benefiting from it to obtain the desired results in determining the most important biomechanical variables for the stage of hitting and changing the path of the ball, the device was placed in the area of the left side of center (4) and outside the court, and the movement sensor was placed at a distance of (1.5 m) from the field of approaching movement of the player. Lighting strips were placed distributed in three centers (1, 6, 5), and the reference entitled (Scientific Foundations of Volleyball and Methods of Measurement and Evaluation 1997) was used (Mohamed Sobhi Hassanein and Hamdi Abdel Moneim: 1997: 206).

Utilizing it to determine the precise areas and the distances based on which they are placed from the final side edge of the L-shaped stadium at centers 1 and 5, each area was divided into three parts (the first part 1.5 m * 1.5 m, the second part 1 m * 1 m, the third part 50 cm * 50 cm) We also relied on the accuracy values that were used in those sources in order to calculate the accuracy of the high crushing hit. Three zones were identified for this type of crushing hit, and using three zones to calculate accuracy and change the ball's path was necessary, as increasing their number It makes the matter more difficult and the lack of expectation of the location that will be determined by the device makes it more complicated because the main purpose of the experiment is to know the most important variables that determine the path of the ball.

It is unexpected, as this happens after the player crosses the field of the sensor and one of the light strips lights up. Therefore, using more than one hitting area is more vital in achieving the goal of the study, even though center (6) is rarely directed to the ball because it is located behind the blocking wall. However, This situation is expected to be an important point that contributes to revealing the most important variables that achieve a change in direction during

the ball striking phase. The scoring of points for accuracy areas while using the device was as follows:

- 4 points for each correct smash hit in the third part
- 3 points for each correct hit that falls in the second part
- Two points for each correct hit landed in the first part
- One point for each correct smash shot that falls outside the three parts, provided that it does not exceed 3 meters from the highest required accuracy

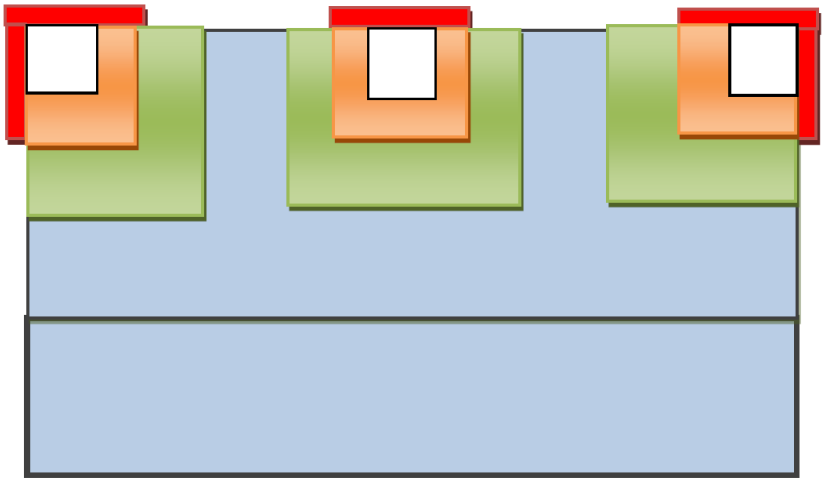

Figure (3) Figure showing the distribution of accuracy areas for the high smash skill

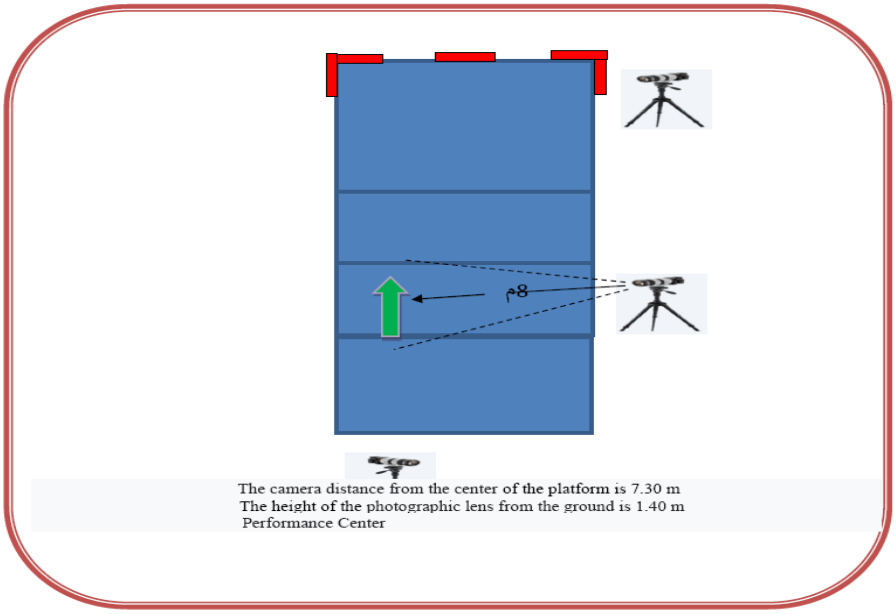

Figure (4) Shows the location of the video camera

Analyses

1- SPSS statistical program, arithmetic mean and standard deviation. 2- Standard deviation 3- Correlation coefficient 4- Coefficient of variation

