

# UG-Based Rehabilitation of Wheelchair Design and Simulation Analysis

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**Abstract.** As a result of disease or sports injuries in patients with a lot of limb movement disorder, the patient's healing process to go through the majority of sports training from passive to active exercise training. According to agency theory, the kinematics of the human body through the analysis of crank connecting rod mechanism is proposed based on a new rehabilitation wheel chairs, and its main function is to assist patients with movement disorders to complete recovery of motor function training. The rehabilitation wheelchair can not only achieve the common means of transport functions, and can control the left and right limb movement separately, reached by wheelchair users when the body can be an effective exercise and training purposes in order to meet the needs of patients with hemiplegia. Has carried on the three dimensional modelling and the movement, mechanics simulation analysis using the UG three dimensional design software to it. Through simulation analysis further rehabilitation wheelchair design parameters be modified to meet the vehicle's movement, functional and mechanical requirements. This rehabilitation wheelchair as a means of transport, while the recovery of the body to play the role of adjuvant therapy.

**Key words:** rehabilitation wheelchair; optimal design; simulation analysis; crank and connecting rod

## 1. Introduction

Wheelchair as a means of transport for persons with disabilities, with a different structure and working principle, because of their disabilities in different parts and bodily functions, we need to design different types of wheelchairs, in order to meet the demand for more disabilities, to a certain extent, for them to alleviate the inconvenience caused by physical suffering.

At present, fewer types of rehabilitation wheelchairs, in particular the rehabilitation of dual-use wheelchair types of travel less. General wheelchair only has travel features, users take when the limb is not an effective movement and exercise, which is very unfavorable for the rehabilitation of the patient. In order to solve the user when engaging in outdoor activities in wheelchairs, physical exercise, lack of effective campaigns and issues, based on this design and development of rehabilitation wheelchair. The rehabilitation wheelchair can not only achieve the common means of transport functions, and can control the left and right limb movement separately, reached by wheelchair users when the body can be an effective exercise and training purposes in order to meet the needs of patients with hemiplegia to make up for now wheelchair deficiencies.

## 2. Kinematic Analysis of The Human Body

Rehabilitation wheelchair features must conform to the basic law of human body kinematics in order to provide the human body the correct trace. Skeletal structure of the human upper limb, lower limb skeletal structure, as shown in Figure 1.

Elbow joint: By the humerus, radius and ulna and so on are composed. Humerus and the radius and ulna at the formation of a spin joints with a degree of freedom, achieved a forearm flexion and extension movement.

Knee joint: By the thighbone, the whirbone and the shinbone and so on are composed. Femur and tibia at the formation of a spin joints with a degree of freedom, achieved a calf flexion and extension movement<sup>[1]</sup>.

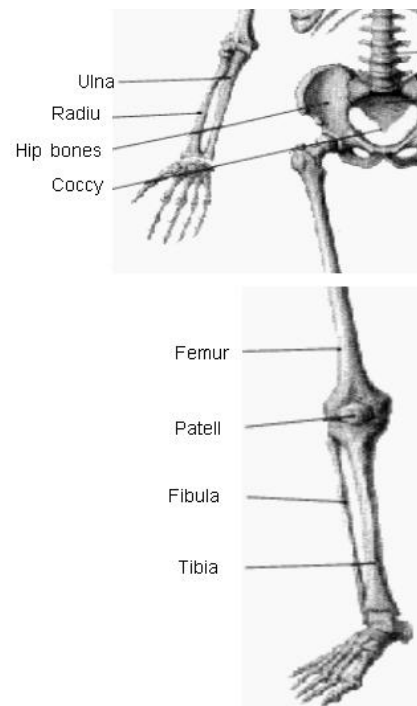


Fig.1: Human body upper limb skeleton lower limb skeleton structure drawing

The rehabilitation wheelchairs through the wheel to provide power to achieve the flexion and extension of the forearm and leg movement, driven upper limb, lower limb bones and muscles of the rehabilitation training.

