Numerical simulation of ocean sea temperature based on feature prediction and monitoring of coastal running health data

Shan Huang 1 · Xu Li 2

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Abstract
The condition of ocean underlying surface is an important factor to determine the predictability of short-term climate. Different forms of ocean boundary conditions are often used in dynamic forecasting models for forecasting objects with different characteristic scales. Many institutions are still using a forced general circulation model (GCM) based on given SST to predict climate, but there are still differences in the degree of short-term climate prediction affected by different SST frequencies. Considering this, this paper uses the BCC model of the National Climate Center_Agcm3 which is used to develop and conduct multiple sets of numerical simulations and experiments to predict the impact of SST at different frequencies of each month, week, and day. The results show that the frequency of SST forcing field is similar to that of Asian summer monsoon. As we all know, sprint and middle- and long-distance race belong to speed race group or endurance race group. The movement speed of two types of sports depends on their physiological mechanism, the transformation speed of cerebral cortex motor center, and the performance of nervous system. Although there are many studies on the speed of short-distance running and medium- and long-distance running, there are relatively few studies on the characteristics of middle- and long-distance runners in various sports. The system uses STM32 + MTK dual processor system and uses mpu9250 nine axis inertial sensor and max30102 heart rate sensor to develop acquisition module, positioning module, low-power consumption module, motion data detection module, and heart rate software and hardware system. Finally, this paper designs the results of SST numerical simulation and prediction experiment.

Keywords Feature prediction · Numerical simulation of sea surface temperature · Coastal running · Data monitoring

Introduction
In the past decades, great progress has been made in numerical modeling, numerical weather prediction, and seasonal climate prediction (Arentze and Timmermans 2000). However, due to the limited resolution of the model, the uncertainty of the initial value error, and the limited predictability of the climate phenomenon itself, the impact of the ability of climate model modeling and prediction (especially the world summer climate) is still very small. Among them, seawater temperature is the dominant factor in the underlying surface. Due to the interaction between the atmospheric circulation and the ocean, the change of its thermal conditions will affect the distribution of summer monsoon intensity, temperature, and precipitation. Therefore, seawater temperature is very important for model modeling and performance prediction. The forced conversion of seawater temperature to different frequencies reflects the accuracy of ocean value in simulation and prediction. Previous studies have shown that, compared with monthly low-frequency SST information, more accurate high-frequency SST effects are useful for improving modeling and predicting intraseasonal fluctuations in the model (Benhammadi and Chaffai 2015). This paper studies and analyzes the finger frequency values of some athletes with different sprints and middle- and long-distance running in China’s coastal areas, and considers the particularity of finger frequency differences of Chinese athletes with different sprints and average scores, as well as long-distance travel. By analyzing the frequency of finger use among
short-distance, medium-distance, and long-distance athletes, and investigating the reasons for their differences, it is possible to obtain reference information about Chinese athletes’ selection and sports training. Although many studies have studied the speed of coastal sports, there are relatively few studies on the finger frequency characteristics of sprinters and middle- and long-distance runners with different difficulty. It is very important to help people make a healthy and reasonable diet plan and organize the amount of daily exercise by controlling the daily sports activities of the human body in order to improve the healthy living standard and exercise safety. In many physiological parameters of health, heart rate, as an important indicator of human health, is also common (Chen et al. 2010). It is a parameter with low power consumption and continuous monitoring, which is relatively easy to realize for modern biosensors and wearable technology, and makes contributions to the prevention, diagnosis, and treatment of diseases (Çil et al. 2020). In modern medicine and human research, heart rate is defined as the number of heart beats per minute. Pulse rate can reflect the state of human circulatory system. Therefore, heart rate has become the most common measurement method in modern medical research and clinical medicine.

Materials and methods

Data sources

The horizontal resolution of sea water temperature reconstruction data provided by NOAA is 2° longitude × two° latitude; the analysis period is from 1967 to August 2020.

