Simulation of plain rainfall runoff and monitoring of basketball players’ sports fatigue based on heterogeneous computing

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Received: 1 June 2021 / Accepted: 7 July 2021 © Saudi Society for Geosciences 2021

Abstract
In-depth understanding of the core content of LDPC code aligned cvqkd, and in-depth study of SEC protocol-based coordination process and multidimensional data coordination. Aiming at the problem of long code length and low coordination rate caused by multiple iterations of decoding algorithm in coordination process, a heterogeneous OpenCL platform is proposed to facilitate heterogeneous computing and differential code. The platforms involved are CPU / GPU and CPU / FPGA. Then, the IFAS model uses the uncorrected radar precipitation data to simulate the runoff process, and there are many errors in the simulation results. The IFAS model combined with the corrected precipitation radar data can simulate the discharge process of the upper reaches of the X river with high accuracy. This shows that the use of the data has a basin specific practicability for correcting the radar precipitation data in measuring the plain rainfall near the small river basin; the corrected precipitation radar data can be used as plain rainfall data in IFAS model; finally, this paper studies the influence of sports fatigue on basketball players’ free throw, and provides a lot of theoretical basis for exploring the biomechanical mechanism of sports fatigue in free throw and avoidance mechanism. The results show that the bending angles of the wrist and knee do not change before and after fatigue, but the angular velocity of the knee changes significantly. During the picking process of wrist and fingers, the flexion angle of hip joint changed significantly before and after fatigue. At the same stage, the bending angle or angular velocity of shoulder joint did not change significantly. Based on the heterogeneous computing of runoff simulation, combined with relevant materials and research, this paper has a good effect on the development of athletes’ fatigue detection technology.

Keywords Heterogeneous computing; Plain rainfall; Runoff simulation; Basketball players; Exercise fatigue

Introduction
As a branch of quantum communication, quantum key distribution (QKD) has been widely concerned. QKD is divided into two different multiple key distributions, which have continuous and discrete variable quantum key distributions. Compared with dvqkd, cvqkd has simpler training and lower cost, so it attracts more attention from researchers at home and abroad. However, compared with dvqkd, the current transmission distance of cvqkd is shorter, and data coordination as post-processing of cvqkd is an important factor to solve the above problems. Referring to the current short rate of cvqkd coordination, this paper discusses the following conclusions by comparing the experimental results. (1) This experiment is based on OpenCL / GPU heterogeneous computing coordination system. The SEC coordination algorithm can produce 146 KB / s original standard deviation, and the coordination speed of multi-dimensional data can reach 218.2 KB / s, which is 7.4 times and 11 times higher than that of single processor. (2) Because we are not familiar with the parallelism of FPGA pipelined tasks, we only perform a simple GPU heterogeneous computing porting, which leads to the low utilization rate of the SEC experiment and multidimensional data coordination system in heterogeneous OpenCL / FPGA platform, which is only 4KB / s and 29.3kb/s, and the improvement of computing speed still needs to be explored (Hooke 2019). Then, this

This article is part of the Topical Collection on Environment and Low Carbon Transportation

Responsible Editor: Sheldon Williamson

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Published online: 28 July 2021
paper takes s basin as the research area, and uses Nash satellite certainty coefficient, waveform error, volume error and peak error to evaluate the results, so as to confirm that the integrated flood analysis system (IFAS) model is located in the farthest channel. This paper discusses the problem of using IFAS model under extreme flow conditions, studies the accuracy of using different precipitation products of IFAS model, and the effect of applying the modified data combination to measure radar rainfall and s-x basin IFAS model. RNN (recurrent neural network) model and LSTM (long-term and short-term memory) (Abushandi 2016) model can predict simple rainfall per unit time in plain, and check the combination of hourly rainfall predicted by LSTM model and IFAS model to achieve the accuracy of rainfall runoff simulation in plain. Finally, through the analysis of the relevant literature, the relevant sports experts and researchers have done a lot of research on the changes of basketball players’ shooting movements caused by fatigue (Kalnay et al. 1996). However, most of the research areas are focused on the impact of local muscle fatigue on shooting. In view of the relatively limited characteristics of previous research results, most of the research is aimed at the sudden stop jump shot, running without the ball and jumping after catching the ball. Therefore, it cannot fully explain the factors that change the shooting way of basketball players. There seems to be limited research on technical movements such as stop shots and free throws (Li et al. 2014). On the basketball court, especially in the fourth quarter and other key time points, the physical strength of the players has reached the limit, at this time, the free throw rate is more critical for the team to win. If you can hit each free throw, it can directly affect the result of the game. Therefore, it is very important to continue to study the influence of sports fatigue on basketball players' free throw.