### 3. Leg Training Requirements

People sitting in rehabilitation wheelchair leg movements are mainly alternating kick the leg and receives the leg. Causes the knee joint and the both sides muscle frequent activity and the extension, restores to the leg function has the very big help. From the proximal tibia, distal femur and patella of the knee joint composed of roughly divided into: tibial - femoral joint and patella - femoral joint (patella joint). Patella is located in front of the femur, knee joint can only be completed in the sagittal plane flexion and extension movements, known as the bend leg and legs straight action. A major reason for people with mobility difficulty is the iliotibial tract of outer thigh is too tight and the medial part of the weak quadriceps. Iliotibial tract is not a muscle, but a thick, tough fascia, located in the lateral thigh, the top link buttocks big muscle, fascia lata tensor and so on, downward to the lateral condyle of tibia and fibula head. In addition to limited lateral condyle of tibia and fibula head part of things, it includes a section surrounding the femoral quadriceps limited. There is also a small part of the lateral patellar connected, you can pull the patella out. Iliotibial tract primary function is to help the buttocks big muscle and fascia lata tensor to complete the role. Iliotibial tract, though not muscle, but because it is connected to the top of the muscles, so it involved in hip flexion and hip internal rotation movements of people do not always stretch more easily strained iliotibial tract.

## 4. The Institutional Design of The Rehabilitation Wheelchair

### 4.1. Department of Limb Movement

Rehabilitation wheelchair with two sets of transmission, respectively, controls left and right side of the human body movement, as shown in Figure 2.

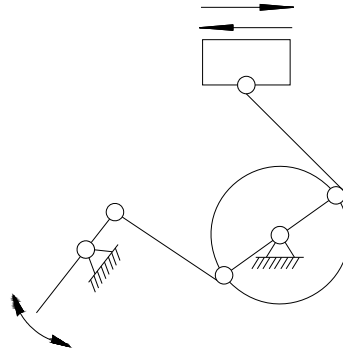


Fig.2: Body movement department schematic drawing

The trailing wheel fixes on the frame, as the driving wheel. Pin wheel with the key and the driving shaft connected, the first chain wheel and the driving shaft empty sets, pin wheel can slide along the axis to achieve with the first chain wheel off, combination, to control the movement the chain wheel. The lower limb movement uses the link motion gear impetus, the link motion gear is composed by the lower limb connecting rod and the outrigger. Articulated connecting rod end of the lower extremities in the post-sprocket on the other end through the rod and pedal hinged together. A lower limb connecting rod end hinge on after chain wheel, another end passes the outrigger and the footboard hinge in the same place. Use hands to promote wheelchair, the rear wheels turn to drive pin wheel, chain wheel, lower limb connecting rod, and promote the pedal swing. The upper limb movement uses the link block organization impetus, the link block organization is composed by the upper limb connecting rod and the slide. An upper limb connecting rod end hinge on after chain wheel, another end hinge on slide. Use hands to impels wheelchair, the trailing wheel rotation, drives the pin wheel, the chain wheel, the upper limb connecting rod, and leads around the slide the movement.

#### 4.2. Drive Clutch Division

The rehabilitation wheelchair another personal design is the ability to make vehicle drivers and the limb movements by users based on the needs clutch, its structure shown in Figure 3, the simulation shown in Figure 4. Therefore, the driveshaft in the rehabilitation wheelchair adds a clutch disc and the rear chain wheel coaxial installation. Through the clutch disc and move around, may cause the driveshaft to lead the flywheel rotation in the rotation process, through chain drive impetus limb movement department work. In this way, people can adjust the clutch disc according to their individual needs, controls the handrails and pedals movement or not.