Design of feature fusion algorithm

Firstly, considering the mismatch between the size of the feature map and the number of stages, the feature map with the size of 1/2, 1/4, and 1/8 of the original image is obtained as the input of the adaptive spatial feature fusion algorithm. The size and number of channels of 1/4 function diagram are selected as fusion criteria, as shown in formula (1)

\[ a_{i,j}x_{i,j}^1 + b_{i,j}x_{i,j}^2 + c_{i,j}x_{i,j}^3 = Y_{i,j} \]  

(1)

Feature maps come from different depths in the encoding stage, so they contain different details. Through the multi-scale combination of functions, the proportional combination of these three function diagrams should be realized. The pixels at the same position on the three feature maps are defined as derived from different feature map pixel weights, so the feature fusion strategy is defined as formula (2):

\[ a_{i,j} + b_{i,j} + c_{i,j} = 1 \]  

(2)

The adaptive spatial feature fusion algorithm aims to adaptively adjust the scale parameters used as the network model. The updateable parameters used to update the melting coefficient by backpropagating the error gradient, such as formula (3):

\[ a_{i,j} = \frac{e^{A_{i,j}}}{e^{A_{i,j}} + e^{B_{i,j}} + e^{C_{i,j}}} \]  

(3)

Change the number of channels of the function diagram, and then connect different function diagrams through concat, and finally get a function diagram with a size of 3 and the number of channels is 3, such as formula (4) and formula (5):

\[ b_{i,j} = \frac{e^{B_{i,j}}}{e^{A_{i,j}} + e^{B_{i,j}} + e^{C_{i,j}}} \]  

(4)

\[ c_{i,j} = \frac{e^{C_{i,j}}}{e^{A_{i,j}} + e^{B_{i,j}} + e^{C_{i,j}}} \]  

(5)

Monitoring of the finger frequency at coastal running health data

This paper analyzed the frequency characteristics of athletes’ fingers in short, middle and long distance competitions in coastal areas of China. The “0710-Speed Frequency Meter” is used to measure the sprint and middle- and long-distance running of the top 16 athletes in the track and field team, and the result exceeds the second stage in the national top 16 finger frequency test. The test subjects performed finger frequency tests on sprinters and middle- and long-distance runners. According to the available energy characteristics of the three-energy systems of the human body, special races of 100m, 100m, 110m, 200m, and 400m are divided into sprint sports, and 1500m, 3000m, 3000 obstacles, 5000m, and 10000m are divided into middle- and long-distance running sports. The athletic level of the tested athletes was evaluated according to the athlete level standard proposed on the official website of the Chinese Athletic Association.

Results

Analysis of SVD results of sea level pressure and sea temperature

The non-uniform correlation field distribution of the standardized SST anomaly in the tropical Pacific in Fig. 1 shows that the large areas of the equatorial central Pacific and the eastern Pacific are important areas of negative correlation. Therefore, it can be assumed that the June pressure anomaly field in the North Pacific in Figure 1 actually reflects the anomalous structure of the pressure anomaly field in the North Pacific during the development stage of the La Niña event in June. The
significant heterogeneous correlation indicates the sea level pressure field in the North Pacific in June. This anomalous structure has a good correspondence with the La Niña incident.

By calculating the spatial correlation coefficient, it is possible to analyze in which year the abnormal distribution of SLP similar to the first pattern was observed.

The two-dimensional phase space consists of the first and second sea level pressure coefficients in June, and the first and second sea level temperature ranges at the end of December obtained through SVD decomposition. When the two types of sea level pressure change, the phase space will affect the sea level pressure. This article analyzes the relationship with sea temperature, which can be seen in the phase space of the sea level pressure field in Figure 2.

**EOF analysis of sea surface temperature**

In order to understand the temporal and spatial development characteristics of sea surface temperature, hereinafter referred to as the sea temperature anomaly field, this paper uses empirical orthogonal functions to decompose the tropical Pacific sea temperature anomaly from 1961 to 2020. Figure 3 shows the observation data and modeling based on seven models. The spatial feature vector of the sea temperature anomaly is derived from the data.

If this article combines the corresponding time coefficients in Figure 4, this article finds that the observed data and the simulated data are almost the same.

