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TOWARDS A SOFT EXOSUIT FOR HYPOGRAVITY ADAPTATION: DESIGN AND CONTROL OF LIGHTWEIGHT BUBBLE ARTIFICIAL MUSCLES

Abstract

Lower body soft exosuits have been shown to improve the capabilities of humans in a wide range of applications, from rehabilitation to worker enhancement. Their light weight and easy integration in fabrics make them attractive for both terrestrial and space exploration uses. One unaddressed challenge in space exploration is the prevalence of low (hypo) gravity conditions, which can have a serious deleterious effect on the human body. To address this challenge we propose the hypogravity exosuit (or HEXsuit), which can help maintain the physical fitness and health of inter-planetary travellers. A core component of the HEXsuit is compliant, comfortable and efficient soft robotic artificial muscles. A recently proposed pneumatic actuator, the Bubble Artificial Muscle (BAM), is particularly suited for integration into hyogravity exosuits. In this work we explore the design and control of lightweight BAM actuators, which has previously been unaddressed. Characterisation results show that a thin actuator is capable of high contraction, while a thicker actuator can be used for high load applications. Two control modes were implemented: displacement control and force control. Both controllers achieve low steady state error and show high accuracy. The displacement controller is also shown to be capable of maintaining the required displacement while actively changing external loads, a typical use case within the proposed hypogravity HEXsuit.