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DESIGNING KANGAROO-INSPIRED SOFT EXOSKELETON TO ASSIST HUMAN MOVEMENT ON THE LUNAR SURFACE

Abstract

In the future, whether for lunar exploration, lunar base construction or lunar tourism, all these activities require the participation of human. However, from images and videos of NASA's Apollo missions, we can see that it is very difficult for astronauts to move on the lunar surface, and they easily lose their balance and trip up. This is caused by the special environmental factors of the moon, such as the hypogravity, soft lunar soil and complex terrain. Therefore, it is necessary to design wearable exoskeleton for human on the moon to assist their movement, and to help them adapt to the particularity of the moon environment. Through analysis, it is known that jumping, compared with walking and running, can make better use of the moon's hypogravity and adapt to the complex terrain environment. Kangaroo, as a jumping animal, has fast movement speed, strong balance ability and low energy consumption. The kangaroo's skeletal and musculotendinous structures have a great reference value for the exoskeleton designing.

Accordingly, in this paper, we propose a soft lower limb exoskeleton design to assist human on the moon with the inspiration of the kangaroo's physiological structures. In this design, each leg of the lower limb exoskeleton consists of three parts: the thigh, the calf, and the soft long foot part which is composed of arched sole and chained toe. This kind of structure can not only improve the stability of human movement through shock absorption, but also reduce the human energy consumption through the storage and redistribution of its elastic potential energy. Like the musculotendinous structures of kangaroo's legs, the exoskeleton proposed is driven by the active linear actuators and the passive elastic actuators. This driving mode of active-passive combination can reduce the mass of the exoskeleton and improve its energy efficiency. In addition, the novel exoskeleton design proposed in this paper can not only enhance the movement ability of human body on the moon, but also be popularized as entertainment equipment on the earth.