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SHOULDER EXOSKELETON WITH NOVEL SLIDER MECHANISMS

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People with disabled or weaken shoulder have to perform forced shoulder motions. Some of those disabilities are due to various diseases such as muscle atrophy, peripheral vascular disease, meningococcal septicemia or accidents. These people face greater difficulty when they carry out tasks in their day-to-day life. Even though many studies have been carried out to develop exoskeletons for the human upper limb, exoskeleton devices for shoulder motion are limited in literature. Exoskeleton robot is a device, which contains joints and links, which are aligned with joints and links in the human skeleton. Such devices are used currently as motion assist devices, human power amplifiers, haptic devices, *etc*. Exoskeleton robot can be used to assist motions of disabled people who have less capability of moving their limbs. In this research, a 3DOF shoulder exoskeleton robot is proposed to be used for rehabilitation of the shoulder joint of disabled people. It can generate shoulder flexion/extension, shoulder abduction/adduction and shoulder internal rotation/external rotation. Since an upper-limb disabled person has limited strength, the exoskeleton robot is attached to the wheel chair of the disabled person. The novelty of the shoulder exoskeleton design is having two slider mechanisms with linear motion bearings and linear guide rail. Base of the shoulder joint of the exoskeleton robot is attached to the wheel chair and an attachment is available to fix it to the wearer's hand. The exoskeleton robot consists of two main links. First link is attached to the wheel chair through a linear rail guide whereas the second link connects to the end of the first link and wearer attachment connects to the second link through linear motion bearings. The length between the attaching point of the wheel chair and the wearer attachment is changing with the wearer shoulder motion due to the muscle contraction while moving the shoulder. Therefore, fixed length links cannot be used in the shoulder exoskeleton. Two slider mechanisms have been designed in the proposed shoulder exoskeleton robot to facilitate the link length change. The first slider mechanism facilitates to change the length of the second link which consists of wearer attachment. In addition, the second slider mechanism facilitates to slide the whole exoskeleton robot through the wheel chair. The first link of the robot is attached to a linear guide rail and the rail can slide through a shaft fixed to the chair. In order to reduce the weight of the exoskeleton robot main links of the robot are manufactured by aluminum and the gear wheels are fabricated from a lightweight material. The ranges of motions at joints were simulated in CAD environment and experiments were carried out using a human subject with the developed prototype in order to verify the workspace of the exoskeleton robot. The results of motion ranges of the robot were analyzed. They showed that the robot can generate required ranges of motions to perform daily activities and two sliders facilitate every motion to achieve full motion range without disturbing the motions of exoskeleton wearer. Mechanical stoppers have been used in the exoskeleton in order to avoid the excess motion range compared to natural human range of motion.

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