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Application of TRIZ and Human Factors Engineering Method to Bicycle Handle

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Abstract: *This study explores the application of TRIZ and human factors engineering methods to bicycle handlebars. The research methods used in this study include literature, TRIZ methods, human factors engineering methods and general design methods for analysis and design. Firstly, we will refer to the literature to understand the literature on handle and sports injuries, and then use the 39 contradictory matrices of the TRIZ method to find the corresponding 40 invention principles, and select the appropriate invention principles for analysis and design, and then use the human factors engineering method. The man-machine system analyzes the operation mode of the person and the bicycle handle as a reference. Finally, the universal design is used to improve the innovative design of the bicycle handle mechanism, so that the innovative design of the bicycle handle mechanism can make the interaction between the user and the product more harmonious. . The prototype structure of the design is drawn in drawing software, and the research results are as follows. 1. In the bicycle handlebar, the height adjustment of the chute design and the front and rear angle of the handle are added, so that the user can change the posture of the waist, the cervical vertebra and the arm by changing the height of the handle and the change of the front and rear angles, and improving the long-term fixed posture to the waist, The damage caused by the cervical spine and the arm. 2. For the bicycle handlebar, add 10,000 street mechanism and handlebar extension design in the handle part, so that the handlebar can be adjusted to various angles, suitable for a variety of wrist posture changes and changing postures, and to improve the damage caused by the long-term fixed posture of the wrist. 3. In the handle of the bicycle handle, the angle of the handle is changed, the height is adjusted up and down, the front and rear angles of the handle are designed to add a new sensor, and the angles and heights are respectively displayed on the screen, so that the user can clearly know the current posture data and adjust the most. Comfortable posture.*

Keywords: *Bicycle handles, sensors, human factors engineering, TRIZ, universal design.*

1. Introduction. In modern society, global warming has become a common issue for human beings. "Carbon reduction and energy conservation" has become an unavoidable issue. Green transportation policy has become the key. Bicycles are no longer just a common means of transportation, but also one of leisure and entertainment. In order to meet the needs of various parties, and to extend the different types of vehicles and corresponding handles, the commonly used handles can be roughly divided into three types:

ascending type, straight type, and drooping type (Wuzheng Wu, 2001).
Bicycles are long-term rides, repetitive movements and high postures. If there are wrong movements, postures or inappropriate bicycle accessories, it may cause discomfort in the relative parts of the body. In severe cases, it may even Causes damage and pathology on muscles or nerves (Yin Zhong, 2007).
There are many types of handles for bicycles in general, but most of them do not have the function of adjusting the posture and changing posture in accordance with the height and the arm of the user, and the function of knowing the height angle of the change. This study is directed to the handle of the bicycle. Designed to manipulate the handle to adjust the body posture and understand the parameters of the change, reduce the movement damage caused by fixing the same posture for too long.

2. **Discussion of the literature.** This study mainly discusses that when the user rides the bicycle handle for a long time, it may cause a fixed posture for too long and cause sports injuries. This study first collects the types of bicycle handles, sports injuries, sensors, and collects and analyzes relevant data to serve as the research basis for research and discussion. Finally, the innovative design of the smart bicycle handle mechanism is carried out by TRIZ innovation method, human factor engineering method and general design method, and it is used as the reference design of the third chapter. The details are as follows.
2.1 Discussion on the literature of bicycle type and handle type. Since the ancient times, bicycles have developed bicycles of various types according to different needs of users, including road racing vehicles, mountain biking vehicles, multi-purpose off-road vehicles, downhill off-road vehicles, off-road vehicles, technical bicycles, folding bicycles, children. Cars, daily cars, electric cars, co-operating vehicles, etc., provide a variety of, selective and various types of bicycles for people to use (Zhide Huang, 2011). The classification is made by the handles, which are ascending type, straight type, and drooping type (Wuzheng Wu, 2001).
(1)Ascending type: The two sides of the driver are raised, and the angle between the grip and the axle of the driver is about 45 degrees, and the height is different, which is suitable for use in recreational vehicles.
(2)Straight type: The rider and the grip cover are in the same axial direction. There are also a few concave or divided parts in the middle of the rider, and the grip sleeve part is still in the same axial phase, suitable for off-road vehicles and mountain bikes.
(3)Drooping type: The sides of the rider are bent downwards. When riding, the user's body bends forward to reduce the wind-receiving area of the human body. It is used in road racing vehicles (Binghong Guo, 2010).
2.2 Sports injury related literature. In recent years, the movement of bicycles has become very popular. It is not only a moderate aerobic exercise that enhances muscle strength, muscular endurance and cardio endurance. It is popular among the public because it tries to enjoy the hurricane and enjoy the scenery while pedaling on the pedals. However, it is not "if you have a foot, you will ride a bicycle." Whether it is a professional driver or a casual free rider, if the riding posture is not correct, it may easily cause soreness or sports injuries in different parts. The bicycle has a downwardly curved handle, and the body is bent downward to lower the handle than the upper body tube. The ascending handle extends upwardly to position the handle at a higher position, and the straight body is aligned with the handle and is held on different roads. Lead to different body dip, indirectly affect the activation of upper limb muscles, long-term riding may lead to injury (Chen et al., 2019).