**Analysis of sea temperature numerical simulation results based on ENSO events**

Figure 5 shows the sea surface temperature anomaly field of event L from January to June. This article found that in April, a large number of important areas appeared in the central and eastern tropical regions of the Pacific Ocean, accompanied by negative SST anomalies. Thereafter, in May and June, the main area of the tropical eastern Pacific gradually increased, and the SST anomalies below zero also gradually increased. It shows that for all La Niña and El Niño events, April is a period when the sea level temperature difference between the tropical central Pacific and the eastern Pacific is significant. This is earlier than the time of the EL event in this article, which occurred at 0°C in the central tropical and eastern Pacific in June.
Figure 6 shows the abnormal surface wind field. This article found that only in February and May, there were obvious anticyclones at 10°N–30°N. In the subtropical area of the northeastern Pacific Ocean and an important area in the v direction, especially in May, this corresponds to a significant anomaly above zero. The sea level pressure in this area is shown in Figure 5c. The results show that for all La Niña events in May, there are obvious positive sea level pressure anomalies at 10°N–30°N. In the subtropical area of the Northeast Pacific, there is a clear anomaly of southerly winds. A typical event earlier than EL in June, it also corresponds to the decomposed result of SVD.

Figure 7 shows the abnormal sea surface temperature field of event L from January to June in the test results. Since January, this article has found a significant negative SST anomaly in the tropical eastern Pacific. As time passed, a large part of the tropical eastern Pacific gradually changed westward to about 150°E, and the absolute value of the anomaly below zero sea temperature gradually increased. Compared with the reanalysis of the test data of all La Niña events, the zero sea temperature anomaly in the tropical eastern Pacific obviously occurred earlier, with a wider range and greater intensity.

Figure 8 shows the abnormal pressure field on the sea level. This article found that since February, there has been a obvious positive sea level pressure anomaly in the mid-latitudes of the North Pacific. Later, from March to June, a wide range of sea level pressures were observed in the central North Pacific, tropical central Pacific, and eastern Pacific. This is an abnormal phenomenon, and the northernmost point reaches about 50°N north latitude. Compared with the result of data reanalysis, the positive sea level in the north is larger, and it appears earlier and stronger.

Analysis of monitoring results of coastal running health data

Table 1 shows the finger frequency test for middle- and long-distance runners of different genders and above level 1 using 0710-speed frequency.

Use the “0710 Speedometer” to test the finger frequency of middle- and long-distance runners of different genders and above refer to Table 2:

As shown in Table 3, the finger frequency test was conducted on male athletes from two different sports groups using the “0710-Speed Frequency Meter.”

The finger frequency test was conducted on female athletes from two different sports groups using the “0710-Speed Frequency Meter,” see Table 4.

Discussion

The influence of stress and fatigue on the biomechanical parameters of lower limbs

This study attempts to study the impact of stepped leg compression on the biomechanical parameters of the lower limbs under different stress levels during long-term endurance training. During a 30-min treadmill run, the adjustable leg compression cuff only affects the minimum knee angle and range of motion during support. A special achievement is that when running without stepping on the pedals, the knee joints of the lower limbs have a greater range of motion and a smaller minimum angle (Entezari et al. 2016). The results of ground trajectory data show that the angle and maximum angle of the knee joints are greater when landing under high pressure, but there is no difference in wearing graded compression leg covers. The degree of stress has a greater impact on the
dynamic data, and is mainly concentrated on the stiffness of the lower limb joints. In addition, when the pressure is high, the stress level and positive work of the ankle joint are also high. In long-term endurance training, with the increase of time, the hip angle and knee angle and the minimum hip angle when lifting the floor on the treadmill tend to increase (Gemici et al. 2016). This difference is important for early and late endurance training. The opposite trend is the angle and maximum angle of the ankle above the floor, and the minimum angle of the knee angular velocity. Only the latter shows significant differences in the later endurance exercise, while the rest are very different during the entire exercise. Research results on treadmills show that the ankle movement is consistent with treadmills. In addition, the ultimate knee angle and minimum joint strength and strength increase after fatigue, while the maximum ankle torque and ground reaction force decrease after fatigue.