Results

Table (2) Results, values, and description of the kinematic variables for performing the high crushing skill

standard deviation	Arithmetic mean	less value	highest value	Variables	Sequence
2.38565	61.3967	56.78	68.00	Flight angle	1
3.02199	168.0669	161.00	174.00	Shoulder angle at the moment of impact	2
4.49118	163.5219	154.00	170.00	Angle of the wrist at the moment of striking	3
3.32292	169.1558	154.00	176.10	Attachment angle at the moment of impact	4
1.84426	12.7650	9.00	18.00	The angle of inclination of the trunk at the moment of impact	5
4.28321	168.8911	159.34	181.03	Hip angle at the moment of impact	6
.06500	.9078	.66	1.05	The distance of the center of mass at the moment of multiplication	7
.03157	3.2293	3.12	3.29	The height of the ball at the moment of hitting	8
.04531	1.8159	1.68	1.96	Hip height at the moment of striking	9
39.40072	385.7546	270.10	459.00	Angular velocity of the striking arm	10
.94762	84.9000	83.00	87.00	The angle of inclination of the head at the moment of impact	11
.01167	.4082	.38	.44	Flight time	12
.00141	.0298	.02	.03	Contact time with the ball	13
.09439	.5794	.36	.80	Horizontal distance of the ball	14
.09039	.7493	.55	1.00	Vertical distance of the ball	15
13.35928	14.3786	9.00	145.00	Ball launch angle	16
1.51132	23.1431	20.73	27.00	Ball launch speed	17

Table (2) shows a description of the values of the kinematic variables for the two overwhelming multiplication skills, as it is not possible to deal with these values unless there is a complete description of the nature of the measures of central tendency and normal distribution, and this description indicates the moderate distribution of the data in representing the sample to obtain more accurate values for those variables.

The table above shows the results of the arithmetic means for each variable of the high overwhelming multiplication variable, through which the reader can understand the level of performance, as the arithmetic mean is one of the most accurate measures of central tendency, but it does not show how far or close the values are from the mean unless it is coupled with the standard deviation, and the smaller the deviation indicates The closeness of the values to

the mean and the increase in deviation from a quarter of the mean value gives an indication of a high dispersion of those values (Authorship and Translation Committee: 16:2007).
It was shown that the variables have a low dispersion value through the standard deviation values of the variables.

Table (3) It shows the percentages of contribution to the independent variables of the high crushing skill

Contribution percentages of variables according to importance				Contribution percentages of variables	
Sequence	Variable name	percentage	Sequence	Variable name	percentage
1	The height of the ball at the moment of hitting	23.2	1	Flight angle	0.2261
2	Flight time	10.9	2	Shoulder angle at the moment of impact	9.09
3	The angle of inclination of the trunk at the moment of impact	9.861	3	Angle of the wrist at the moment of striking	9.292
4	Angle of the wrist at the moment of striking	9.292	4	Attachment angle at the moment of impact	0.1754
5	The distance of the center of mass from the grid at the moment of striking	9.1921	5	The angle of inclination of the trunk at the moment of impact	9.861
6	Shoulder angle at the moment of impact	9.09	6	Hip angle at the moment of impact	0.1941
7	The angle of inclination of the head at the moment of impact	8.7861	7	The distance of the center of mass from the grid at the moment of striking	9.1921
8	Ball launch angle	8.4	8	The height of the ball at the moment of hitting	23.2
9	Hip height at the moment of striking	8.311	9	Hip height at the moment of striking	8.311
10	Contact time with the ball at the moment of hitting	0.821	10	Angular velocity of the striking arm	0.0116
11	The horizontal distance of the ball from the net at the moment of hitting	0.5246	11	The angle of inclination of the head at the moment of impact	8.7861
12	The vertical distance of the ball from the net at the moment of hitting	0.522	12	Flight time	10.9
13	Ball launch speed	0.493	13	Contact time with the ball at the moment of hitting	0.821
14	Flight angle	0.2261	14	The horizontal distance of the ball from the net at the moment of hitting	0.5246
15	Hip angle at the moment of impact	0.1941	15	The vertical distance of the ball from the net at the moment of hitting	0.522
16	Attachment angle at the moment of impact	0.1754	16	Ball launch angle	8.4
17	Angular velocity of the striking arm	0.0116	17	Ball launch speed	0.493

The table above shows the percentage (%) of each variable to obtain an accuracy of 100%. From the table it can be seen that there are variables that have a large and direct effect, such as the variable the height of the ball at the moment of hitting, while there are variables that have a very small and ineffective effect, such as the variable the angular velocity of the

striking arm. A graph has been drawn that shows these variables and the percentage of their influence, as in Figure (1).