The entrapment neuropathy of the upper extremity is also called the handlebar palsy. The most common nerves that are oppressed are the ulnar nerve and the median nerve. The sensory disorder is the main manifestation. Under severe compression, the hand will appear. Muscle weakness. Mainly because of the long-term grip of the bicycle handle, pressing the median nerve in the ulnar nerve or wrist tunnel of the Gai's tube(Lin, & Liang, 2009).

2.3 TRIZ method literature discussion. TRIZ can solve the least amount of design conflicts inherent in the research case. One of the main concerns of TRIZ is to recognize the difficulties that arise when dealing with complex problems with this theory. The evolution of the TRIZ knowledge system will be expected to increase its ability to support multiple contradictions (Borgianni et al., 2016; Zanni et al., 2011). TRIZ is the theory of "Theory of Inventive Problem Solving" for solving problems related to creativity. It is translated into "extraction" or "extraction" in China (Chen & Chen, 2011). TRIZ theory is to find the solution to the problem through the analysis of the interaction between components, using physical contradictions, technical contradictions, and combining the principles of invention (Zhang et al., 2018). TRIZ is one of the most powerful and popular ways to make system innovations. Although the official development of TRIZ ended in 1985, researchers continued their development by proposing new methods (such as OTSM, TRIZ +, SPARK) or extending existing methods. After all these efforts, the spread of TRIZ never reached the expected level of capillary action (Spreafico & Russo, 2016).

The product design and development stage simplifies the cumbersome production and assembly process, shortens the development time, reduces the cost and improves the production efficiency, and also reduces the customer's adaptability to the new product. The learning time makes the product clearer and easier to use, and the mass factor decomposition is applied. The method of combining the TRIZ method with the TRIZ method (39 engineering parameters and 40 innovation rules), proposes a process that can be referenced when designing a shared component of a product application, and introduces the TRIZ innovation principle when applying the shared component design, which can also be used for the creator. More limited associations and inspirations in the limited parts of the shared parts enable designers to develop design concepts more systematically when developing new products, and to apply functional design elements to create functional aesthetic values (Chen & Wang, 2018).

2.4 Human factors engineering literature. In the early days of the United States, the human factors project was Human Engineering. In Taiwan, some scholars originally translated it into ergonomics or ergonomics. Now it has gradually declined. The name Human Factors Engineering or Human Factors is replaced by Human Factors, so Chinese is also translated into human. Due to engineering or human factors(Xu et al., 2013). Human factors engineering is to improve the relationship between "people" and tools, machines, equipment and the environment through design to achieve the best cooperation(Hou & Zheng, 2010). The "human factors project" was enlightened in the Second World War, and the beginning of the project was initiated by the "People's Engineering Promotion Team" established by the National Science Council (now the Ministry of Science and Technology) in 1984 and was established in 1992. "Industrial Engineering"(Shi et al., 2018).

In the past 50 years, Taiwan has combined the industrial design and human factors engineering, from the human development process, the combination of human factors and design, case analysis to the establishment of cultural human factors analysis model, in addition to providing human factors engineering to apply to the current stage of cultural and creative industries. It also provides readers with a reference to cross-cultural design in the future(Yan et al., 2018). The formation of a human factor (HF) assessment is an important activity in the design of the control room. The purpose is to provide design feedback during the development process, preferably early, in order to reduce the risk of late and suboptimal design changes. Early assessments need to be evaluated at a higher level. Design decisions, as design decisions become more concrete as the development process progresses, further development of HF methods for practice is needed(Simonsen, 2019).

For example, the prevention of musculoskeletal injuries in labor is one of the most important topics in occupational safety and health in China. In order to cope with and improve the musculoskeletal injury of workers at the workplace, China has also passed legislation to make occupational musculoskeletal prevention one of the responsibilities of employers. Today, many institutions still lack the application of human factors to improve their operations. experience. Improve the musculoskeletal injury risk of the work by improving the work of the energy industry work site through the advanced improvement method of human factors engineering. The result can be provided to the work site of the public institution as a case of advanced improvement of human factors engineering. Laoan staff reference(Du & Tan, 2017).