Pressure mainly affects the kinematic parameters of the knee joint, but these graphs show that this effect does not occur between wearing a compressed leg, but it occurs between two pressure levels. When exercising on a treadmill, the main manifestation is that pressure increases the minimum knee angle and reduces the range of motion of the knee joint. This indicates that the higher compression ratio of the leg

Fig. 3  Spatial distribution of observational data and 7 model simulations
cuffs increases the minimum knee flexion, but also reduces the knee angle changes during exercise. Although the track data result only shows the difference between different exercise levels, the trend is similar to the treadmill data result (Ho et al. 2010). In a study of healthy college students wearing compression stockings, Wu Xiaojie pointed out that a certain amount of pressure can improve knee stability and reduce excessive knee changes. Research by Doan et al. also found that elastic pants can reduce the tilt angle of the knee and hip joint when walking. However, Hasan’s research shows that...
wearing compression socks and textured insoles will increase the range of motion of the foot at the ankle, which contradicts the results of the above research, and the reason may be a change in the form of action. Compared with exploring the gait cycle at different speeds, the heel moves are faster, have a wider range of movements, and are task-based movements (Hwang and Yoon 1981). Therefore, using pressure may be more suitable for this type of exercise and thus make a difference. Therefore, it can be concluded that a certain amount of pressure is beneficial to the stability of the knee joint.

Under a given load, there is a negative correlation between stiffness and deformation. During running, the movement of the lower limb joints and the antagonistic muscles work together in the support phase, so that the joints have a certain degree of stiffness when braking and pedaling. This feature of
the lower limbs can reduce the vibration frequency of the supporting pedal, maintain moderate shock absorption and body vibration, and improve the stability during riding. It is this stability that contributes to the accumulation and transformation of elastic energy potential and contributes to energy saving (Malczewski 2002). Currently, there are many studies on the apparent stiffness of the legs, with similar results. Increasing leg stiffness can reduce oxygen consumption in this area and increase RE. The accumulation of fatigue will also affect running to exhaustion.

To reduce leg stiffness, external factors can also cause changes in leg stiffness. For example, a moving surface that is too smooth may produce similar results (Miao et al. 2013). On the contrary, there is less discussion about joint stiffness. Joint stiffness reflects the ability to control the body’s movement, rather than the characteristics of tissue stiffness (Opricovic 1998). Therefore, the stiffness of the joint is essentially related to the form of movement and the purpose of the movement, and should be discussed together.

If it is greater than L, the stiffness of the step is greater than C, and the damping stiffness of the knee joint is less than L. Under high pressure and low pressure, higher pressure will improve the stopping ability of the ankle joint, but it will reduce the stopping ability of the ankle joint. Compared with the control group, higher pressure prevents the ankle from stretching during the step. This may be because the pressure level in the graded compression leg cuffs is too high, which to some extent restricts the movement of the ankle and thus the internal structure of the body. Higher pressure during the buffer period will increase the ankle restraint, which seems to have a positive effect on the progress of the exercise. However, during the stepping phase, a higher pressure level also shows...
the same effect, which will have a negative impact on the acceleration of the stepping. Since existing research still cannot determine which of these two stages has the greatest impact, it cannot be simply concluded whether higher stress levels are beneficial.

Under normal circumstances, when the muscle generates mechanical energy through active centripetal contraction, the muscle will play a positive role. On the contrary, the eccentric contraction caused by passive stretching will reduce the mechanical energy. At this time, the joint torque and angular velocity are opposite, and the work is negative. The results of this study show that wearing high-pressure compression foot covers can make the ankle show better results. Combined with the effect of pressure on the stiffness of the ankle, this may be because higher pressure increases the braking ability of the ankle, and this ability is mainly provided by the muscles around the ankle.

When landing on the ground, the change in the ground reaction force may reflect to some extent the different patterns of the human body when it hits the ground. Based on this, input the load value as an estimated value in order to more clearly evaluate the changes in the ground reaction force during landing and to study the possible effects of muscle contraction and neural response.

