Satellite technology of ocean climate detection and design of monitoring system for group movement in coastal areas

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Abstract

Through the analysis of the principle of building energy use, we can understand the four meteorological parameters that have the greatest impact on the energy consumption of marine buildings: the first is air temperature, the second is relative humidity, the third is wind speed, and the fourth is the sun. Now China’s satellite technology is constantly improving. People can already use satellite data to time weather data. This kind of satellite data can provide weather data for various periods of time for a long time. Therefore, this article contains the satellite data of recent decades and the data simulation model of the same period. In order to ensure the accuracy of the experimental data, we took into account the influence of air temperature, humidity, and wind speed when collecting the data. In order to prevent accidents, a new sports monitoring system is designed. This sports monitoring system can provide people’s physical conditions in real time, as well as people’s postures during exercise, to prevent people from causing sports injuries due to errors in exercise postures. Not only that, this kind of the exercise monitoring system can also monitor the calories consumed by people exercising. Based on this exercise posture and calorie consumption, a modeling evaluation is also established. This modeling evaluation can effectively prevent people from accidents due to physical exhaustion, and at the same time, this modeling system can also locate the position of the person according to various trajectories during the movement and determine whether the athlete is in a safe state according to the physical condition of the athlete, so as to ensure the physical health of the athlete.

Keywords Ocean climate detection · Satellite technology · Coastal areas · Mass movement monitoring

Introduction

China’s advanced satellite technology can provide a lot of big data, such as sea surface temperature data, but China’s satellite technology is not omnipotent. Chinese satellites are also helpless with difficult-to-measure data like air temperature data, but it does not trouble us. We can calculate the air temperature data based on the measured sea surface temperature data and then use the BOWEM ratio method and empirical coefficients, which are easier to check, to infer the overall air temperature data (Kasanzu et al. 2008). Since the solar radiation data cannot be directly obtained, we choose using the temperature difference model to calculate the solar radiation data; in addition to the solar radiation data, we also need to collect the solar radiation value in the climate simulation data. We found through experiments that in the two algorithms, the empirical formula can better infer the air temperature data, and the empirical formula model is relatively more stable, and various factors have less influence on it, and the experimental results are more accurate. However, the various factors to be collected by satellite data are more complicated (Kossoni and Giresse 2010). This simple result does not meet the requirements. The climate simulation data can directly obtain the required parameters and then compare and analyze the solar radiation values collected before to obtain new information (Madhavaraju et al. 2019). In data and conclusions, the solar radiation calculated by the
temperature difference model is similar to the true value of the climate simulation, and there is no obvious advantage or disadvantage. The society is developing, mankind is progressing, and people’s living standards are improving day by day. At the same time, people’s spiritual pursuit is constantly improving. People no longer pursue fast-paced life but turn to leisure life, which also gives rise to a new leisure era (McDonough and Sun 1995). Under the background of the leisure era, leisure cities have naturally emerged, so of course the most important thing in leisure cities is sports and leisure. This lifestyle provides a new path for China’s development. Although exercise can help people strengthen their bodies, they may also cause damage to physical functions. Therefore, we have established a new model and system to detect the effects of various factors on people during exercise (McLennan et al. 1990). The main factors we detect are the influence of air humidity, air temperature, wind speed, and solar radiation on movement. In summary, this article discusses the methods for obtaining various meteorological parameters in a certain area of China and at the same time studies the relationship between meteorological parameters and building energy consumption in a certain area, and provides an accurate theoretical basis for building energy efficiency in China (Meng et al. 2012).

Materials and methods

Data source

The data used in our research comes from the National Atmospheric and Oceanic Administration of the USA. In this study, we use more advanced satellite remote sensing technology, because this will obtain more accurate data, and satellite remote sensing data can directly obtain sea temperature, series parameters such as wind speed (Mortazavi et al. 2014). These existing data lack the most important air temperature and relative humidity, so we need to make inferences through formulas. The data needed for inference can be obtained from major websites. Most of these inference data are counted every 3 h (Nesbitt and Young 1982).