Materials and methods

Data collection and collation

In this study, two separate promotion data were used. One is to download height data by using general IFAS function, the other is to use global map in this study, and the other is height data processed by ArcGIS software. The height of watershed s is shown in Fig. 1. The land use of the study area is shown in Fig. 2.

Data coordination design of heterogeneous computing

After receiving each successive change of the total pulse, Bob first quantizes the optimal level of up to 16 levels. Then, the assumed samples are customized to 4 pieces by natural coding. For the next discussion, the inverse modulation is represented by four identical binary channels. Bob creates four levels of binary code words, which are represented by L1, L2, L3, and L4, where L1 represents each continuously changing level 1 binary bit. Consistent with the multilevel coding theory, L1 and L2 are slightly interfered by noise during the handoff process, so their contribution to the flow information is almost zero. In order to save decoding time in standard classical reverse channel transmission, these two levels have been fully disclosed, and decoding can be added to two advanced sequences (L3, L4). By selecting the best coding rate, the corresponding analysis matrices of H3 and H4 are constructed respectively. The corrector sequences of the two sequences are calculated to complete SW compression, as shown below.

\[ S_j = L_j \times H_j, j = 3, 4 \] (1)

Specific changes in level j probability:

\[ O_j^{(0)} = \frac{q_{jk}^1}{q_{jk}^0} = \frac{\sum P(y_j = 1|x_{i1}, x_{i2}, x_i)}{\sum P(y_j = 1|x_{i1}, x_{i2}, x_i)} \]

\[ = \frac{\sum_j \int_{t_{j0}}^{t_{j1}} \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{y_j^2}{2\sigma^2}} dy}{\sum_j \int_{t_{j0}}^{t_{j1}} \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{y_j^2}{2\sigma^2}} dy} \] (2)

Defining \( \delta q_{jk} = q_{jk}^0 - q_{jk}^1 \), there are:

\[ \delta r_{jk} = \prod_{i' \in \mathcal{M}(j)} \delta q_{jk} \] (3)

It is equivalent to the step-by-step level calculation of Gallager BP decoding algorithm. Consistent with the s check received from Bob, the message transmitted from check node K to variable node ij is calculated by formula (4) and updated to:

\[ u_{kij} = \begin{cases} 
1 + \delta r_{ijk}, & \text{if } (S_{ij} \geq 0) \\
1 - \delta r_{ijk}, & \text{if } (S_{ij} < 0)
\end{cases} \] (4)

Variable node iteration kernel: after all check node kernels update their \( u_{kij} \) messages, the variable node kernel will update the messages sent from variable node ij to check node K according to the following information.

\[ v_{ik} = \prod_{k' \in \mathcal{E}(j) \setminus k} u_{kij}, \lambda_{ij} = O_{ij}^{(0)} \prod_{k \in \mathcal{N}(j)} u_{kij} \] (5)

They correspond to the vertical calculation steps of the Gallager BP decoding algorithm.
Hard decision: after repeating a certain number (e.g. 100), each score of all variables will be estimated and calculated according to formula (6).

\[
y_{ij} = \begin{cases} 1, & \text{if } \lambda_{ij} \geq 1 \\ 0, & \text{else} \end{cases} \quad (6)
\]

Phase iteration: \( j, j' \in [3, 4] \), in order to obtain the best performance, repeat between the steps between the levels \( j \) and \( j' \) in the same variable \( i \). We only need to enter the hard information in the initial kernel:

\[
O_t(y_{ij}) = \sum a \left[ P(y_{ij} = 1 | y_{ij}, y_{i'j}, y_{ij'}, x_i) - P(y_{ij} = 0 | y_{ij}, y_{i'j}, y_{ij'}, x_i) \right] 
\]

\[
= \sum a \left[ \text{erf} \left( \frac{\tau_a - x_i}{\sqrt{2} \sigma} \right) - \text{erf} \left( \frac{\tau_{a-1} - x_i}{\sqrt{2} \sigma} \right) \right] 
\]

\[
= \sum a \left[ \text{erf} \left( \frac{\tau_a - x_i}{\sqrt{2} \sigma} \right) - \text{erf} \left( \frac{\tau_{a-1} - x_i}{\sqrt{2} \sigma} \right) \right] 
\]