The rate of force application reflects the relationship between force and time. Therefore, a higher exercise frequency means that the time required for the maximum gender response force (when the athlete is shorter) may not have mobilized neural control to change its strategy. However, since it is impossible to accurately measure the specific time when the
Fig. 8 The synthetic sea-level pressure anomaly field of the L event from January to June in the test results

Table 1 Finger frequency values of middle- and long-distance runners of different genders and above level 1

| Item (male)         | Grade    | Finger frequency (times/8S) | Item (female)    | Grade    | Finger frequency (times/8S) |
|--------------------|----------|-----------------------------|-----------------|----------|-----------------------------|
| 5000m Master       | 83       | 1500m Master                | 77              |
| 5000m Master       | 87       | 1500m Master                | 67              |
| 10000m Master      | 70       | 1500m Master                | 64              |
| 10000m Master      | 84       | 1500m First level           | 63              |
| 3000m obstacle     | Master   | 82                           | 3000m Master    | 79       |
| 3000m obstacle     | Master   | 87                           | 3000m Master    | 83       |
| 10,000m Master     | 81       | 3000m Master                | 84              |
| 5000m Master       | 93       | 3000m Master                | 83              |
| 1500m Master       | 97       | --                           | --              |
| 10,000m Master     | 60       | --                           | --              |
nerve control is transmitted to the muscles around the joints, and because athletes of different fitness levels also have large differences in this index, from the following point of view, the reaction force explains the changing trend of force. The results of this article show that wearing a higher pressure leg compression cuff will result in higher pressure levels, which is the same as the previous high-pressure trend for stiffness and normal ankle function. Therefore, it can be concluded that the higher pressure helps the braking of the vehicle body during landing. However, the question of whether this effect can achieve the destructive effect needs further study. In long-term endurance training, fatigue has a greater impact on the biomechanical parameters of the lower limbs. According to previous studies, fatigue affects kinematics and dynamic parameters in different ways.

Fatigue increases the angle of external rotation and flexion of the knee joint. The results of this study are similar. Fatigue increases the minimum and maximum knee flexion. Studies have also shown that fatigue caused by running increases the ability to react. When the human body is under heavy pressure, fatigue also increases the strength of the joints of the lower limbs. The results of this study show that fatigue increases the strength of the ankle and knee joints, but reduces the strength of the vertical floor reaction force. This may be due to knee fatigue caused by large angle fatigue. Due to the larger flexion angle, the lower limbs have better cushioning to a certain extent, thereby reducing the support reaction force. Of course, this may also be due to the adaptability of the body when switching from the treadmill to the track again.

### The impact of stress and fatigue on running economy

Billat defines operating economy as oxygen consumption below the maximum intensity, which is closely related to operating performance. The measurement method is relatively simple, and most available studies have developed appropriate testing methods for exercise level, gender, and other characteristics of subjects. This seemingly simple test method actually reflects the unique metabolism, cardiopulmonary function, and biomechanical parameters of the human body. This is the running speed used in the test, that is, the specific speed corresponding to the maximum oxygen consumption, expressed as a percentage. It also reflects the exercise intensity

| Table 2 | Finger frequency values of different genders, second-level middle, and long-distance runners |
|---------|--------------------------------------------------------------------------------------------|
| Item (male) | Grade | Finger frequency (times/8S) | Item (female) | Grade | Finger frequency (times/8S) |
| 5000m | Level 2 | 79 | 1500m | Level 2 | 84 |
| 5000m | Level 2 | 89 | 1500m | Level 2 | 72 |
| 1500m | Level 2 | 57 | 1500m | Level 2 | 81 |
| 5000m | Level 2 | 88 | 1500m | Level 2 | 79 |
| 1500m | Level 2 | 74 | 5000m | Level 2 | 87 |
| 1500m | Level 2 | 64 | 5000m | Level 2 | 86 |
| 5000m | Level 2 | 86 | 1500m | Level 2 | 85 |
| 1500m | Level 2 | 80 | 1500m | Level 2 | 75 |
| 1500m | Level 2 | 79 | -- | -- | -- |

