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Human - exoskeleton interaction via tactile sensors for the motion assistance

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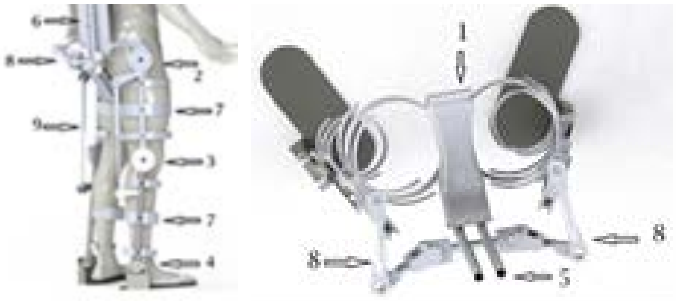
The paper describes conceptual design and control of a new fully autonomous lower limb exoskeleton system via a number of tactile sensors. The aim of the exoskeleton is to support the subject weight and provide an additional strength and endurance for the subject. The designed exoskeleton can decouple the weight/mass carrying function of the subject/human from its forward motion function. This newly proposed approach effectively reduces the power and size of propulsion motors and thus the overall weight, cost of the system. The interaction between the system and subject takes place by means of two types of sensors. The system measures the pressure applied by the subject's feet on the ground. If the pressure exceeds the set value the system blocks the motion at the knee joint by means of a passive air cylinder across the knee joint. This data is used by the PID controller to force the exoskeleton to follow precisely the motion of the subject legs in swinging motion by means of hip and knee motors. The mechanical structure of each leg has six degrees of freedom: four at the hip, one at the knee and one at the ankle. Only one degree at the hip and one at the knee are motor driven. In Fig. 1: 1 is a seat; 2 and 3 are hip and knee motors; 4 is an ankle join; 5 and 6 are bars to support the electronics and power supply; 7 are leg belts; 8 is a hip lateral motion mechanism; 9 is an air cylinder. This exoskeleton is power efficient because the system motors are not used to support the subject weight like in most of the existing exoskeleton designs.



Exoskeleton mechanical structure

Recent Publications

1. Chen B, Ma H, Qin LY, Gao F, Chan KM, Law SW (2016) Recent developments and challenges of lower extremity exoskeletons. Journal of Orthopaedic Translation 5:26:37.
2. Leslie M (2012) The next generation of exoskeletons, A Magazine of the IEEE Engineering in Medicine and Biology Society, 3(4)56-61.

Biography

Nazim Mir-Nasiri has obtained his PhD in Technical Sciences from Azerbaijan Technical University in 1989. Later he has built up his career in Malaysia as Head of Mechatronics Department at IIU Malaysia. From 2005 to 2013 he was holding a position of Professor and Head of Robotics and Mechatronics Program at the Swinburne University of Technology (branch of Australian University in Malaysia). Currently he holds a position of Professor and Head of Electrical and Electronic Engineering program at Nazarbayev University in Kazakhstan. He has published about 80 scientific papers in robotic design and control, machine vision, intelligent systems, design of mechanisms. He has received several awards at the International Competitions. In 2016 he has received NU Research Grant (USD 300,000). He is the member of IEEE for ten years and member of IMechE and UK Charted Engineer, Editorial Board Member of the "International Journal of Mechatronics and Automation" and "International Journal of Automation and Computing".

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