Powered 2-DOF Ankle-Foot Prosthesis for Agile Gait

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Abstract

In the past decade, several powered ankle-foot prostheses were developed by various research groups. They were designed to improve sagittal plane mobility by focusing on control of the ankle in one degree of freedom (DOF); that is, each seeks to regulate plantarflexion and dorsiflexion of the robotic ankle. Activities of daily living however, include gait scenarios that require agility and maneuverability, such as turning, traversing slopes, and adapting to uneven terrain profiles. These activities require ankle action in both the frontal and sagittal planes [1]. The authors developed a 2-DOF cable-driven powered prosthesis with controllable Dorsiflexion-Plantarflexion (DP) and Inversion-Eversion (IE) (Figure 1) [2]. This prototype uses Bowden cables allowing the placement of the motors and gearboxes away from the distal parts of the limb and near the center of gravity of the user, reducing the metabolic cost. In addition, they allow for flexibility on the customization of the prosthesis, especially when long residual limb would limit the amount of space available for the active components. The proposed design offers versatility to the users by allowing them to switch between powered and non-powered states by physically disconnecting the actuation (DC motors, Bowden cables, and battery) from the prosthesis. Therefore, the device can be used as a passive or active device based on their daily activity. The results of the preliminary evaluations show that the prosthesis can closely follow the recorded human ankle trajectories, as shown in Figure 2 [2].

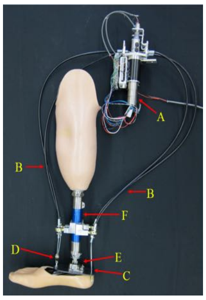

Fig. 1: 2-DOF ankle-foot

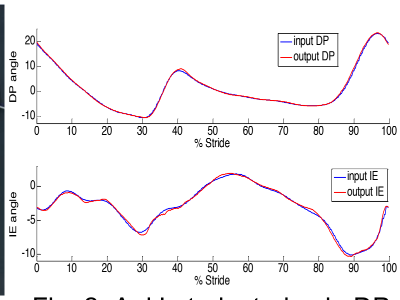

Fig. 2: Ankle trajectories in DP and IE directions closely follow the human ankle rotations

References

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Short Biography

Mohammad Rastgaar received his Ph.D. degree in mechanical engineering from Virginia Tech, Blacksburg, VA, USA (2008). He was a postdoctoral associate at the Newman Laboratory for Biomechanics and Human Rehabilitation at the Massachusetts Institute of Technology, Cambridge, MA, USA (2008–2010), before joining Michigan Tech, where he is an associate professor of mechanical engineering and the director of the Human-Interactive Robotics Lab (HIRoLab). His present research focuses on advancing the maneuverability in ankle–foot robotic prostheses and lower extremity assistive robots by characterizing the agility in the human gait. Dr. Rastgaar is a recipient of 2014 NSF CAREER Award.