Design of sitting lower limb rehabilitation training robot

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Abstract: Based on the theory of sports rehabilitation medicine, aiming at the needs of early, middle and late rehabilitation training of patients with lower limb paralysis, a sitting lower limb rehabilitation robot is designed to train muscles with impaired motor function of the limbs. The innovative design of the sitting lower limb rehabilitation training robot consists of two parts. They are the lower limb rehabilitation mechanism and the seat auxiliary mechanism, which can restore and reconstruct the impaired motor function of patients as much as possible.

1. Introduction

With the deepening and aggravation of the aging population in our country, the number of stroke patients is increasing. Some of the wounded can recover and walk independently after timely surgery and drug treatment, but most people will have some sequelae, such as joint stiffness, gait distortion, decreased motor coordination ability, which seriously affect the normal walking ability of patients. Medical research shows that the recovery of physical activity ability is closely related to scientific and correct rehabilitation training [1-2]. Based on this, this paper designs a sitting lower limb rehabilitation machine to train the muscles with impaired limb motor function, so as to maximize the recovery or reconstruction of the impaired motor function [3-5]. In order to observe the rationality of the design of the sitting lower limb rehabilitation robot intuitively, the three-dimensional model of the sitting lower limb rehabilitation robot is established by using solid works software.

2. Overall structure design of sitting rehabilitation robot

The overall structure of the designed sitting rehabilitation robot is shown in Figure 1. The main parts include: seat angle adjustment device 1, seat front and rear adjustment device 2, foot drive device 3, seat as the foundation, as a connecting part of the lower limbs and waist and back parts, so that the parallel legs and waist and back move together. By using foot drive, the foot can simulate the gait, and the hip, knee and ankle can get accurate and continuous circular motion, so as to achieve the purpose of simulating human gait for muscle training. At the same time, the sitting rehabilitation can meet the needs of patients with different heights to achieve the function of sitting and lying angle adjustment. (what is the confusion between legs and back)
3. Working principle

3.1. Foot drive mechanism
The working principle of the sitting rehabilitation training robot is to use two crank linkage mechanisms to simulate the human foot, use the rotating pair to replace the knee joint, and form a space four-bar mechanism with the seat and human lower limbs. Using the human foot to drive the crank to drive the two legs to achieve lower limb rehabilitation training. Its main motion is driven by motor 1, which drives a four-bar linkage composed of crank 2 and pedal 3 to realize foot movement, as shown in Figure 2.

3.2. Seat assist mechanism

3.2.1. Front and rear adjusting mechanism of seat
Because the adjustment speed is very slow and the position is not fixed, the driving part is locked for manual shaking. Because the installation space of the designed sit type rehabilitation training machine is small, and the requirements of transmission accuracy and efficiency are not high, the ordinary trapezoidal lead screw and nut mechanism is selected. The nut 1 is connected with the seat, the screw 2 is connected with the base through the support of the bearing 3, and there is a guide rail between the seat and the base. The handle is used to drive the screw 2 to rotate, and the nut 1 drives the seat to move in a straight line, so that the seat can move on the guide rail, as shown in Figure 3.
3.2.2. Angle adjusting mechanism
The seat angle adjusting device drives the back of the seat to rotate by controlling the stepper motor to achieve a certain angle change, and uses the pawl 5 and ratchet wheel 6 to complete the positioning, as shown in Figure 4. The ratchet wheel 6 is fixedly connected with the seat back shaft 2 at one end, and the seat back shaft 2 is connected with the seat back hole through the key 1 to transfer motion and torque. In order to realize the rotation of the seat back, the cam 5 on the camshaft 3 controls the ratchet wheel 6 through the pawl 4 to realize the transmission movement. When the seat back rotates upward and clockwise, there is an overrunning clutch between the cam 5 and the shaft. When the chair back rotates downward, the chair back cannot rotate counterclockwise due to the action of ratchet and pawl. At this time, it is designed to press the down button and make the chair back rotate clockwise for a certain angle and then counterclockwise through programmable control. When the back of the chair rotates upward, the cam still doesn’t work; but the pawl can get rid of the ratchet. When the back of the chair rotates downward, the teeth of the chair rotate in the opposite direction, which drives the cam to rotate in the opposite direction. At this time, the camshaft can rotate, and the cam presses the pressure bar so that the pawl can & apos; t work. When the back of the chair reaches the position parallel to the ground, the pawl can just work.

4. Innovation of sitting lower limb rehabilitation training robot
(1) A crank rocker lower limb rehabilitation robot based on foot driving is designed, so that patients can imitate gait to exercise hip, knee and ankle joints in sitting posture.
(2) Through the comprehensive design of overrunning clutch, cam, ratchet and pawl, the angle adjusting device of the back chair can complete the function of turning the back chair upward at a fixed angle and reaching the next position.
(3) through the design of the screw nut to achieve the purpose of adjusting the seat back and forth.

5. Conclusion
According to the needs of early and middle and late rehabilitation training for patients with lower limb paralysis, the designed sitting lower limb rehabilitation robot has reasonable structure and can effectively make the foot simulate the gait, and make the hip, knee, ankle three links get accurate and continuous circular motion, so as to achieve the purpose of simulating human gait for muscle training. The sitting lower limb rehabilitation robot can meet the design requirements and has practical significance. It has good promotion value.
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