In addition,long-term care organizations are facing increasingly serious residents with complex medical problems, residential equipment and major health care risks, all of which are considered risk factors for drug-resistant organisms, and for infection prevention programs in long-term care. The guidelines are still ambiguous and the implementation of these guidelines is challenging, mainly due to staff mobility, limited resources, knowledge gaps and lack of organizational support. The human factors engineering approach has become an important innovation in addressing patient safety issues and developing interventions that support human performance in healthcare systems (ie tools, technologies, tasks, organizations, physical environments), which in turn leads to improvements in the process. Medium (for example, adherence to infection prevention guidelines) and results (eg, reduced infection rates) (Katz, & Gurses, 2019).

2.5 Universal design literature discussion. The evolution of design began in the 1950s, when people began to notice the problems of people with disabilities in their lives. In Japan, Europe, and the United States, "barrier-free design" removes obstacles that exist in the environment for people with disabilities. In the 1970s, Europe and the United States adopted "accessible design" for the needs of people with reduced mobility in their living environment, not for products. The concepts of universal design, inclusive design and universal design are recognized, but none of them can meet the requirements of every possible user (Pennick et al., 2016).

One American architect Michael. Michael Bednar argues that after removing the barriers in the environment, everyone's faculty can be improved, and it is necessary to establish a new and broader concept that goes beyond a broad design, that is, the term extensive design. It is not possible to fully explain their philosophy. The purpose of universal design is to promote interaction between the product and the environment and allow the user to use the product effectively without having to adjust the product (Lin & Wu, 2015). Universal design is a worldwide movement that engages the widest range of users with the environment, products and communication (Ergenoglu, 2015). The trend of "normalization" and "returning to the mainstream" has made "accessibility" an important part of the issue of physical and mental obstacles, and "general design" has been further promoted (Su Yuwen et al., 2018). Universal design is a design philosophy that aims to create an inclusive and sustainable society where everyone can participate as much as possible (Preiser, 2001; Ostriff, 2001). In addition, the Universal Design Learning (UDL) framework increasingly attracts the attention of researchers and educators as an effective solution to bridge the gap between learner and individual differences (Al-Azawei et al., 2016).

3. **Research design.** Innovative design for smart bicycle handle mechanisms, in light of the foregoing objectives and related literature. In order to achieve the aforementioned objectives,Through the bicycle handle, sports injury sensor literature analysis, patent analysis, human factors engineering, TRIZ method, general design, innovative design research. In order to be able to clearly explain these research processes, explain the current situation of related products and related patent technology analysis through bicycle handles, use the human-machine system of human factors engineering method, analyze the operation mode, and then use the TRIZ method contradiction matrix and forty invention principles. Based on the design basis of the product, and finally using the universal design to make the innovative design of this research more perfect, the following details are explained in detail.

3.1 Explore the height of the handlebars and the design of the front and rear rotation. This section is designed for the artificial height and front and rear rotation of bicycle handles designed by human factors engineering and TRIZ method. The human hand engineering method, TRIZ method and universal design are used to design the upper and lower heights of the bicycle handle and the front and rear rotation.The content is explained below.

3.1.1 The TRIZ method introduces the height of the handle of the bicycle and the design of the front and rear rotation. Generally, bicycle handles are mostly fixed and cannot be changed in accordance with the posture of the operator. Long-time riding and fixing postures for too long may cause sports injuries of the cervical vertebra, the waist, and the arms. In order to improve this problem, this study is aimed at the innovative design of bicycle height and front-to-back change. With the thirty-nine engineering parameters of the TRIZ technical contradiction matrix, find out that the parameters to be improved are No.03 (moving object length), No.09 (speed).), No. 27 (reliability), No. 35 (adaptive), avoiding deterioration parameters are No. 33 (easy operation), No. 36 (device complexity), No. 37 (detection and measurement difficulty) Degree) Use the above engineering parameters to produce a contradiction matrix, as shown in Table 3-1.