Alternatively, we can extract the soft information \( \Omega_{ij} = \prod_{k \in X(j)} u_{ik} \) from the previous iteration and input it into the initial kernel as the initial equation (8).

\[
O_t^{(i)}(y_{ij}) = \sum a \left[ P(y_{ij} = 1 | \Omega_{ij}, y_{ij'}, y_{ij'}, x_i) - P(y_{ij} = 0 | \Omega_{ij}, y_{ij'}, y_{ij'}, x_i) \right] 
\]

\[
= \sum a \left[ \text{erf} \left( \frac{\tau_a - x_i}{\sqrt{2} \sigma} \right) - \text{erf} \left( \frac{\tau_{a-1} - x_i}{\sqrt{2} \sigma} \right) \right] 
\]

The purpose of this research is to study the influence of sports fatigue on free throw method of basketball players. The subjects of this experiment are eight basketball players from J University, and the sports level of the subjects in this subject is the national second level. The athletes who participated in the test did not take part in any strenuous exercise 48 hours before the test, so it can ensure that all the tested athletes did not have obvious injuries (Loucks et al. 2005). Before the experiment, make sure that the athletes keep healthy for at least one hour after the meal, and make sure that they all wear the same basketball suit and the sensors of the test equipment required for the test.

According to the purpose of the research and the content of the paper, the relevant literature was consulted in J University Library and CNKI. On the basis of reading the specific
literature and related papers, summarize and organize the relevant resources of this study, and investigate the existing problems (Stow et al. 2004).

SPSS software is used to process the data to get the mathematical statistical information about the experimental test results, and then the control and ranking of strength training are analyzed; statistical processing of test data, calculation of each index of descriptive statistical parameters, and provide a strong scientific basis for this study. By using spss22.0 to compare the data obtained in the test, the data with the result higher than 0.05 is considered to be significant.

Results

Watershed runoff model design

IFAS watershed data manager is a digital mapping River modeling system. The system has a simple GIS height editing function, which allows to create water level limit according to digital height map, and divide the basin into sub basins according to category settings. This study uses two methods to calculate the water level limit, one is the automatic operation of IFAS model, the other is the hydrological analysis module of ArcGIS basin software to obtain the water level limit. Figure 3 shows the channel in river s. Figure 4 shows the status division IFAS model for sub watershed s. Figure 5 shows the internal characteristics of the s River Basin. Figure 6 shows the aquifer parameters of the s River Basin. Figure 7 shows the flow channel parameters in the s river.

Analysis of simulation results of rainfall runoff in plain

IFAS can use rainfall observation data from rain stations and satellite precipitation data to simulate rainfall. Satellite data can be obtained directly from IFAS download function, and precipitation data with observed ground readings must be manually input. This function uses the precipitation data of groundwater station and satellite precipitation data to simulate the flow of s basin, and compares the simulation results with the measured flow (Al-Qurashi 1995). The IFAS model uses three different precipitation data to obtain simulation results, which are determined by the values measured by Nash Sutcliffe. The coefficient of performance is above 0.7. Among them, the Nash satcliffe certainty coefficient obtained from the precipitation data of the observation station is the highest, reaching 0.79. Using satellite precipitation data TRMM_3b42rt (V7) and gsmap_ The certainty coefficient of NRT is 0.75. The results show that no matter what kind of precipitation data is used, IFAS can accurately simulate the flow process and capture the flood peak, and the simulation accuracy is higher, which fully proves the applicability of IFAS model in s basin, and the results are shown in Fig. 8. Figure 9 shows the rainfall and runoff simulation results for September 2019. Figure 10 shows the results of simulating precipitation and runoff between August and September 2018. The corrected data is compared with the uncorrected data, and the comparison of time distribution is shown in Fig. 11. The comparison of cumulative time is shown in Fig. 12. It can be seen from the comparison chart that there is a big deviation between the corrected radar precipitation data and the uncorrected radar precipitation data: the time distribution is especially visible during heavy rain, especially from 1:00 on August 30, 2019 to 1:00 on September 2, 2019; The time cumulative comparison is equivalent to the time distribution...
deviation, and it also intuitively shows that the corrected radar precipitation data is compared with the uncorrected radar data in the whole research process (Booth et al. 2002). There is a great difference between the precipitation data and the total precipitation. The total precipitation of corrected radar precipitation data is 1149.3 mm, and that of uncorrected radar precipitation data is 739.1 mm.