Ocean climate calculation method

Although we can detect the temperature of the sea surface, it does not represent the temperature of the air. There is still a big difference between the two. As we mentioned before, the satellite data cannot directly get the temperature of the air surface, so it needs to be carried out (Nesbitt and Young 1984). Reasoning, then we will use the air temperature equation to reason, as shown in Eq. 1:

$$T_a = T_s \left\{ \frac{C_c}{C_n (q_s - q_a)} \frac{Q_s(T)}{q_a} \left[ \frac{1}{C T} \right] \right\}$$

(1)

Each letter has its own meaning. We infer the number of blocks based on what we have learned, as shown in Eqs. 2 and 3:

$$C_n = \frac{3.2-1.10(T_a-T_s)u}{(Ts-T_a)u} * 10^{-3}$$

(2)

$$C_c = 1.15 * 10^{-3}$$

(3)

We use the known wind speed, sea surface humidity, sea surface temperature, and air specific humidity to obtain the air temperature equation as shown in Eqs. 4 and 5:

$$e_a = \frac{Pd_a}{0.622 + q_a}$$

(4)

$$T_a = -273.2 \left[ \ln \left( \frac{e_a}{5419.285} \right) \right] + 16.11 - 19.836$$

(5)

Now, as we have a complete system for calculating solar radiation. The predecessors have obtained many formulas through calculations. These formulas are very valuable, but we generally use single-parameter model formulas, because the single-parameter model formulas have few influencing factors, and the multi-parameter model formula has many influencing factors, and it is easier to cause errors (Ngama et al. 2019). Next, we use the temperature difference model to obtain the required solar radiation data, as shown in Eq. 6:

$$\frac{G}{G_0} = a (T_{\text{MAX}} - T_{\text{MIN}})^{0.5}$$

(6)

After obtaining the data, use the altitude parameter to make corrections, as shown in Eq. 7:

$$\frac{G}{G_0} = a (1 + 2.7 * 10^{-5} * Z) (T_{\text{MAX}} - T_{\text{MIN}})^{0.5}$$

(7)

Under normal circumstances, the simulated values provided by the data we get will not have the maximum and minimum values but will take the average of all the numbers and interpolate the data to get all the temperature values of the day.

Analysis of mathematical modeling of motion information

There are various formulas to calculate the step length and step frequency. According to the obtained step length and step frequency data, the average speed per second can be obtained. The average speed obtained by different people’s step length and step frequency is different. For this reason, we have come to a conclusion: the energy consumption during exercise
varies with different people’s exercise frequency (Ngueutchoua et al. 2019). We tested a large number of athletes to observe their energy consumption and changes in step length and step frequency during exercise and finally got the approximate relationship between step length and step frequency, as shown in Table 1.

After obtaining the average speed, we deform it and get the energy consumption analysis of the average speed after deformation. Table 2 shows the relationship between the average speed and energy (Ongboye et al. 2019). The preliminary modeling analysis is completed by deriving Table 2.

The human body is composed of many parts. If we establish a human body coordinate system with human body parts as a reference, we can judge the energy consumption produced by various human postures. There are two main angles for judging human posture. The first is Pitch angle, and the second is the roll angle. Next, we will use the method of derivation to find each measurement value, as in Eqs. 8 and 9:

\[
\theta = -\arcsin\left(\frac{G_x}{g}\right)
\]

\[
\gamma = \begin{cases} 
\arcsin\left(\frac{G_z}{g}\cos\theta\right), & G_z < 0 \\
\pi - \arcsin\left(\frac{G_z}{g}\cos\theta\right), & G_z > 0 & G_x > 0 \\
-\arcsin\left(\frac{G_z}{g}\cos\theta\right) - \pi, & G_z > 0 & G_x < 0 
\end{cases}
\]

We can regard everyone as a motion model. This motion model is composed of several basic elements. The posture of the person is entered into the system for system recognition, and the human body is divided into vertical space and horizontal space. The division method can be seen in Fig. 1 (Pettijohn et al. 1972).

We divide the human body into several areas and divide each posture into the corresponding area, establish the human body coordinate system, find the vertical axis and the horizontal axis, divide the intensity of the movement into the corresponding area, and divide in number sequentially, so that we get the required data, and then use the formula to get the initial state, intermediate state, and final state of the threedimensional vector to further determine the process of posture change, as shown in Table 3 (Potter 1978).