| Table 3 | Finger frequency value of men’s sprint and middle and long-distance runners above level 1 |
|---------|-----------------------------------------------|
| Project | Grade | Finger frequency (times/8S) | Project | Grade | Finger frequency (times/8S) |
| 100m | First level | 80 | 5000m | Master | 83 |
| 100m | Master | 100 | 5000m | Master | 87 |
| 100m | Master | 106 | 10,000m | Master | 70 |
| 100m | Master | 93 | 10,000m | Master | 84 |
| 200m | First level | 105 | 3000m obstacle | Master | 82 |
| 400m | First level | 93 | 3000m obstacle | Master | 87 |
| 100m | Master | 100 | 10,000m | Master | 81 |
| 100m | First level | 86 | 5000m | Master | 93 |
| 100m | Master | 96 | 1500m | Master | 97 |
| 100m | Master | 93 | 10,000m | Master | 60 |
choose other grouped test groups for reliability and validity test. The subjects were randomly divided into three groups, with four people in each group and tested under the three conditions of H, L, and C. The results show that, from a numerical point of view, the maximum difference does not exceed 4%. Statistically speaking, the correlation between the test group and the formal test group is very strong, $r=0.63$, $p=0.000$. In order to study the impact of pressure on RE during running and the relationship between the lower limbs and biomechanical properties of RE, this paper uses a large amount of synchronously collected kinematic data, kinetic parameters, and oxygen consumption test results for discussion and analysis. The analyzed data refers to the kinematic parameters and gas collection data corresponding to 5, 15, and 25 min of a 30-min run on a treadmill, as well as the biomechanical parameters of the route at the beginning and end of the run. If you apply leg cuffs with different pressures in stages, in this article, it is found that during a 30-min run, the effect of pressure on RE is not statistically significant.

Studies have shown that with the passage of time, fatigue intensifies and oxygen consumption gradually increases, while RE shows a clear downward trend. According to the wear time of pressure equipment, the statistical analysis of various studies by Moore et al. showed that wearing pressure measuring equipment can reduce muscle vibration and edema only during exercise, but most of the mechanisms involved are hypothetical. In addition, the use of pressure equipment during exercise has little or no effect on physiological indicators such as heart rate, creatine kinase levels, and plasma lactic acid. Finally, it was found that wearing stress-relieving drugs during the recovery period seemed to have a positive effect on the efficiency of the recovery process and the relief of muscle soreness. Endurance athletes must provide a high level of muscle strength over a long period of time to prepare for sprints and high-intensity training. Kremer believes that stress-relieving machines can increase muscle strength and improve athletic performance. This article aims to investigate whether the use of equipment will affect long-term running results due to increased muscle strength or reduced muscle vibration, and to investigate the possible effects of different

### Table 4 Finger frequency value of female sprinters and middle- and long-distance runners above level 1

| Project   | Grade | Finger frequency (times/8S) | Project   | Grade | Finger frequency (times/8S) |
|-----------|-------|-----------------------------|-----------|-------|-----------------------------|
| 100m column | First level | 87                          | 1500m     | Master | 77                          |
| 100m column | First level | 94                          | 1500m     | Master | 67                          |
| 100m       | First level | 87                          | 1500m     | Master | 64                          |
| 100m       | First level | 83                          | 1500m     | First level | 63                        |
| 400m       | First level | 106                         | 3000m     | Master | 79                          |
| 400m column | First level | 88                          | 3000m     | Master | 83                          |
| 400m       | First level | 89                          | 3000m     | Master | 84                          |
| 400m       | First level | 88                          | 3000m     | Master | 83                          |

during the test and the approximate time required reaching a steady-state metabolism.

Research has confirmed that when the maximum VO2 speed is 60–90%, RE performance has nothing to do with operating speed. This article recommends using a maximum oxygen uptake of 70% and a running speed less than about 85% of the maximum oxygen uptake as the test speed. Ren Zhanbing tested the RE of excellent middle- and long-distance runners with maximum oxygen uptake of 65%, 75%, and 85% in 5 min, and found that the oxygen consumption of 12km/h is the most suitable for evaluating the RE of the middle distance. Therefore, in conjunction with the test subjects of the maximum oxygen uptake test level, this article uses a maximum oxygen uptake of 75% for testing, and the actual test speed is between 9 and 12km/h. For the purpose of this article, the body’s metabolism is constantly monitored during a 30-min run. In order to more accurately represent the development status, in this article, oxygen consumption data is collected every 10 min after the 5th minute for analysis. Because of this article, Daniels et al. believe that during low-to-medium-intensity exercise, it takes about 5 min for the human body to reach a stable state of energy metabolism. However, due to some objective differences, this cannot be used for uniform level comparison.