Table 3-1 Technical contradiction matrix of the height and the rotation of the bicycle handle

Avoid deterioration Parameters / Want to improve the parameters	33. Easy to operate	36. Device complexity	37. Detection and Measuring difficulty
03. Moving object length	15, 29, 35, 4	1, 19, 26, 24	35, 1, 26, 24
09. speed	32, 28, 13, 12	10, 28, 4, 34	3, 34, 27, 16
27. Reliability	27, 17, 40	13, 35, 1	27, 40, 28
35. Adaptability	15, 34, 1, 16	15, 29, 37, 28	1

In the invention principle corresponding to the summary technical contradiction matrix, the number of occurrences is as follows: No. 1 (segmentation) appears 5 times, No. 28 (displacement mechanical system) appears 4 times, No. 15 (dynamic), No. 27 (discarded), No. 34 (removed and produced parts) appeared 3 times, No. 16 (partial or excessive operation), No. 24 (medium), No. 26 (reproduction), No. 29 (air pressure or Hydraulic construction), No. 35 (changing material properties) appeared twice, the other time. In order to solve the problem of innovative design of bicycle height and front-to-back change, after discussion and analysis, several invention principles were adopted, and No.1 (segmentation) was found: divided into two parts, rotating shaft, slide mechanism and rotating shaft to control angle change. The distance between the front and the back is raised and lowered with the slide rail mechanism. No. 28 (replacement mechanical system): Use the lifting structure instead of the expansion and contraction method. No.35 (Change material properties): Change the material of the parts to reduce the weight, so that the overall weight of the bicycle handle is not too heavy.

3.1.2 The ergonomic design introduces the height of the handle of the bicycle and the design of the front and rear rotation. At present, most bicycle handles are fixed and cannot be operated according to the operator's use. The fixed posture during riding is too long, which may cause sports injuries such as neck, hand and back muscle bond inflammation. In order to improve this problem, this study is aimed at the innovative design of the height and front and rear changes of the bicycle handle, using the human-machine system analysis of human factors engineering, analyzing the user's operation for the height and front and back problems of the fixed handle, and finding the height and front and rear of the bicycle handle. The innovative design of the change requires two modes of operation.

1. Handle height adjustment: The handle can be up and down to change the height, so that the user can adjust the height of the handle according to the height and body shape.
2. Adjust the front and back of the handle: Make the handle change the front and rear distance, so that the user can adjust the distance during long-term riding and change the posture to avoid sports injury.

3.1.3 Universal design introduces the height of the handle of the bicycle and the design of the front and rear rotation. In the innovative design of the height and front and rear of the bicycle, the connecting rod is designed under the handle so that it can be moved up and down, and then the position of the handle is used as the center of rotation, and the angle is controlled. The front and back distance of the handle, using the 39 engineering parameters of the TRIZ method and forty principles of invention as the reference basis for the foundation, and finally the fair use, simple and intuitive use of the universal design method, is used when the size and space are used. The improvement of the innovative design of the cyclist's angle change.

1. Fair use: The bicycle handle can adjust the height up and down and control the distance. It can adjust multiple postures of the body to reduce the long-term sports injury. This design is suitable for various operators and conforms to the fair use principle of universal design.
2. Simple and intuitive use: Quickly loosen the handle rails and the mounting shaft to adjust the height and angle with the quick-release screws, and then quickly press the fixed angle and height to make the operator easy and intuitive. This design is universal. Simple and intuitive use of the design.
3. When the size and space are used: the height and angle of the handle adjustment are designed to suit the general public size. The height and angle functions can be adjusted to allow the user to adjust the size and posture according to his or her preference. When used in size and space.

3.2 Explore the design of the rotation and extension of the bicycle handle. This section is designed to rotate and extend the bicycle handle with the innovative design of the bicycle handle in combination with the human factors engineering and the TRIZ method. The TRIZ method, the human factor engineering method, and the universal design are used to design and rotate the bicycle handle. The contents are as follows.

3.2.1 The TRIZ method introduces the design of the rotation and extension of the bicycle handle. In general, bicycle handlebars are mostly fixed and cannot be operated according to the operator's use. Long-term riding and fixed postures for too long may cause sports injuries of the wrist. In order to improve this problem, this study aims at the innovative design of the bicycle driver's angle change, and finds the parameters to be improved as No. 09 (speed), No. 12 (shape), and thirty-nine engineering parameters of the TRIZ technical contradiction matrix. No. 33 (easy to operate), No. 35 (adaptive), to avoid deterioration parameters are No. 27 (reliability), No. 36 (device complexity), No. 37 (detection and measurement difficulty) Use the above engineering parameters to produce a contradiction matrix, as shown in Table 3-2.