**The overall structure design of the system**

The above-mentioned human body coordinate structure is actually a 3-week acceleration system. The system can calculate the calorie consumption very well. The calorie consumption is used to calculate the human energy consumption for the purpose of detecting the human movement state. Not only that, the system can also determine the area where the athlete is located by positioning and at the same time detect whether the athlete is safe and whether there is a tendency to fall according to the person’s movement posture (Ramos-Vázquez and Armstrong-Altrin 2019). The overall structure of the system is shown in Fig. 2.

The system for detecting human motion state consists of six parts in total. Figure 3 is the system framework and information flow diagram. It shows us the parameters obtained by the system. The parameters include human body temperature parameters and human motion parameters (Ramos-Vázquez et al. 2019). Table 1:

| Cadence/(step 1s) | Step size/m |
|-------------------|-------------|
| 2                 | 0.75        |
| 3                 | 0.79        |
| 4                 | 0.84        |
| 5                 | 0.93        |
| 6                 | 1.12        |
| 7                 | 1.07        |
| 8                 | 1.05        |

Table 2:

| Average speed/(km/h) | Energy consumption/(C/kg/h) |
|----------------------|----------------------------|
| 8                    | 10                         |
| 12                   | 15                         |
| 16                   | 20                         |
| 20                   | 25                         |

Fig. 1 Horizontal and vertical division method
et al. 2017). The system is actually composed of three as the central part, and the axis acceleration sensor obtains and analyzes the athlete’s state during exercise. During the analysis process, the athlete’s body temperature, heartbeat, and various vital characteristics can be obtained (Ramos-Vázquez et al. 2018).

The system adopts an advanced microprocessor method, which is small in size but powerful in function. The microprocessor can display the obtained data on the display screen and store it while displaying the data. The stored data can be analyzed and extracted when offline, and the stored data can also be associated with the mobile phone through the background. After being associated with the mobile phone, it can be edited in the Android system. After editing, it can show that the human body is in the state of motion and the function and finally got the calories (Regnoult 1986). The consumption status is shown in Fig. 4.

The system frame structure adopted by Android phones is the same, and the stored data can be moved to the database for backup. Figure 5 shows us the server-side architecture diagram (Sharma et al. 2013). The server-side seems simple but consists of multiple structures. In the entire server-side, there are a control layer, a model layer, a persistence layer, and a filtering layer. On the server side, we first receive the customer’s request (Singh 2009). After receiving the request, we forward the request to the backend of the system. The backend personnel use advanced technology to perform precise services and finally transmit the data.

Most of the positioning systems we use nowadays are GPS positioning systems. Nowadays, with the increasing development of technology, our mobile phones have positioning functions. No matter where we are, satellites can find our position and change our position (Roser and Korsch 1986). The information is sent to the terminal console, and the staff of the terminal console can find our specific location based on the data. In addition, we can also call Baidu’s technical side, construct a corresponding service system, this service system can realize three-D service, so that people can understand the map more clearly and can also zoom in and out of the map (Ségalen 1994).

Results

Spatio-temporal variation characteristics of marine climate environmental factors

We can use the data table to collect and organize the data of the ocean surface temperature. According to seasonal

| The magnitude of θ | Area | Status               |
|--------------------|------|----------------------|
| 0°<θ<20°           | I    | Upright              |
| 20°≤θ≤40°          | II   | Transition state     |
| 40°<θ<90°          | III  | Horizontal state     |

Fig. 2 Overall flow chart of the system
changes, the sea surface temperature will also change (Tawfik et al. 2018). We use the orthogonal function decomposition method to analyze and obtain the distribution characteristics of China’s surface temperature changes in recent years. As shown in Fig. 6 and 7.

In the previous modes, the variance contribution rate reached about 80%. The first mode has the largest contribution value, which can well explain most of the variation information of the SST in the South China Sea. The most obvious one is the Taiwan Strait. In the nearby sea area, according to our experiments, it can be concluded that the SST season has obvious characteristics of inter-annual and inter-decadal changes. In comparison, the variance contribution value of the second mode is relatively small, and some detailed problems can be reflected in the second mode. Most areas of the South China Sea have signals, but the northeast areas have particularly strong signals. According to surveys, the northeast area is the waters of the Taiwan Strait. We can see that the eastern waters of the South China Sea are positive based on the data obtained showing an upward trend year by year, while the western waters are just the opposite. Next, let us take a look at Fig. 8, the monthly average satellite observations of precipitation data.