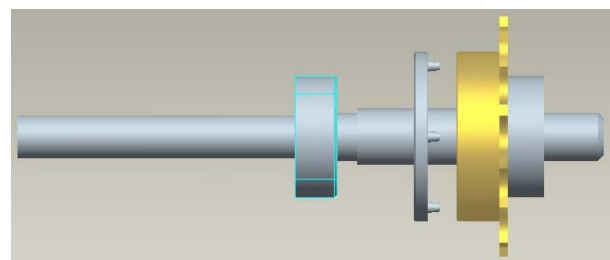
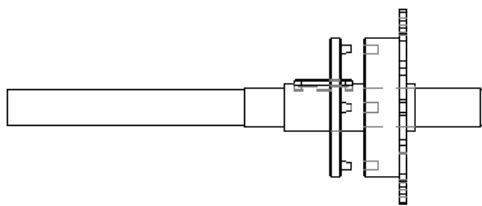


Fig.3: Actuation meeting and parting structure drawing Fig.4: Actuation meeting and parting structure simulation chart

#### 4.3. Transmissions Department

Rehabilitation wheelchair transmission system use chain drive as shown in Figure 5. Learn the most common bicycle chain drive principle, will be rehabilitation wheelchair drive and the body movement organic synthesis. By improving the big chain wheel the structural style, will assemble the link rod of the control arm and pedal with the big chain wheel, when the combination of clutch and flywheel, the flywheel along with the driveshaft rotation, through the chain drive driven big chain wheel rotation, the two link rod due to was  $180^\circ$  on the big chain wheel installed, the big chain wheel rotation will cause the link rod alternating motion, thus achieve the rehabilitation wheelchair arm and pedal motor function.

### 5. Rehabilitation Wheelchair Sports Simulation Analysis

The round of rehabilitation wheelchair three-dimensional model was joined to the movement simulation

to carry on a full range of motion, mechanics simulation analysis. Further carries on the revision through the simulation analysis to the rehabilitation wheelchair design variable to meet the vehicle's movement, functional and mechanical requirements. The round of vehicle simulation shown in Figure 6.

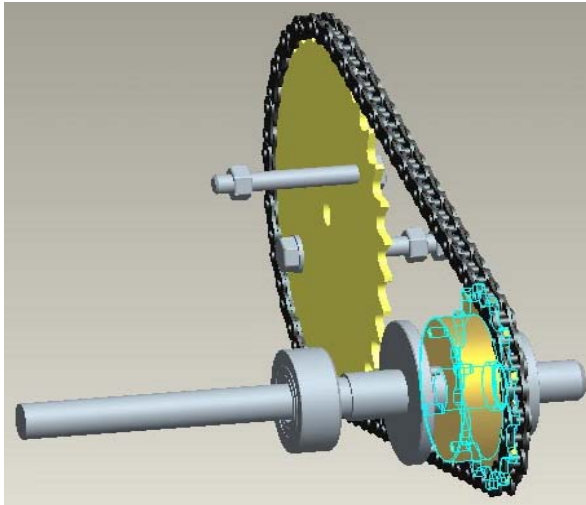


Fig.5: Chain drive structure simulation chart

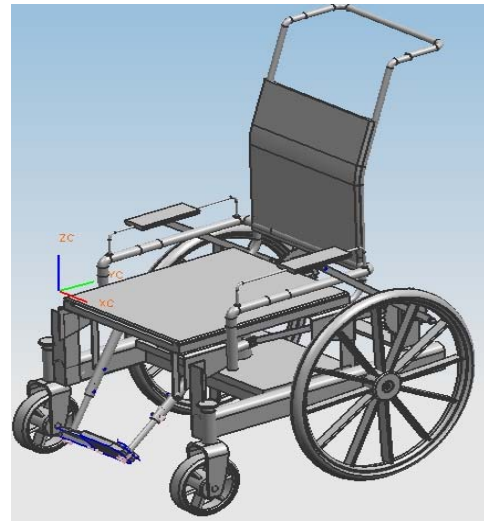


Fig.6: Recovery wheelchair simulation chart

## 6. Conclusions

The design of the rehabilitation wheelchair based on the crank and connecting rod conforms to the human body kinematics basic rule. Through the mechanical system motion simulation analysis, mechanical motion meet the design requirements, there is no interference between the various parts of, force, velocity and acceleration in line with the actual situation, reaching the dual role of travel and exercise.

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