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Abstract. This research is about the analysis and design of the user in a wheelchair use posture can be changed. So user can through different sitting posture changes to provide different needs, so the folding design patents for the existing data collection and classification, through the analysis of advantages and disadvantages, further to find the innovative design approach. Finally through the multi linkage mechanism system, change the seat, handlebars and rear position, provide different posture context. In order to reduce the cost, this study is designed to integrate the innovation input mechanism, multi linkage system, through the construction of 10 joints and degrees of freedom of the bicycle frame. Then use 3D software to design of bicycle the size of the frame of innovation, through the three-dimensional CAD model to simulate the mechanism between movement and interference, and to evaluate the 3D The virtual prototype can meet the requirement. It will also enable CAE to analyze and determine the strength and the safety of the bicycle frame structure of ANSYS11.0 stress. Finally, we have integrated design through CAID to make a product appearance, the focus of research is mainly a study of CAD, CAE, CAID integration the production and the completion of a prototype.

1. Introduction
Generally the wheelchair user in force are used in the upper part of the body, with the strength of the hand wheel to drive. But it is easy to cause people in the long-term use of shoulder joint and waist joint damage, because the force in a wheelchair on the handle only accounted for 25% of the body weight to 40%. This is why in recent years to a lot of Lun to changed structure similar to a bicycle, but the use of electric motor, at the same time to different wheelchair user needs, for example in the design of the bicycle, designed to provide different positions [1] horizontal bicycle system. It can reduce the burden of the body, can also provide a more comfortable environment this can be in the future. In order to study the design, the more rapid goods, and provide maintenance services in the future better, the research content will be with the bicycle frame as Design basis, change with multi link mechanism to guide the frame position. Provides two different postures, users can use a higher position in crowded urban areas to improve visibility, lift and can easily enter an indoor heat, and does not need to be outdoors after the move, need to replace vehicles to then enter the room, provide a more secure and comfortable environment. For a long distance ride, users can be replaced in the lower position, allowing the body to maintain a recline posture to reduce drag and improve the ride comfort. Of course, in the end, we try to use a simplified multi link mechanism to achieve the design goals, such as figure 1, as shown in figure 2.
2. Literature review
This study will use for different situations were investigated, including research and design organizations fold related innovation patent, also can according to international regulations to do a complete discussion and integration can be a creative design content, then according to the different demand to the wheelbase design and development, innovation after the design is completed, the hope can provide the disabled with different needs, on the other hand can reduce the vehicle parking area, save space and increase road can be used. The most important thing is to provide users with comfortable environment and products that can be used in different locations, indoor and outdoor.

2.1 The variable-wheelbase bike that can narrow the parking space
This kind of type use P-Pair as the construction of folding bike chassis. The only machinery that qualifies this function is from Toyota Company’s “i-unit future concept bike” which shown in 2004[2]. As shown in figure 3, it turns the machinery into skeleton picture. In figure 4[3], the design concept is to view the bike frame as the combination of rigid body and linkage machinery for 10 bars, 13 joint and one freedom folding bike. Use P-Pair as the main connection is the bar 10 in figure 6. The design can drive a 4 bars linkages mechanism (bar 4, 8, 5, and 2) by the control of bar 10, and by this move can make the bike machinery to engage in the motion of folding or can get the same purpose by pushing the rear wheel slide part 9 to move to the front wheel. The other feature of this bike is there are 2 sets of R-Pair on the rear wheel slide part 9. It would do the rear wheel axle with a Row-way fixed function, so the rear wheel axle would become one freedom on the ground. The axle is basically qualified with great sustainability which is easy to install motor or battery component here.

![Figure 1.](image1)

![Figure 2.](image2)

![Figure 3.](image3)

![Figure 4.](image4)
2.2 The variable-wheelbase bike that can adjust riding position

In order to make it possible to commercialize the results of this study sooner, we will introduce the currently products available in the market when we embark on the establishment of actual restrictions and specifications for design, to make product viability fast. To enable adjustment of riding postures, our design allows adjustment of the distance between the shafts. As such, this study will set restrictions to product design with references made to the common bikes and recumbent bikes among the existing bicycle products.

Variable-wheel bike combines the merit of high efficiency from traditional bike, and the comfortable advantage of recumbent bicycle. However, in those two kinds of bicycle there consist of a big different in riding position, plus the harsh human size specifications in bicycle design and the rare document left in this field. In figure 5, it shows the bicycle frame construction of adjustable riding position. The patent use linkages set to lead saddle and frame construction moving, which can proceed the manual adjustment to the angle of saddle and the axle distance of wheels.

![Figure 5. Patent exploded view.](image)

3. Innovative design

This research take the bicycle frame as the design base and leading by multiple-linkages to alter the position of frame construction. User can adopt higher position when riding in the crowded urban area, which can raise the visibility and gives the user a safe ride. For long-distance riding, user can change for lower position in order to level down the wind resistance and step up for a more comfortable riding. We try to use simplified linkages to achieve the design goal. This study will also be through a variety of patents and research results, to do a concept and simulation analysis, and through the computer structure and strength of the analysis, and finally through the industrial design and sample production as a study of verification.

4. Conclusion

This study will be discussed and summarized through the relevant literature, and the relevant design and analysis, through the analysis of CAD and CAE, and then through the sample production to view the design differences and future changes in the direction, the contents of the design are as follows.

4.1 The specifications condition of variable-wheelbase bicycle

According to the user's findings and the collection of relevant laws and regulations, the following important design reference can be obtained:

(a) The design for front wheel steering more convenient, the innovation in the design of the front of the car with a wheel, and a motor, is behind the two wheels, a brake device, and in order to existing collocation commercially available products and convenient maintenance, so the tire diameter is 20 inches.