In IFAS model, corrected radar precipitation data and uncorrected radar precipitation data are used as precipitation input, and runoff and precipitation are simulated in X River Basin. For error analysis, the component still uses Nash Sutcliffe certainty coefficient, error waveform, volume error and peak error to evaluate the accuracy of the results (Mishra and Singh 2013). The measured water flow is located in the first part of the X River Basin, so the point selected in the simulation process is also the lowest point of the X River Basin. The results are shown in Fig. 13.

Therefore, if we do not have enough observation of surface precipitation in the future, we can try to use this method to correct the radar precipitation measurement data and obtain the basin precipitation data, which is also very useful for using this model for precipitation simulation.

**Analysis of monitoring results of sports fatigue of basketball players**

The purpose of this research is to study the influence of sports fatigue on free throw method of basketball players. The subjects...
of this experiment are eight basketball players from J University, and the sports level of the subjects in this subject is the national second level. The athletes who participated in the test did not take part in any strenuous exercise 48 hours before the test, so it can ensure that all the tested athletes are not injured. Before the experiment, make sure that the athletes keep healthy for at least one hour after the meal, and make sure that they all wear the same basketball suit and the sensors of the test equipment required for the test. As shown in Table 1:

In the process of bending the knee and holding the ball, the wrist joint and knee joint are bending at the same time. In the preparation stage before and after fatigue, when the knee bends and holds the ball, the left wrist angle curve increases gradually, and then both decrease first and then increase, while the right wrist elbow angle increases first and then decreases. Before and after fatigue, the angle curve of the left and right knee joints rises slowly, and then decreases slowly. When holding the ball with both hands, the bending angle of wrist strap before fatigue was slightly less than that after fatigue, but the angular velocity of knee joint before fatigue was that the preparation time of knee bending was less than that after fatigue ($P < 0.05$). Wrist and knee flexion adjustment is mainly to improve stability and accuracy. The maximum flexion of knee joint after fatigue is more obvious than that before fatigue. Table 2 shows the biomechanical parameters of the wrist and knee during the preparation phase.

In the process of raising elbow and extending arm, elbow joint and ankle joint are in bending state at the same time. Before and after fatigue, the bending angles of the left and right elbows are equal, first rising, then falling, and finally rising gradually. Before and after fatigue, the left ankle first rose to the top, then decreased and stabilized. The right ankle showed a tendency of bending, but there was little difference between the left
and right ankle (Skrynnik and Skrynnik 2009). When the elbow is raised, the bending angle of elbow joint before fatigue is greater than that after fatigue; When the arm is extended, the bending angle of ankle joint before fatigue is smaller than that after fatigue. The change of elbow and ankle angle can moderately improve the accuracy of free throw. There was no significant difference between the maximum elbow flexion and ankle flexion before and after fatigue. Table 3 lists the biomechanical indexes of elbow and ankle bending during elbow and arm extension before and after fatigue:

In the process of bending the wrist and fingering, the angle curves of the left and right shoulder joints decrease gradually before and after fatigue, and the flexion angle increases slightly before fatigue, which is far greater than that after fatigue. The angle curve of the left and right hips showed a constant upward trend, but after fatigue, the angle curve of the left and right hips began to decrease, and then showed an upward trend. The peak value of hip angle curve after fatigue is usually lower than that before fatigue.

To compare and analyze the flexion and extension phases of the wrist and fingers, three-dimensional kinematic data of the shoulder joint and hip joint were selected. Table 4 shows that the flexion angle of shoulder joint may increase slightly after fatigue, but the change is not obvious. There was no significant difference in flexion angle and angular velocity of shoulder joint before and after fatigue ($P > 0.05$), but there was significant difference in flexion angle of hip joint ($P < 0.05$), and there was no significant difference in angular velocity ($P > 0.05$).

### Discussion

**The influence of sports fatigue on the performance of basketball players**

Through the experiments on several subjects, it can be clearly seen that if the subjects complete the fatigue model in the “run and jump” mode, it may be due to the contraction of triceps, quadriceps and gluteus maximus...
of the leg. Most of the subjects' joint movement angle after fatigue is smaller than that before fatigue. These data indicate that the subjects are already in a state of fatigue. The results of this study are consistent with previous studies by many experts and researchers, and the feasibility of the fatigue model has been verified at the same time (Mohammed 2019). In addition, the number of free throws required by the target after fatigue is more than that before fatigue. Since the number of experimental samples is not large enough, it is not clear whether the decrease of hit rate is directly related to fatigue. However, the author thinks that sports fatigue will inevitably have a significant impact on the sports condition of basketball players, which may be one of the reasons leading to the decline of sports performance.