It has been shown that the height of the ball at the moment of hitting had the largest percentage of influence, and obtaining the highest degree of importance means an increase in the time that the athlete is in the air, which gives the player a wider view and reveals a greater area of the opponent's area, and thus enables him to direct the ball with greater accuracy in order to achieve the desired goal, which is to score the point (northrip:1979:252) In addition, increasing the height contributes to the player's ability to move away from the blocking wall while hitting the ball in actual situations during matches. Ya'rab Abdel Baqi believes, "Increasing the height of the player means an increase in the point of finishing the main movement, and this is better, especially in Volleyball skills, which are serving and smashing the net" (Y. A. B. Dikh, 2021)

While the flight time variable achieved a high degree of importance, as an increase in time means an increase in the player's flight speed and thus an increase in the maximum height reached by the player. This means that the body remains in the air for a longer period, which increases the concentration time, the guidance time, and taking sufficient time to direct the ball to the accuracy areas (Yaarub (2020) Therefore, it is considered an important factor in order to achieve the required accuracy. As for the variable angle of inclination of the torso at the moment of hitting, it opens an angle in a specific direction and fixes the path of movement in the lateral direction. It is affected by the variable of the height of the ball at the moment of hitting, as it requires extending the arm completely, and thus the hip angle is affected accordingly.

While the wrist angle variable is also considered an important variable, as it is possible through the wrist to rotate the ball quickly when hitting in close areas, as it has a major role in directing the ball to the accuracy areas in the opposing team's court (Hamza & Yaarub, 2021).

The variable distance of the center of mass from the net helps the player control the orientation of the torso and arm better when it is close to the net, which restricts the player's arm movement and thus may cause an error in touching the net.

It has been shown that the shoulder angle at the moment of hitting is an important factor, as it changes depending on this elbow angle, because the elbow angle is a relative angle to the shoulder angle, and since increasing the elbow angle increases the point of the ball's height at the moment of hitting (A. A. B. Dikh, 2018), which gives room to control directing the ball to areas of accuracy in a way. better

The angle of inclination of the head at the moment of hitting is considered the field of vision of the player. Therefore, when hitting the ball in close positions, the angle decreases, but when hitting in close positions, the angle increases. This is why this variable is considered one of the important variables that influence accuracy. The visual scene has an important relationship with success, so it has become possible. Evaluating the visual scene by the extent of the success of the performance of the high smashing skill is a fairly good indicator in view of the success achieved in the smashing hit (Othman et al., 2023).

The launch angle of the ball is the angle that determines the direction of the ball towards a specific point, and the difference in this angle (large or small) will affect accuracy. It is worth noting that this angle is affected by the maximum height of the ball at the moment of hitting and the vertical distance of the ball above the net, as it determines the launch angle of the ball and its location. It falls on the opponent's court. Raysan Khuraibet and Najah Mahdi indicate that the launch angle is affected by the speed of the body, as well as the distance from which the shot is made (Raysan Khuraibet and Najah Mahdi Shalash: 1992: 401). The height of the hip at the moment of hitting is also considered one of the important factors on which many variables depend, and increasing this The variable increases the height of the ball's striking point and thus achieves the goal of crushing the ball in terms of direction and ball speed (Ali & Daikh, 2021)

Also, increasing the hip height means prolonging the flight time and increases the period of time he stays in the air, which means taking enough time to focus, and this helps the player direct the ball better. (Lazem et al., 2024)

The horizontal distance from the net, when this distance decreases, will affect the movement of the arm and the performance of the swing in a comfortable manner, which leads to the possibility of hitting the net. However, if the horizontal distance increases, it gives the player the freedom to swing at the player, and this enables him to achieve accuracy in a comfortable manner.

CONCLUSIONS

It was found that the height of the ball at the moment of hitting achieved the highest degree of importance in accuracy

2- It has been shown that there are variables that have an important effect on accuracy, such as (the shoulder angle at the moment of hitting, the angle of the wrist at the moment of hitting, the angle of the elbow at the moment of hitting, the angle of inclination of the torso at the moment of hitting, the angle of inclination of the head at the moment of hitting, the angle of launch of the ball, the height of the hip at the moment of hitting)

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