ACHIEVING POWERED ASSISTED MOTION OF THE TRUNK WITHOUT AN ARTICULATED EXOSKELETON

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Background

Currently, wearable exoskeletons, based on rigid link systems, are widely used in medical rehabilitation, rescue operations, military, etc. focussed mainly on providing support to the lower body [1]. A major shortcoming in current exoskeleton systems is that none of them are capable of achieving correct whole body motion support because the torso is locked in position and cannot perform the normal movements required for correct postural motion and gait. Furthermore, the bulkiness and weight of such articulated systems make them unsuitable and unattractive for patient use, particularly in older, frailer individuals, and/or in a home setting. In such cases, the patients own skeleton and joints are usually relatively healthy, while it is muscle strength and control that is the problem (e.g. following a stroke). What is needed is a soft exoskeleton based support structure capable of providing motion assistance to the torso and upper back.

Methods and Results

This project aims to develop a soft exo-suit (Figure 1) that is flexible, lightweight, and able to provide safe motions for the human trunk. The ability of the actuator system was evaluated using a full musculoskeletal model of the human lumbar spine (Figure 2) in OpenSim software [2]. The soft actuator system was found to reduce muscle forces required for motion from standing posture to full flexion by up to 90% (Figure 3). Additionally, as the soft actuators act on a larger lever arm than the corresponding muscles, they were found to reduce the compressive forces acting on the lumbosacral disc by 15% (Figure 4). Maximum compression force on the lumbosacral joint with the exoskeleton engaged was determined to be 1.35 KN, less than half of the maximum allowable compression force of 3.4 KN [3].

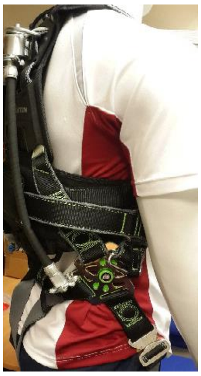

Fig 1: The suit prototype.

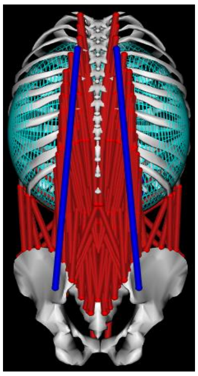

Fig 2: The soft model.

Mohammed is studying for his PhD in Biomechanics at the University of Nottingham on the development of soft exoskeletons. He has previously achieved his BSc and MSc in Mechanical Engineering in 2007 and 2009 respectively from the University of Basrah, Iraq.

Future Work

A prototype of the powered soft exo-suit has been constructed and full laboratory tests of the suit on healthy volunteers are planned. This work will look at muscle activation reduction, wearer comfort and ability to achieve motion. It will also consider the use of muscle activation and force sensors, in the development of a feedback control system. In future the soft torso suit will be expanded to a soft full body suit to provide actuation support.

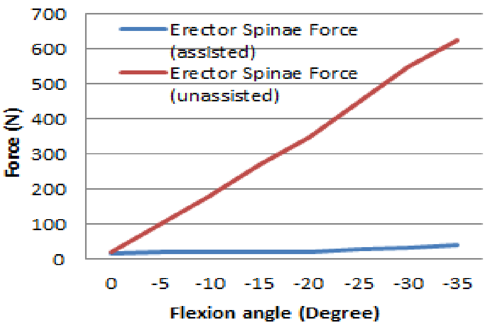

Fig 3: Assisted & unassisted Erector Spinae force

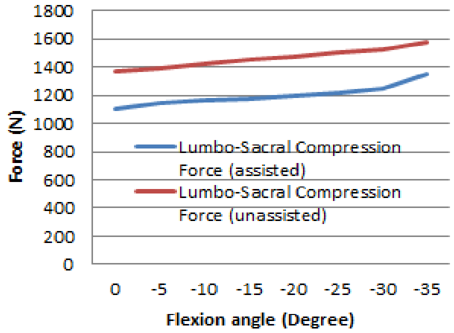

Fig 4: Assisted & unassisted Lumbo-Sacral Compression Force.

References

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