Summing up previous studies, it can be concluded that if the subjects feel tired after a certain period of exercise, the effect of appropriate muscle discharge may be more significant, which makes the number of muscle recruitment increase. It leads to the decrease of muscle strength, which reduces the exercise ability of the subjects.

The influence of sports fatigue on the biomechanical parameters in the preparation stage of holding the ball

From a series of data obtained from several tests, it can be seen that there is no significant change in the angle and angular velocity of the wrist joint in the process of holding the ball, which indicates that the movement mode of the wrist joint will not change significantly in the fatigue stage. However, there is a significant difference in the angular velocity of the knee, which will affect the movement of the knee (Chow et al. 1988). As fatigue is the main cause of athletes’ injuries, many experts and researchers in this field have done a lot of appropriate research on fatigue. Previous studies have shown that the knee joint and wrist joint are the most vulnerable parts in the process of movement (Costigan et al. 2016). Therefore, if we want to analyze the movement in the stage of holding the ball, we must check and study the signs before and after fatigue.

Previous studies have shown that under normal conditions, the bending angle of the knee and the angle of the wrist move...
after fatigue. The results of this study also confirm the accuracy of previous studies, but not significantly. At the same time, several measurements of angular velocity of two joints were proposed (Telesca et al. 2014). The results show that there is no significant difference in the angular velocity of wrist joint before and after fatigue, but there is significant difference in knee joint. However, previous studies have shown that the angular velocity increases significantly before and after fatigue. Even if the angular velocity of the knee has little effect on the resultant force in the process of holding the ball, it will also affect the ACL load.

As for ACL, it has become the most serious type of injury in the sport. The research on ACL load has also attracted the attention of scientists. In his own study, Nunley found that ACL load increased by reducing the knee flexion angle and increasing the leg tilt angle. At the same time, Heijin also pointed out that when athletes complete closed-loop exercise, the load on ACL increases and the angle of knee joint decreases (Graf 1988). Through a large number of research results represented by more than two researchers, it can be seen that increasing the angle of the knee joint during the holding period is of great practical significance to reduce the injury. Previous studies have shown that when subjects feel tired, the flexion angle of their knees decreases. However, the results of this study are inconsistent with those of previous studies. The results of this study indicate that the knee flexion angle increases after a certain degree of fatigue (Nandalal and Ratmayake 2010).

The author thinks that the reasons for the difference between the conclusion of this study and the previous conclusion are as follows: firstly, due to the small number of subjects in this experiment, the knee joints of the subjects after fatigue show no significant difference from those before fatigue. If a specific number of subjects are added to increase the sample size, there may be significant specific changes in the knee angle data. However, if this fatigue causes ACL damage, as the researchers have said before, it will continue to be validated in the next phase. Secondly, the subjects selected in this study are all male basketball players (Hawkins et al. 2019). According to the previous research on the physiology of men and women, it can be concluded that the shear force of tibia will increase in men after fatigue. However, the range of change is much smaller than that of women, so the conclusion is different from previous studies. There was no significant difference in knee flexion angle before and after fatigue, but there was significant difference in angular velocity.

**Effect of exercise-induced fatigue on biomechanical parameters of elbow lifting and arm extension**

In order to improve the accuracy of basketball players’ free throw as much as possible in the whole free throw movement, the player should increase the angle of take-off and bend his elbow at a larger angle. But the requirement is very high on the muscle strength of athletes. After a series of experiments, it is found that the elbow flexion angle does not change before and after fatigue, but the ankle joint has a specific change in the stage of elbow elevation and arm extension (Öztürk et al. 2013). This indicates that when the subjects feel tired, their muscle strength decreases. In order to obtain higher energy

| Age (y) | Height (cm) | Weight (kg) | Years of exercise | Short-term sports injury history |
|---------|-------------|-------------|-------------------|---------------------------------|
| 20.2±0.5 | 1.81±0.3 | 75.1±4.33 | >5 | no |
output and greater take-off force, it is necessary to bend the ankle joint to a greater extent. Therefore, after fatigue, the athlete's stretching and pedaling will be more powerful.

