Design of Network Sense Topic Detection and Tracking System

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Abstract: The saddle is the main functional part of the bicycle and is the most critical part of contact with the human body. The rationality of the bicycle saddle design directly affects people's health. Finite element simulation technology applied in industrial design can quantitatively analyze various conditions of products in the digital design stage, and improve the technical level of industrial design. Finite element simulation technology is applied to the design of bicycle saddles in this article. Firstly, an ergonomic system for bicycle saddles was established. Then, based on the finite element simulation technology, the finite element model of the human body, the saddle, is analyzed. Finally, based on the results of the finite element model analysis and a specific example, a personalized bicycle saddle was designed.

1. Introduction

Bicycles are favored by consumers because of their advantages such as non-pollution and energy saving [1-2]. The function of today’s bicycles has evolved from the original alternative to leisure, entertainment, and fitness. With the development of social economy, people are pursuing the improvement of the quality of life. Bicycles are no longer a low-value product. High-end bikes can better meet users' fitness, leisure and sports functions. It has higher requirements for quality, aesthetics and comfort [3-4].

The saddle is a bicycle component used to support the body. The design of the saddle directly affects riding comfort. Bicycles have a history of hundreds of years. However, there are still many problems in the design of bicycle saddles. Especially saddle comfort issues. Therefore, systematic research on bicycle saddles has important theoretical and practical significance.

China is a world famous "bicycle kingdom." Bicycles are the most commonly used means of transportation for the working class [5]. Cycling out can not only exercise, but also economical. However, some bicycle riders often feel perineal pain and abdominal bulge. If you do not rest and treat in time, the symptoms will gradually increase, causing painful urination, frequent urination, pain pills and other symptoms. This is because the perineum is squeezed for a long time while riding, resulting in congestion, swelling, and chronic inflammation of the prostate [6].

In addition, surveys and studies have shown that about 90% of men who ride bicycles have abnormal deformities. Ninety percent of riders feel scrotal discomfort or erectile dysfunction [7]. According to a report from China’s male medical science, cycling has a large share of the causes of prostatitis in China. Therefore, how to solve the man-machine system problems of the saddle and the human body and improve the comfort of the saddle is a very urgent and necessary issue.

2. Establishment of human-machine system

2.1 The ergonomics of the saddle

The design of the saddle directly affects the rider's comfort and health. Firstly, the size, shape, size, and stiffness of the saddle will affect the pressure in the ischial reproductive area [8]. Secondly, the rider's angle between the body and the horizontal plane during cycling will affect the pressure in the ischial reproductive area. In addition, changes in the posture of a person during riding will exert

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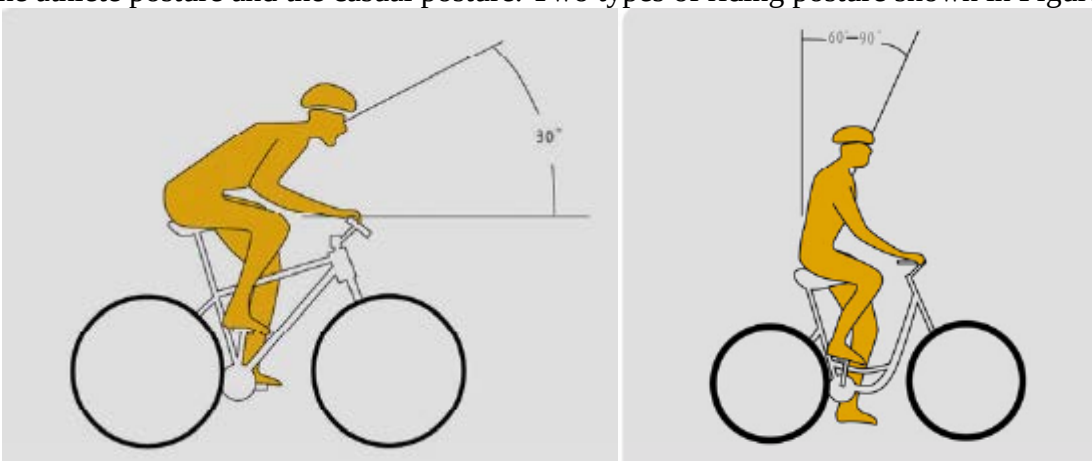
varying pressure on the human spine. If the riding posture is not standardized, the deformation of the spine will be aggravated, resulting in an increase in intervertebral disc pressure, long-term depression, and easy spinal diseases and endanger human health.