Observing Fig. 9, we can find that the variance contribution value of the first mode is about 30%. The strong point in the South China Sea is near the sea basin. The sea basin and the surrounding area have the same phase change. The inter-decadal change in this place is also quite obvious. The variance contribution of the second mode is about 13%. The South China Sea is not integrated. It is divided into two azimuths. There is a boundary between these two azimuths. This boundary is a latitude of 16 degrees north latitude. In short, the South China Sea is divided into two directions.
China’s waters are growing exponentially over the years, and there is a trend of shocks.

**Marine climate results based on satellite detection**

In fact, the surface temperature of sea water is lower than the temperature of air surface. Next, see Fig. 10.

We also need a data relative humidity. We cannot measure the relative humidity directly, and we need to calculate it. Next, we use the dew point temperature and the sea surface temperature to get the data we need. In addition to this, we can also use the air near the sea. The temperature is calculated. Next, look at Fig. 11. From Fig. 11, we can find a new relationship. In fact, the annual difference is also related to the latitude.

In addition to the above relative humidity, we also need a piece of data. This data is the saturated vapor pressure at a certain temperature. The saturated vapor pressure cannot be directly measured. We need to calculate it through the Magnus formula. First, we need to measure the dew point temperature. We use the air temperature obtained above, the saturated water vapor pressure data can be obtained when the two data are available at the same time, and the relative humidity is the ratio of the saturated water vapor pressure at a certain air temperature to the saturated water vapor pressure at the dew point temperature at a certain temperature. The dew point temperature changes with the change of the air temperature, and the dew point temperature decreases as the dimension increases, as shown in Fig. 12.

From Fig. 13, we can know that compared to the sea, the land has a lower annual wind speed, and the average score in winter is lower. Each letter in Fig. 13 represents a region. Next, let us look at Fig. 13.

From Fig. 14, we can see that the pressure in some areas changes with the seasons. The pressure varies with the latitude. In some areas, the pressure changes significantly with
the seasons, and in other areas, the pressure changes significantly with the latitude.

In all regions of China, the highest temperature of the day is between 14:00 and 16:00, and the lowest time of the day is around sunrise. The time of the highest temperature and the lowest temperature in each day are different, and there will be local or subtle differences. Sometimes there will be unexpected situations. For example, the maximum and minimum temperatures will be much lower than usual when the weather is cooling down, and the maximum and minimum temperatures in winter and summer are also different in China. With the advancement of science and technology, people can accurately judge the minimum temperature and maximum temperature of the day based on the data returned by satellites. We have determined the daily maximum temperature and daily minimum temperature based on many experiments. In our basic processing of data, the principle is as follows: When measuring the maximum temperature and the minimum temperature, the maximum temperature and the minimum temperature in the obtained data are respectively removed, and then the average temperature is obtained. In this way, we can obtain the more accurate daily maximum temperature and minimum temperature in 24 h. Our classmates also found that these temperatures usually appear on the hour. This paper uses the spline interpolation method to carry out the experimental results as shown in Fig. 15.

The degree of solar radiation in each place is different. In order to prove this conclusion, Fig. 16 is drawn. Figure 16 shows the annual solar radiation in a certain place. From this figure, we can see that the difference in solar radiation between summer and winter is different. We can find that the solar radiation is the largest in summer, but the solar radiation starts to decrease gradually in the last 2 months of summer. From this we can guess that the solar radiation will get smaller and smaller in the future, because the direct sun point is near the Tropic of Cancer, so there is a high probability that this phenomenon will occur.

Analysis of the research results of the group exercise monitoring system

In order to enable people to have a better experience when using the exercise monitoring system, we conducted the experiment. We selected ten volunteers with the same physical condition and similar height and weight to conduct the experiment. We asked these ten volunteers to walk, run, and jump. After a series of exercises such as falling, falling, and then collecting their physical function indicators in real time, and comparing the obtained indicators with the indicators measured by the treadmill, the accuracy of the experimental results can be tested. Table 4
We compare the data measured by the exercise system with the data measured by volunteers on a treadmill. The test data are shown in Tables 5, 6, and 7.