It can be seen from the above data that the inclination angle of elbow and ankle before fatigue has no obvious change compared with that after fatigue. The data set shows that in order to obtain higher accuracy, the object must have higher tangential initial velocity. After fatigue, the muscle strength of the subjects was slightly insufficient, so the angular velocity of the ankle and elbow joint increased compared with that before fatigue. However, in terms of exercise physiology, the ankle is the end of the lower limb chain, and its surrounding tissues and muscles are smaller than those of other lower limb joints (UNDP 2014). Therefore, the contribution rate of ankle joint is very low when the subjects complete the free throw movement of elbow elevation and arm extension. Therefore, in order to restore the accuracy before fatigue, the ankle should be bent as far as possible.

**Effect of exercise-induced fatigue on biomechanical parameters of wrist flexion and fingering**

In the final stage of wrist flexion experiment and finger flexion in the process of free throw, from the analysis of relevant data, it can be seen that the flexion angle of the hip joint changes significantly. The results showed that the bending of wrist and the grip strength of fingers changed significantly. In the free throw movement, the amplitude enhancement plays a very important role in the stability of human dynamic posture. According to human dynamics, when the initial static balance is destroyed, people usually use the hip joint to adjust (Zhang et al. 2009).

In this study, the experimental analysis of wrist joint changes and finger flexion showed that the bending angle of hip joint after fatigue was greater than that before fatigue, while that of shoulder joint was the opposite. The angle after fatigue is slightly smaller than that before fatigue. This final study is inconsistent with the results of Caulfield's 2006 study, according to which the hip flexion angle decreases and the shoulder joint angle decreases during the free throw. The main reason for this situation is that when the human body completes the process of wrist movement and finger flexion, the lower limbs should have a buffer effect (Panidi et al. 2019). As one of the main buffer joints of human body, knee joint achieves the maximum buffer angle before fatigue. The human body only uses the hip joint to rebound to the ground better, so it will increase the angle of the hip joint before and after fatigue.

On the shoulder movement, the conclusion of this study is contrary to the previous research conclusion of experts and scholars, that is, the shoulder angle of the subjects before fatigue is much larger than that after fatigue. Consistent with human knowledge, studies have shown that there are specific differences in the activation of scapular muscles during wrist flexion and finger flexion. At the same time, combined with the results of previous researchers, the movement of the wrist is controlled by bending before and after fatigue.

In the process of bending wrist and fingers, there was no significant difference in the bending angle of hip joint before and after fatigue. From the general change of the tip, it can be seen that in the whole process, the change of hip flexion angle after fatigue is much higher than that before fatigue. Hip joint plays an important role in maintaining the balance of human body, reducing the buffer force of the ground (Robinson et al. 2017). This can be explained to some extent by reducing the ability of human body to maintain stability after fatigue, which will lead to joint damage.

Through a long-term study, Skelly et al. Found that subjects can increase the overall balance and reduce the flexion force by increasing the flexion angle of the hip joint. Chappell continued his research in this area, and found that the initial flexion angle of hip joint would increase appropriately after fatigue, while the forward shear force of tibia would increase moderately. The research of these experts and researchers shows that if the flexion angle of hip joint is increased at the
 beginning of exercise, the burden of hip joint will be reduced (Skrynnik and Snizhko 2008). The conclusion of this study is basically consistent with the previous experimental results. In the wrist flexion and extension and finger flexion and dial stage, the subjects' hip flexion angle increased significantly.

Compared with the stage of holding the ball, there are two ground reactions during wrist and finger flexion, which are the first and second reactions on the ground. In this paper, through the specific comparison and analysis of biomechanical parameter data, it is found that there is no significant change in the reaction force during the pulse frequency stage and finger movement before and after fatigue. The previous conclusion is the same whether it is the maximum time or the maximum value. At the same time, combined with the wrist flexion stage and finger flexion stage, the hip angle after fatigue is larger than that before fatigue, which indicates that the body balance is relatively poor and the flexion ability is low after fatigue.

Conclusion

The area studied in this paper is a basin. In the process of runoff simulation, Nash satcliffe reliability coefficient is studied. Waveform error, quantity error, and volume error are used to verify the accuracy of simulation results, and the problems in the application of this model in runoff simulation are discussed. By combining the model with the measured data of rainfall radar and the predicted hourly precipitation, the applicability of the model is expanded and the applicable value of the model is developed. Finally, the fatigue model used in this paper is the combination of Chappell’s fatigue model and the related research. In this model, the subjects must use the combination of three groups of movements to sprint, jump, and shoot after jump. This group of actions combined with the basketball sports scene, especially suitable for the current stage of basketball, in order to truly simulate the fatigue state of basketball.

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