When the human body rides a bicycle, the saddle is in direct contact with the human buttocks. Most of the body's weight is transmitted to the saddle through the buttocks. The two ischial tuberosities on the buttocks are in close contact with the saddle. For a long time, the human body will produce obvious fatigue and pain.

When the seat is level, the position of the femur outside the ischial tuberosity is also normal. At this time there will not be much pressure and riding will be more comfortable. The rider's riding posture is different, and the saddle's stress is also different. According to the angle between the upper body and the horizontal plane when the rider rides, the riding posture can be divided into two types: the athlete posture and the casual posture. Two types of riding posture shown in Figure 2



(a) Athlete posture (b) Casual posture

Figure 1 Riding posture

Most of the athlete's posture is used by road racing athletes. In order to speed up the rider's upper body and the ground angle is not more than 30 degrees. The narrower the saddle face, the more it can reduce the friction between the saddle and the thigh, which greatly improves the rider's riding speed. However, due to poor cushioning, riding will not be very comfortable. Most of the ischial reproductive area is located on the saddle, and it is compressed by the weight of the upper body, which is very unfavorable to the athlete's sciatic region.

It is very comfortable when the rider's body is 60-90 degrees from the horizontal plane. At this point the body is in an upright position. The weight of the upper body is mostly transferred to the ischial tuberosity, which reduces the contact area between the saddle and the sciatic region. The pressure on cyclists is reduced. Most of the upper body's weight is absorbed by the ischial tuberosity, and the pressure on the ischial reproductive area is also slightly reduced.

2.2 Human parametric model establishment

The number of people who work mentally is significantly expanded by the advent of the knowledge economy. Most of today's office workers sit to work. When a person is in a sitting position, the weight will exert pressure on the backrest and the seat surface, which is called a sitting posture body pressure distribution. As the number of people travelling on bicycles or electric vehicles gradually increases, the comfort level of saddles is as important as the comfort of chairs [9]. When a person is in a sitting position, the weight will exert pressure on the backrest and the seat, which is what we call the sitting posture body pressure distribution. Sitting posture pressure distribution is one of the key parameters to assess the ergonomics of a bicycle saddle. Measuring body pressure distribution in sitting posture includes four principles: barometer method, pressure sensor method, pressure-sensitive paper method, and total internal reflection of light.

In the research and design of bicycles and electric bicycle saddles, full consideration should be given to the physiological conditions of people riding for a long time. Blood flow can effectively

reflect the body's physiological conditions. Changes in blood flow mainly affect the human perineum. Long-term squeezing of the perineum has hidden dangers in the reproductive system. Prof. Sommer, a US scientist, tested a variety of saddles and found that there is no saddle to avoid blood flow inhibition. Therefore, in the saddle design, in order to evaluate the extent of perineal oppression by the saddle, medical use will be used to measure changes in blood flow.

According to the actual sampling, the basic parameters of the saddle are shown in Table 1.

Table 1 Saddle basic parameters

Number	Name	Content	Number	Name	Content
1	L1	Saddle total length	6	W2	Depression area width
2	L2	Saddle face length	7	W3	Nose width
3	L3	Depression area length	8	H1	Depression area depth
4	L4	Nose length	9	S1	Edge size
5	W1	Saddle total width	10	S2	Root size

3. Human-machine finite element simulation analysis

3.1 Finite Element Theory

The finite element idea was first proposed by Courant in 1943. For the first time, he used the method of defining the principle of minimum potential energy and the piecewise continuous function in the triangular region, and obtained an approximate solution to the St.Venant torsion problem. In the mid-fifties of the 20th century, in the field of aviation, this idea was used to perform matrix analysis on the structure of the aircraft. The basic idea is to regard the entire aircraft structure as an assembly formed by the tight connection of a finite number of small units in the form of mechanics. The mechanical properties of the overall structure can be represented by a combination of this limited number of mechanical units. In 1960, the Claver scientists of the United States first publicly proposed the term "finite element method" in an article entitled "Finite Element Analysis of Plane Stress Analysis."

With the rapid development of computer technology, the finite element method continues to develop rapidly. Large-scale finite element analysis software has become an indispensable analytical tool in various fields. The technical methods of the finite element model have also been continuously improved. The size of the finite element model has gradually grown from a simple unit that can only be established with hundreds of meters to a hybrid unit that can be measured in hundreds of thousands of meters. The field of application of finite element method has also been extended from the field of early continuum mechanics to some areas of continuity problems, such as solving fluid mechanics, heat conduction, electromagnetic fields, and so on. The basic solution process of the finite element method is as follows.