The average value obtained by ten volunteers in the same exercise situation is represented by the vector composition of the three-axis acceleration.

The average value when the human body walks normally is different from the average value when the human body is in an upright state. The movement posture of the athlete in different movement states is represented by letters. At this time, the average movement value of the person is also different. Next see Table 7.

Discussion

Land and sea mass movement planning in coastal areas

If you want to build a sports and leisure place in the coastal area, you must first investigate the topography, such as the landform of the cover, the shape is a triple island; then in order to make it more regular, China’s current industrial trend is internationalization, and the future trend is industrialization. In order to achieve the great goal of tens of billions of annual output value, the government must increase support for projects and invest more energy. Various industries are emerging in the world now, but relatively speaking, it is recognized that the industry with the greatest added value should be the yacht industry. Yachts are used for leisure and entertainment, as well as for commercial purposes, and can also be turned into entertainment venues. It is a kind of leisure destination that people like very much. Now many places have formed a large-scale yacht industry. With the continuous improvement of the economic level, people’s spiritual and cultural pursuits are also constantly improving. Now people are more and more like fitness and often carry out some recreational and cultural activities, and people often hold rowing competitions, running competitions, fitness competitions, and so on. These competitions are not only beneficial to the health of the citizens but can also increase the specialization and industrialization of the region and increase the regional influence. If these entertainment cultures reach a certain level, they can also radiate the charm of the city. Take a certain area as an example. Suppose there are six district-level sports centers in a certain area. The sports centers of the DC district take different locations as the...
axis to develop the axis sports and then gradually expand to
the surrounding area to expand the scale. The goal is to build a
full-featured leisure and sports center and build a district-level
sports center. At the same time, the towns and villages where
these six districts are located also establish leisure and cultural
sports venues and organize various leisure and entertainment
cultures to keep residents in good physical condition. In our
daily life, we must also actively exercise physical fitness, tak-
ing physical fitness as our goal. At the same time, we must
organize the people around us to consciously perform physical
exercises in the stadiums all year round. We must also develop
distinctive community activities to win everyone, participate
in sports and leisure sports, make a certain contribution to
improve the physical health and quality of life of the residents,
and jointly build a harmonious community. Combining with
the trend of social development, we start from the following
aspects: First, establish a practical and convenient bicycle
path, plan according to the terrain of a certain place, and then
establish a bicycle lane suitable for the terrain of the place, so
that people are convenient while exercising. In order to travel,
it can also enhance the overall image of the place in an all-
round way. This is a project that benefits the country and the
people. Secondly, establish a unique competition pattern.
Each sport has its own characteristics and sports have infinite
charm, because in the competition we can get friendship and
health, which also satisfy our pursuit of dreams and the stars in
various sports fields. They all have their great patriotic feel-
ings. As a support, it is their constant pursuit to win glory for
the country. We should reasonably use our advantages to
maximize our strengths and avoid weaknesses when we exer-
cise and improve our physical fitness while having fun and
leisure. Finally, we want to develop a new type of visual
sports. When developing visual sports, we should promote
the landmark landscape or architecture of the place as the
background to perfectly show the advantages of the place
and improve the influence and influence of the place.
Popularity, we must also vigorously promote and integrate
the excellent sports resources of the place, so that sports can
enter the world of more people, become a part of people’s
lives, and bring new business opportunities and lasting vitality
to the development of the place.
Strategies for the construction of mass sports in coastal cities

1) If you want to build a complete sports and leisure city, you must first understand the topography and geography of the city and its geographical advantages and make reasonable use of the topography and geography of the place, and the relevant local departments should actively participate in and provide assistance for sports. For a leisure city, the most important elements are sea areas, beaches, parks, flowers, green plants, etc. These elements can relax people physically and mentally and better engage in sports. In addition to these, they must also have the advantage of the place. Incorporating into it, such as the landmark buildings of the place, excellent publicity slogans, etc., it is necessary to increase publicity, increase its influence, and expand the influence of the leisure sports city so that it has the right to speak in the professional field.