Table 3-2 Technical contradiction between the rotation and extension of the bicycle handle

Avoid deterioration Parameters / Want to improve the parameters	27 Reliability	36. Device complexity	37. Detection and measurement difficulty
09. speed	11, 35 27, 28	10, 28 4 ,34	3, 34 27, 16
12. shape	10, 40 16	16, 29 1, 28	15, 13 6
33. Easy to operate	17, 27 8, 40	32, 26 12, 17	
35. Adaptability	35, 13 8, 24	15, 29 37, 28	1

In the invention principle corresponding to the summary technical contradiction matrix, the number of occurrences is mostly No.10 (pre-action principle), No.28 (generation mechanical system), No.35 (physical and chemical state transformation). 5 times, No. 15 (dynamic principle) is 4 times, No. 8 (balance principle), No. 19 (periodic principle) are 3 times, No. 13 (reverse operation principle) are 2 times The rest.

In order to solve the problem of the innovative design of the folding chair, after exploring the TRIZ method, several invention principles were selected and found No.8 (balance principle): designed to fold the chair and increase the support feet, so that when folding When it is closed, there is enough balance to prevent the folding chair from collapsing. No.10 (pre-action principle): The cushioning sponge is arranged at the rear of the chair and the seat cushion, so that the folding chair can reduce the reaction force and the sound to achieve the pre-action principle. No.13 (reverse operation principle): The operation mode of the pedaling lever is used by the person behind the folding chair, and the folding posture of the general folding chair is different to achieve the reverse operation principle. No.15 (Dynamic principle): Design the spring fasteners so that when the folding chair is folded, the spring rises quickly and fastens to achieve the dynamism principle. No.35 (physical and chemical state change): Change the weight of the chair legs to make the collection more labor-saving.

3.2.2 The design of the rotation and extension of the bicycle handle is introduced by the human engineering method. At present, most bicycle handles are fixed and cannot be operated according to the operator's use. When riding, the posture is fixed for too long, which may cause sports injuries of the wrist. In order to improve this problem, this study is aimed at the design of the rotation and extension of the bicycle handle. The human-machine system analysis based on human factors engineering is used. In order to fix the angle of the handle, the user can change the posture to reduce the sports injury, analyze the user's operation, and find the bicycle. The handlebar must have two modes of operation.

1. Hand 360 degree rotation: The handle can change the 360 degree rotation angle, allowing the user to adjust the wrist position during long-term riding to avoid sports injuries.
2. The handle can be extended left and right: the handle can be changed to the left and right lengths, so that the user can adjust the wrist posture during long-term riding to avoid sports injuries.

3.2.3 Universal design introduces the design of the rotation and extension of the bicycle handle. In the design of the bicycle handle rotation and extension, the universal joint is installed at the handle position, the handle can be rotated 360 degrees, and the left and right lengths of the handle are adjusted by using the telescopic rod connected with the handle and the handle, and 39 engineering parameters of the TRIZ method are used. Forty principles of invention are used as the basis for the reference. Finally, the fair use, simple and intuitive use of the universal design method is an improvement of the innovative design of the cyclist's angle when the size and space are used.

1. Fair use: The 360 degree rotation of the hand and the extension arm can adjust the posture of the wrist to reduce the long-term sports injury. This design is suitable for operators of various wrist sizes and conforms to the fair use principle of universal design. .
2. Simple and intuitive use: Quick-release screws can quickly relax the handle to adjust the angle, and then quickly press the fixed angle, which allows the operator to use it easily and intuitively. This design conforms to the simple and intuitive use of the universal design.
3. When the size and space are used: The handle size is designed to fit the general public size, and the handle adjustment function is used to adjust the size. This design conforms to the general design and is used in size and space.

3.3 Explore the design of angle and distance sensors. For the innovative design of angle and distance sensors, the TRIZ method, human factors engineering method, and universal design are used to design the angle and distance sensors. The contents are as follows.

3.3.1 The TRIZ method is introduced to explore the design of angle and height sensors. Most bicycle handles, most of them can not know the operator's posture data, long time riding, fixed posture for too long, may cause the user's body sports injuries. In order to improve this problem, this study aimed at the innovative design of the angle and height sensor, and identified the parameters to be improved as No. 24 (information loss), No. 27 (reliable) based on the thirty-nine engineering parameters of the TRIZ technical contradiction matrix. Degree), No. 25 (time loss), No. 35 (adaptation), and the above-mentioned deterioration prevention parameters are No. 33 (easy operation), No. 36 (device complexity), and No. 38 (automation degree) are utilized. The contradiction matrix is produced outside the engineering parameters, as shown in Table 3-3.

