**SLAK Completely Supports Sit to Stand***

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**Abstract**—Current soft actuators are favorable for wearable applications because of their intrinsic safety [1] and ergonomic comfort [2]. However, they cannot provide the torque to completely support everyday movements such as sit to stand [3]. High torques, sometimes sufficient for complete support, are important for people with complete spinal cord injuries, rehabilitation of stiff joints, and protecting workers in dangerous environments from injury.

This talk reports the design and preliminary results on a simple high torque actuator, the pleated pneumatic interference actuator (PPIA), that is used in a sit to stand (STS) orthosis (Fig. 1), the soft lifting assistor for the knee (SLAK). PPIAs are based on Nesler et al.’s [4] PIA and made from fabric reinforced rubber bladders. In our previous work [5], the constraints required to laterally stabilize the single PPIA behind the leg limited its range of motion (ROM) well below that required for STS. The 1.35 kg SLAK eliminates the lateral constraints. Instead, it has three parallel PPIAs made of sealed firehose lengths inserted into a 1000D Cordura fabric sleeve.

At 320 kPa the SLAK was shown to completely support standing over 94% of the STS motion (Fig. 2), a very significant improvement over the 67% of the STS motion of our previous design [5]. The SLAK does so with a torque of 3.8 Nm at 7.9° increasing parabolically to 320 Nm at 82° knee flexion.

When worn, the SLAK generates a torque over the knee’s complete ROM, even providing a torque to support the knee in full extension. However, this is not reflected in the data due to the shifting of the SLAK on the smooth test leg, particularly at low flexion angles. At these angles the significant shear component generated by the PPIA’s torque caused the two ends of the PPIA to move away from each other, misaligning it completely away from the knee joint and preventing it from applying measurable torque. Future work will resolve this problem, and characterize the power and speed performance of the SLAK.

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**REFERENCES**


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