Therefore, some studies have shown that the difference between the first and second minutes of the test and the results obtained in the next 3 min is less than 2ml/kg, which is considered stable, and the stability basically occurs in the first minute, about 5 min. Since one of the goals of this study is to study the effect of wearing adjustable pressure bandages on RE during long-term endurance sports, it is impossible to test all experimenters at the same time of day. Undoubtedly, this will increase the error caused by force majeure in the experiment process itself. Studies have shown that among the many factors that affect RE, daytime temperature, wind resistance, and human metabolism will increase the errors that may occur during the experiment. In order to prove the validity of the data in this article, the subjects should not only do their best to ensure the same life span and rest time during the test, but also choose the same time period for each test, and should also
stress levels. However, the results of this study do not support the positive importance of pressure equipment. On the one hand, this may be due to the fact that the use of pressure devices in physical exercise is mainly based on empiricism, and the effect of pressure devices on the body is a research hypothesis. On the other hand, the influence of thrust equipment on muscle strength and other factors may not extend to RE. This difference can change the internal structure of the body, mainly manifested in the characteristics of the joint stiffness of the lower limbs.

Research on the correlation between biomechanical parameters of lower limbs and running economy

The existing running technical characteristics and the biomechanical research of running economics research are relatively independent. Combining these two factors to study its potential influencing factors will inevitably become the direction of more in-depth research in the future. This study collected treadmill and treadmill data, and the correlation test results showed that when landing, the angle of the hip joint when raised from the ground, the angle of the knee joint is the maximum strength of the knee joint, the maximum forward movement, and the ankle joint. At maximum intensity, oxygen consumption is positively correlated with HE; that is, it is negatively correlated with HE. The kinematic measurement methods of the same trend on treadmills include the following: the angle of the hip to the floor, the maximum angle of hip flexion, the angle of the knee above the floor, the angular velocity range of the knee, and the minimum length of the ankle. On a treadmill, the maximum angular velocity of the hip, knee, and ankle joints, the maximum bending angle and bending angle of the ankle joint to the ground, and the landing index are proportional to RE. In various renewable energy research, the contact time between the foot and the ground has been widely discussed.

Many scientists suggest that a shorter tuning time can help improve RE. However, some scientists have not found a positive effect on RE by contact time. Most of the above studies were conducted on a small number of people in this category, so the results obtained may vary widely. Folland et al. recruited 97 subjects of different genders and different levels of physical exercise. Research has shown that there is a significant correlation between ground contact time and RE. More importantly, the study also introduced a fill factor index, which refers to the ratio of the time the foot is on the foot to the time the foot is on the foot during the gait cycle. Compared with the time of a single touch, the landing index can better illustrate the percentage of time that the foot lands during the entire cycle. In addition, this paper found through regression analysis that the landing index has the largest contribution to renewable energy. However, this article also mentions that this does not mean that the landing index is the decisive factor for athletic performance. This article confirms the link between the Land Landing Index and renewable energy. However, the difference is that in this article, as the country’s index increases, oxygen consumption decreases, while renewable energy sources increase significantly.

This means that during the gait cycle, a shorter flight time or a longer landing time will have a beneficial effect on RE performance. This may be mainly due to the fact that the Folland’s study has a larger sample size and wider coverage than this article. Secondly, the first test environment is sound walking, not a walking platform. Daniels once said that attention must be paid when converting exercise on a treadmill into walking on the floor. Finally, the study used regression analysis, and the study only looked at one factor to test the correlation, and there may be differences. On the other hand, the contact time with the ground is shorter, which means that the muscles must contract faster, which will increase the metabolism used to quickly contract the muscles, and on the other hand will increase the cost of energy consumption, the longer it takes to fall. This will lead to an improvement in the vertical vibration of the human body during running, or shorten the life of this offset difference to some extent, thereby reducing energy consumption. In short, just as existing research cannot clearly understand the relationship between landing time and renewable energy, the landing index, as a relatively new indicator, also requires more practical research to test its meaning. Whether it is treadmill testing or lower limb kinematics parameters, the impact on RE is greater. The bending angle of the hip joint when landing and the bending angle of the knee joint when lifting from the ground are inversely related to the RE on the treadmill and treadmill. Although the kinematic parameters of the ankle joint have nothing to do with the RE on the route, the angular velocity, the ground clearance angle, and the maximum flexion angle of the ankle joint are closely related to renewable energy during the 30-min running process. He believes that both the vertical amplitude and horizontal speed of the hip joint affect RE. The results of this study show that within a certain range, the hip joint flexes stronger when landing, more knee flexion when the knee is lifted off the ground, and more ankles toe flexion may be effective in improving RE.