Table 3-3 Technical contradiction matrix of angle and height sensor

Avoid deterioration parameters / Want to improve the parameters	33. Easy to operate	36. Device complexity	38. degree of automation
24. Information loss	27, 22		35
27. Reliability	27, 17 40	13, 35 1	11,13 27
25. Time loss	1, 13 17, 34	27, 35 1	27, 2 10, 34
35. Adaptability	15, 34 1, 16	15, 29 37, 28	27, 34 35

In the invention principle corresponding to the summary technical contradiction matrix, the number of occurrences is as follows: No. 34 (removed and produced parts) appears 5 times, No. 27 (discarded) appears 4 times, No. 01 (split), No. 13 (reverse) and No. 35 (change of substance characteristics) appear three times, No. 10 (pre-action), No. 15 (dynamic), No. 17 (moved to new space), No. 28 (Replacement mechanical system) appears 2 times, the other time.

In order to solve the problem of angle and height sensor design, after discussion and analysis, several invention principles were adopted, and No.1 (segmentation) was found: it was divided into two parts, angle sensor and distance sensor, which were used to measure The angle moves away from the handle. No. 13 (reverse): Use the display panel to display sensor data through reverse thinking to understand the user's body posture. No. 34 (Remove and produce parts): Remove the traditional angle and distance scale and display the panel display instead.

3.3.2 The introduction of human factors engineering methods to explore the design of angle and distance sensors. At present, most bicycle cyclists are unable to know the operating posture according to the data in time. The fixed posture during riding is too long, which may cause sports injuries of the wrist, and adjust several comfortable postures through data to facilitate switching and adjustment. In order to improve this problem, this study is aimed at the innovative design of angle and distance sensors, using man-machine system analysis of human factors engineering. In order to let users know the data quickly, it is found that the bicycle handlebars must have two sensing functions:

1. Angle sensor: According to the distance sensor, the angle of the handle and the handle is obtained to be displayed on the liquid crystal panel as reference data.
2. Distance sensor: According to the distance sensor, the left and right lengths of the handle and the height of the handle are obtained to be displayed on the liquid crystal panel as reference data.

3.3.3 Universal design introduction to explore the design of angle and height sensors. In the innovative design of the angle and height sensor, the angle sensor and distance sensor function have been added, and the LCD panel is used to display the size information, so that the user can quickly understand the posture size and make adjustment adjustments, and then use TRIZ. The 39 engineering parameters and forty principles of the method are used as the reference basis for the design. Finally, the fair use, simple and intuitive use of the universal design method, labor saving, and the use of size and space for rapid handling and deployment functions. Improvement of innovative design.

1. Fair use: The sensor data is suitable for various users to adjust the posture, this design is in line with the fair use of the universal design.
2. Simple and intuitive use: The display can be connected in series as long as one case can be displayed without any individual switch. This design conforms to the simple and intuitive use of the universal design.
3. Obvious information: The parameters of the display can be easily seen by the user, and the posture is adjusted to make changes. This design conforms to the obvious information of the universal design.
4.When the size and space are used: the joints and joint heads extending on both sides of the back of the chair are sized to match the distance between the chair and the chair, so that the innovative design using the quick handling and setting function is at the distance of the chair. Size and space use.

4. Product design. In order to improve the lack of general bicycle handles and to meet the individual differences between different people, this study designed to avoid riding time.Long, resulting in a long-term fixed posture, and the combination of human factors engineering and TRIZ method for bicycle handles. According to the aforementioned research purposes, patent analysis, TRIZ method, human factors engineering, and using general design to analyze how to make the function more in line with the principle of universal design, the improved design combines human factors engineering and TRIZ method in the innovative design of bicycle handle. The product design results are based on (1) the overall structure of the bicycle handle product with human engineering function, and then (2) the design of the upper and lower heights of the bicycle handle and the position of the front and rear rotation, (3) the design of the rotation and extension of the bicycle handle and (4) The design content of the angle and distance sensor is described in detail. After the structural content of the product prototype is determined, the Inventor drawing software is used to design and draw the product parts and structures. To clearly describe the details of the product, the product complete structure diagram, part drawing and operation diagram are respectively described. The details are explained below.

4.1 The overall structure of the bicycle handle product with human engineering function. This section will further explain and discuss the combination of human factors engineering and TRIZ method in bicycle handle and operation mode, through the second chapter related literature discussion and the third chapter research design, TRIZ technical contradiction matrix corresponding to the application of the principle of invention and people Due to engineering, there are two problems with general bicycle handles. One of them is a bicycle fixed to the handle. Generally, the handles mounted on the bicycle are fixed. It is necessary to use tools to adjust up and down, and the body will have a fixed posture when riding for a long time. Causes easy to cause sports injuries. The other is that it can't be adjusted according to people's differences. Generally, the size and distance of the handles installed on the bicycle are fixed. It can't be adjusted according to the rider's body. Even if some don't match themselves, they still don't ride. Mistakes, resulting in incorrect posture and injury, so the combination of human research and TRIZ method in the design of the bicycle handle can be adjusted according to the person to avoid injury caused by fixed posture, as shown in Figure 4-1.