Firstly, the solution domain needs to be decomposed into a finite number of units. The condition of decomposition is that the result of the collection of all these units is equivalent to the original solution domain. The relationship between unit node displacement and unit strain needs to be created. The basis for the creation is the element displacement function and the geometric relationship between displacement and strain.

According to the format of the finite element method, the following forms of algebraic equations are generated

$$[K]\{\delta\}=\{F\} \tag{1}$$

where, $[K]$ represents the overall stiffness matrix, which is formed by the stiffness matrix of each unit. $\{\delta\}$ represents an unknown node displacement array. $\{F\}$ represents the node load array, which is generated in the order of node numbers.

3.2 Human and saddle finite element model

The human body is a non-linear body with distinct physiological boundaries between different parts. Therefore, the human body can be considered as a non-uniform elastic modulus and an inhomogeneous continuum. After being discretized, the human body is divided into 16 physiological processes.

In actual life, the bicycle saddle and the body are rigidly connected. For the convenience of analysis, this article virtualizes the car body and uses fixed constraints instead of the car body. In the saddle bottom shell, spring elements and beam elements equivalent to the actual saddle are created. The spring unit represents the buffer spring at the lower end of the actual saddle bottom shell. The beam unit represents a rigid support connected to the bottom shell. Both the spring and the stand's mathematical data are measured from a standard seat.

4. Bicycle saddle design example

Through the finite element analysis and research on existing bicycle saddles and human saddles, the design of the saddle must be aimed at reducing the compression and friction on the reproductive area of the human ischium. Based on the structure and dimensions of the human body related parts discussed in the previous section, as well as the analysis and design requirements for riding force, the author analyzed the saddle design elements and proposed a new saddle design scheme.

The main steps for designing a personalized saddle are as follows. First, design personalized saddles. The cyclist's information is input into the finite element software. The software can generate saddles that match the cyclist based on the cyclist's personalized information. Second, a saddle designed by Boolean operations. The cyclist can perform Boolean operations on the saddle according to his own needs. Third, generate a personalized saddle. According to the personalized information, the user's favorite shape is adjusted to generate a saddle body.

After the system generates a personalized saddle, the cyclist can adjust the saddle according to his own needs. Modulation measures include point control deformation and overall deformation. Point control deformation is through the adjustment of each control point. The overall deformation is through the adjustment of several control points. The displacement of the movement may be based on the rider's input value or the local adjustment of the saddle surface may be controlled by dragging the mouse.

The saddle parameters designed in this section based on the finite element method are as follows. The cyclists were male, weighing 75 kg, height 177 cm, spacing of ischial tuberosity 84 mm, and riding posture 0-30 degrees. According to the finite element software system, the designed saddle parameters are: saddle width 122mm, saddle length 221mm, and saddle inclination angle 1 degree. The design result is shown in Figure 2.

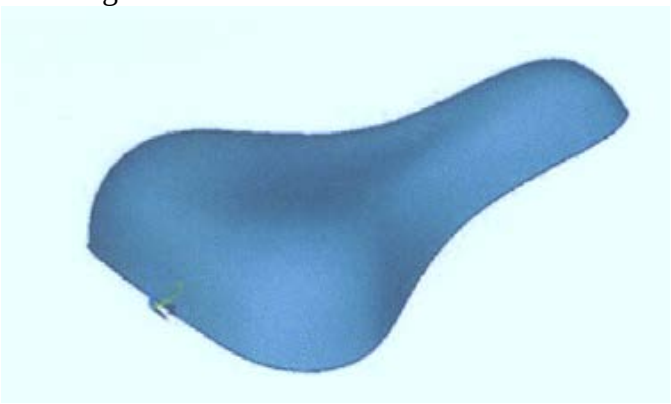


Figure 2 Saddle design result

5. Conclusion

The comfort of a bicycle saddle is crucial to the rider. Improvement of saddle comfort is a major

means by which many bicycle manufacturers improve the competitiveness of their products. Research shows that humans riding on saddles that are not comfortable can affect their blood circulation system, urogenital system, and endanger their health. Using finite element simulation technology to study the design of bicycle saddle was studied in the manuscript. The ergonomics system of the bicycle saddle was constructed, and the characteristics of the human body-the saddle's finite element model were analyzed. A personalized bicycle saddle was designed.

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