Compared with the study by Lieberman and Santos, this work found no significant correlation between knee angle during landing and the range of motion of the knee and ankle during support and RE. This may be due to the fact that the above experiment was conducted on a famous long-distance runner in Kenya, and the fitness level of the subjects in this study varies greatly. For dynamic performance, this paper found that there is no significant correlation between maximum knee joint strength, maximum forward work, ankle joint strength, and RE. Performance is the product of torque and angular velocity and is affected by two factors. In this study,
due to the limitations of the experimental environment, no dynamic data was measured when running on a treadmill. However, a large number of studies have shown that the angular velocity range of knee motion on a treadmill is consistent with the ratio of the maximum back flexion force and RE. Among them, the angular velocity can be used to describe the rate of change of the angle. When the angle changes, it is necessary to pull the fast twitch fibers and consume more energy. There is some relationship between maximum knee joint strength, because knee joint torque and RE are not significantly correlated. This may be because the individual changes in torque and angular velocity are not enough to affect the RE, and the interaction between them acts on the RE, thereby changing the shape of the power. Although this effect may not be strong enough, it will be necessary to target various moving surfaces in the future. At present, the discussion about dynamic data and renewable energy is more reflected in indicators such as gender reaction force, while the relationship with torque and other related content is getting smaller and smaller. This study found that there was no significant correlation between the stiffness of the knee and ankle joints and RE. This may be due to the fact that during 30 min of running on a treadmill, the dynamic parameters of the lower limbs cannot be measured in real time and must be adjusted to a certain extent. The completeness of the experiment is to fix the dynamic parameters of the route before and after running on the treadmill, thereby reducing the possibility of the impact of joint stiffness caused by running on the RE. However, in the two tests before and after the time series, it is found that the angle changes in torque and angular velocity range of knee motion on a treadmill is consistent with the ratio of the maximum back flexion force and RE. In addition, the flexion angle of the hip joint is smaller during the landing process, and the flexion angle of the knee joint is smaller during the landing process, which improves the performance of the RE and the lower limb joint angle changes faster.

Conclusion

This paper proposes a semantic image segmentation algorithm based on improved multi-scale feature prediction and adaptive network fusion Deeplabv3+. The algorithm also uses encoding and decoding models to perform image semantic segmentation tasks. Because the Deeplabv3+ decoding framework is too simple, and only a certain proportion of function maps are integrated in the encoding process, the final result of semantic segmentation is relatively rough. The algorithm proposed in this paper can allocate adaptive multi-scale low-level semantic feature maps during the encoding process, and the combined weight realizes the effective use of multi-scale information in the encoding process during the decoding process, thereby improving the performance of semantic network segmentation. Although the simulation and prediction experiments using different SST propulsion frequencies have reasonable ability to describe the process of interaction between the ocean and the atmosphere. The northeast, south coast, east coast, and north coast are the four main seas, with the strongest overall strength in sports. These regions have shown advantages in many competitions and often have a higher level of competition. This is mainly due to factors such as a superior geographical location, high degree of openness, a developed economy, high-tech components of competitive sports, and a large amount of investment in sports. At present, the problem of population aging is becoming more and more serious. Research on measuring physical activity level and monitoring heart rate has important social health and safety significance. This article explores and develops a portable exercise state detection and data monitoring system using STM32+MTK +MPU9250+MAX30102, and completes the hardware and software of the system development. This paper studies the power consumption of portable devices, proposes a motion state detection algorithm based on time difference and threshold, analyzes motion state detection based on random forest classification algorithm, and realizes data detection. According to the design goals and requirements of the system, the construction of the software package and the connection of the hardware devices have been completed. Combined with the current research status of sports at home and abroad, this article mainly analyzes the situation of a person's walking, running, sitting, standing, and walking stairs. The static, backward, backward, left, and right movements of the data acquisition module, positioning module, and low power consumption module were designed, and experiments were carried out to verify.

Declarations

Conflict of interest  The authors declare no competing interests.
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