Figure 4-1 Overall appearance of the bicycle handle

4.2 The height of the bicycle handle and the design of the front and rear rotation position. At present, most bicycle handles are fixed and cannot be operated according to the operator's use. When riding, the posture is fixed for too long, which may cause sports injuries of the cervical vertebrae, the waist and the arms. In order to improve this problem, the design of the bicycle handle up and down height and the front and rear rotation position, using the TRIZ method and human factors engineering design and universal design, allows users to change posture to reduce sports injuries.

According to the second chapter, the related literature and the third chapter of the human factor engineering method design and the TRIZ technical contradiction matrix corresponding to the application of the principle of invention and the improvement of the general design method, using the TRIZ hairline principle No.1 (segmentation): divided into two parts, The rotating shaft, the sliding rail mechanism, and the rotating shaft are used to control the distance before and after the angle change, and the dividing principle is achieved by the lifting height of the sliding rail mechanism, as shown in Fig. 4-2. No.28 (replacement mechanical system): Use the lifting structure instead of the expansion and contraction method to achieve the replacement mechanical system, as shown in Figure 4-3. No.35 (Change material properties): Change the material of the parts to reduce the weight, so that the overall weight of the bicycle handle is not too heavy.

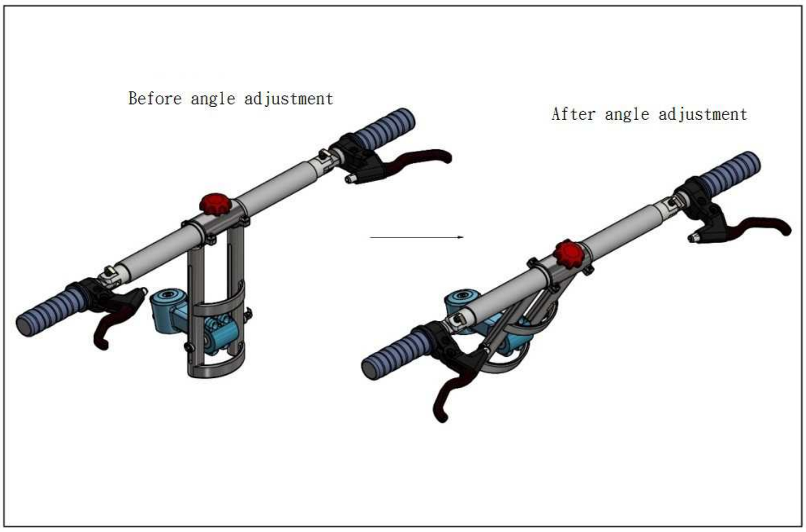

Figure 4-2 Front and rear rotation of the bicycle handle

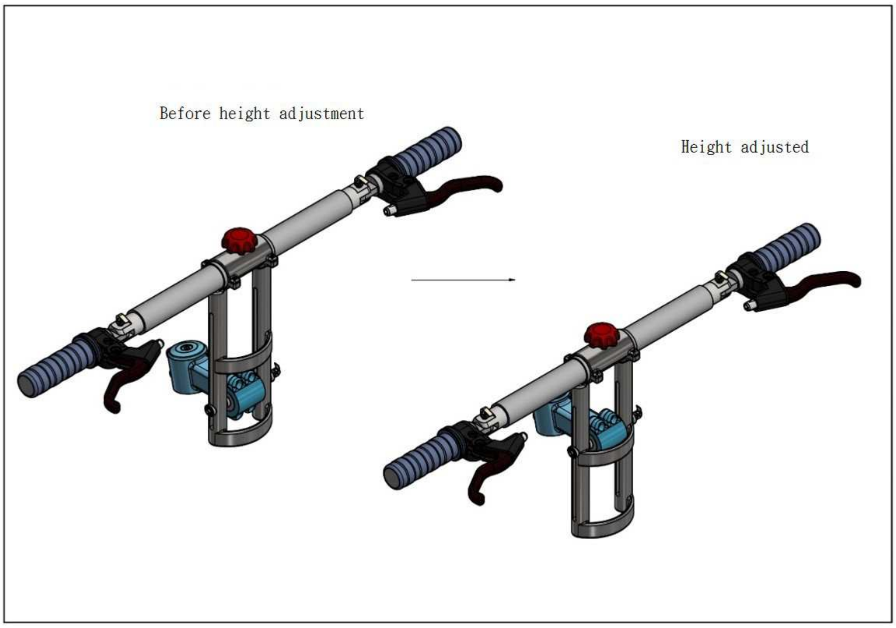

Figure 4-3 Schematic diagram of the height adjustment of the bicycle handle

4.3 Bicycle handle rotation and extension design. At present, most bicycle handles are fixed and cannot be operated according to the operator's use. When riding, the posture is fixed for too long, which may cause sports injuries of the wrist. In order to improve this problem, this study is designed for the rotation and extension of the bicycle handle. Using the TRIZ method and human factors engineering design and universal design, the user can change the posture to reduce sports injuries.

Through the discussion of the related literature in the second chapter and the application of the invention principle of the third chapter TRIZ technical contradiction matrix and the improvement of the human factor engineering method design and the general design method, the No.1 (segmentation) of the TRIZ invention principle is adopted: the income is divided into The left hand handle, the left universal joint extension rod, the handle rotation rod, the right universal joint extension rod, and the right hand handle are used to make the handle change angle and extend left and right by the universal joint to achieve the division principle. No.13 (reverse): With the adjustable angle handle, the original fixed handle has different adjustments to achieve reverse thinking. No.35 (Change material properties): Change the material of the parts, reduce the weight, make the bicycle handle not overweight, and achieve the change of material characteristics, as shown in Figure 4-4.