2) The local sports department, cultural department, and other relevant departments should work together to achieve win-win cooperation, learn from each other’s lessons, learn from each other’s experience, and work together to build a distinctive leisure and entertainment resort while injecting fresh blood into the sports industry. It is also necessary to re-plan obsolete sports items to restore their vitality. Of course, any great project must require the help of the government. We must carry out the planned projects step by step, in a down-to-earth manner and gradually improve action.

3) The government can specifically establish a funding system to support outstanding leisure sports projects, encourage them to build clubs and vigorously promote them, and can also expand their scale and move towards internationalization and occupy a place in the international field.

4) Nowadays, China’s leisure sports education is relatively lagging behind. The main reason is the lack of counterpart talents. To solve this problem, we must give priority to the cultivation of leisure talents. Now China does not attach importance to the cultivation of leisure talents, and few colleges and universities are related to this. Therefore, we propose here that we hope that the education system can attach importance to leisure education and set up its

Table 4  Experimental result

| Table 5  Accuracy of measured data when the same individual walks normally at different speeds |
|-----------------------------------------------|-----------------------------------------------|
| Cadence/(step/s) | Accuracy of normal walking/% |
|------------------|-----------------------------|
| 1.2              | 89                          |
| 1.4              | 93                          |
| 1.6              | 85                          |
| 1.8              | 73                          |

Fig. 16  Results of solar radiation in various places
corresponding majors to better provide China with leisure talents and accelerate the development of the leisure industry.

5) Link leisure and entertainment with trade and coordinate and cooperate with each other for mutual benefit. In the process of urbanization, increase sports investment, strengthen inter-regional industrial cooperation, and give full play to the advantages of ports and trade. Promote the licensing of sports and leisure, adjust the industrial structure, adapt measures to local conditions, share resources, develop together, and make progress together.

Conclusion

At the beginning of this article, a new type of monitoring system is proposed. This system can monitor the physical condition and function of the person when the person is exercising. The system is mainly composed of a microcontroller as the core, which can be related to the Android system of the mobile phone. The data can be transferred to the mobile phone for editing, sorting and analysis. It can also prevent danger in advance according to the person’s exercise posture, issue an alarm, and use the positioning system to report the person’s trajectory in real time, and it can also monitor the calorie consumption of the person’s exerciser. To prevent exercisers from muscle damage due to excessive consumption, in order to obtain the architectural design method of warm in winter and cool in summer in a certain area, we have carried out repeated experiments and analyzed the data. The main data are meteorological parameters, air temperature, for the acquisition of air humidity, wind speed, and solar radiation; some of the data cannot be directly extracted and need to be calculated by formulas. Therefore, we draw the following conclusions: First, after many repeated experiments and using different methods, we finally get the empirical formula inversion method which has the highest accuracy and the best model stability. Second, in general, satellite remote sensing technology is now very mature. China has a greater advantage in this respect, so we have obtained an accurate data source, and knowing the different parameters of different sites has its own advantages; third, since we know the accurate data source, our satellite data will be more accurate, and the frequency of the climate simulation data obtained will be higher; fourth, there are many experiment factors that can cause errors. For example, the temperature, humidity, and wind speed can cause errors in the experimental results. Among them, the biggest influence on Chengdu is the temperature, followed by the humidity. The error caused by the wind speed is the smallest. In order to obtain more accurate experimental results, we are very strict in the selection of data sources. Society is gradually developing, and human beings are also making continuous progress. Now people have entered the era of big data. The era of big data has led to a new era of leisure and entertainment. This leisure mode has spawned a new urban process. The leisure city model consists of many parts, but the most important part is sports and leisure. Sports are very important to people and can make a great contribution to people’s stress and health. In the leisure age, leisure sports venues are specifically set up to meet people’s sports needs. Sports and leisure cities can make people more and more interested in sports. The development of sports and leisure cities is also a new business opportunity that can bring new business opportunities to the city. To develop a sports and leisure city, we must not only build leisure and entertainment venues but also cultivate professional talents, develop new paths with new ideas, and make contributions to future sports work.

Declarations

Conflict of interest The authors declare that they have no competing interests.

| Serial number | Accuracy/% |
|---------------|------------|
| 1             | 89         |
| 2             | 92         |
| 3             | 90         |
| 4             | 83         |
| 5             | 89         |
| 6             | 86         |
| 7             | 90         |
| 8             | 96         |
| 9             | 81         |
| 10            | 89         |
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