(b) This design allows the vehicle to maintain a complete comfort and stability during driving. The front wheel control angles must be the same at high or low riding positions, and maintain control capability.

(c) This design is in a high riding position; the rider's size must conform to the general frame geometry of the bike; at lower position it is necessary to apply the frame geometry to the reclining bike.
(d) This design is the use of a free linkage mechanism, using an electric actuator to drive the bicycle body structure into a higher or lower position when the handle seat height adjustment, the agency will also move, and seat
(E) This design on the change of riding position, the linkage system will automatically adjust the distance between the handlebar and the saddle, and the conversion process can be locked and fixed, and can move in the conversion process to provide fixed function [4, 5]
(f) This design has the same pedal position at high and low position, only the torso and thigh as thousands of angle change simplifies the design of repentance, body structure, and provide more secure to use.
(g) This design must be less than 400 millimeters across height and can touch the ground in any environment, which makes it easier for users to use, [6-8]
(H) This design changes the distance about 200 millimeters, under the long axis condition, the bicycle body lower part slope is biggest, is 25 degrees. (1) using electronic control design, including the design of lithium batteries, wheel motor drive. The electronic driving system controls the change of different sitting posture and adopts the general chain belt drive. (J) in order to qualify for the Taiwan electric bicycle standard, a bicycle without batteries should be light 40 kg, and the maximum speed should not exceed 25 km / h. [9-14].

4.2 Type synthetizing of variable-wheelbase bike
The linkage systems in this research must consider the higher and lower riding position before synthetizing. In order to maintain the same control ability before and after bike body transform, its angle between tube and ground need to sustain in steady value. So, the bike body and front wheel can be viewed as the fixed bar construction. The simplified design condition is more convenient in proceeding type synthetizing. We use 2 sets of 4 bars linkages to guide saddle and back wheel separately, and settle these two elements on the even number shaft of shaft group. Input and output shaft is connected with bike frame (fixed bar) and use the construction position synthetizing formula to calculate the length of 2 sets of linkages. With the same input angle variation, we can combine 2 input shaft with one rigid body, shown as figure 6 and figure 7, Watt-II one freedom.

Figure 6.

Figure 7. Adjust the connecting rod.

4.3 Size synthesizing of variable-wheelbase bike
After the research and analysis of patent information for the first step, we discover that the technology now can only reach to the part of partial adjustment of seat. We aim to improve the skill and design a newly light bike which is able to transforming completely into an innovative bike with the combination of “Backrest Type Bike” and “Lying Bike”, shown as figure 8 and figure 9 and figure 10. To get the right human size to qualify the comfortable appeal, we choose Giant Revive [15] as the higher position bike, whereas Bacchetta/standardare_med is reference in design, shown as figure 11 and figure 12[16]. First, measure and draw the size picture of bike frame, and then overlap two pictures based on the design condition. Shown as figure 13 the reference bike frame, and the position shift and angle variation of saddle, pedal and handle bar. Then leading the reasonable human size design to make sure the research result is qualified to ergonomics. After conforming the angle variation, we can use the sport generator to calculate every shaft length which can achieve the goal of 3 4-bar Group using one input shaft collectively. Figure 14 is the completed picture of frame shaft length design. Figure 15 show diagrams for different riding positions.
Figure 8. Normal high sitting analysis.

Figure 9. Normal low sitting image.

Figure 10. Different high and low sitting analysis. Figure 11. Different high and low sitting limit map.

Figure 12. High sitting bar limit map.

Figure 13. Low sitting angle limit chart.

Figure 14. Linkage mechanism diagram.

Figure 15. Different sitting simulations.
4.4 3D model construction and application analysis of variable wheelbase bike

we use computer assisted design software SolidWorks to draw the 3D model, and design the detailed component size with the reasonable consideration of processing and cost. After completed element has already synthesized on computer, stimulating construction performance to make sure whether the component need interference or in the condition of couldn’t fabricate. When the above condition has been fixed and affirmed, use value analysis software to proceed application analysis. Any defect in construction design which shown in figure 16 and figure 17 needs to change component material or alter the geometry construction in order to obtain completed security condition, and also we can make sure all the detail construction can perfume correctly. Lastly, we go into the product of rendering and animation shooting to 3D model, shown as Figure 18, so we can confirm the outer design before making into a prototype. Stimulating the control status of user and evaluate the future performance of the prototype. After a series of completed design and analysis, we go into processing production of all component output engineering picture, set circuit drive system, improve partial defect, complete the prototype machine, performance test, and confirm the original design idea of designers. Figure 19 shows the final product, including its exterior coating.

![Figure 16](image16.png) 5 points force analysis.

![Figure 17](image17.png) Seat force analysis.

![Figure 18](image18.png) Different sitting simulation.
5. Conclusion
The research of the technology is the use of multi link to achieve a simplified shaft mechanism, further provide different design position, and provide a better control ability, including traveling in the outdoor and indoor, through the sitting posture change to meet the needs of the disabled. Through the relevant literature and other patent to make a comparison and analysis, through the analysis of the data for the design and development, can not only provide a method of sitting the requirement and design more and more can provide design and lower production cost. To provide a method of product design of the innovative design of the study, and the integration of different technologies to provide more innovative design and design method, the disabled can provide a better use of the environment, can also provide young designers a method of innovation integration design. This is mainly through the design and research of the common bicycle parts to make a reference for the design, can provide faster and more convenient use, but also can reduce the weight of the product, through the multi link mechanism design, connection can help the different postures of institutions, a substantial increase in the variety, the design will be again through more intelligent, help the user's physiological response, further to provide better design, of course, these are must from the cognitive behaviors of users to study and observation, the future will continue to research and explore related.

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