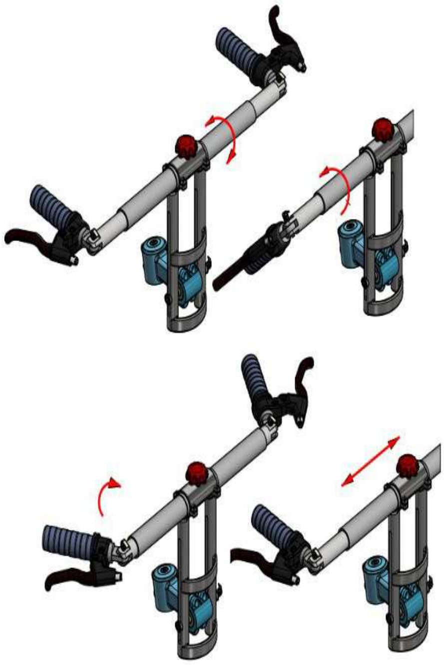

Figure 4-4 Schematic diagram of bicycle handle rotation and left and right extension

5. Conclusions. Bicycles are mainly long-time rides, repetitive movements are extremely high and postures are fixed, which may cause neck, shoulders, upper back, elbows, and hands.Myofascial pain in a stable muscle group at various parts such as the wrist. Excessive force can cause muscle injuries such as strains and tears. This study introduces human factors engineering technology and TRIZ method design, which not only avoids maintaining the same posture for a long time, but also reduces the risk of sports injuries.

1. The innovative design of the bicycle handle angle change

When riding a bicycle, most of the traditional bicycle handlebars use fixed handles. It is not possible to use the handle angle suitable for the rider according to the length and height of the rider, resulting in improper posture, causing sore muscles or other injuries. . Maintaining a fixed posture for too long while riding, may also cause sports damage to the wrist. If the same posture is maintained for too long or the rider's posture is not correct, the user can relax the muscles at the wrist and arm by adjusting the angle of the bicycle handle, so that the user can change the posture to reduce the sports injury.

2. The innovative design of the height and front and rear of the bicycle handle

In the current bicycle handles, most of them are fixed and cannot be operated according to the shape of the rider. When riding, the posture is fixed for too long, which may cause sports injuries of the cervical vertebrae, the waist and the arms. If the fixed posture is too long, the height of the bicycle handle and the distance between the front and the back can be adjusted, so that the user does not need the arm and the waist to cause muscle strain, and the user can change the posture to reduce the sports injury.

3. Innovative design of angle and distance sensors

Most of the traditional bicycle handles are fixed and cannot be used to understand whether the riding posture is correct. In long-term riding, the wrong posture may cause sports injuries of the cervical vertebrae, the waist and the arms. In the riding, the integration of the distance sensor and the angle sensor can be used to inform the user whether the posture angle is correct by using the display data of the liquid crystal display, so that the user can avoid the sports injury caused by the posture error.

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