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AN INFLATABLE ROBOTIC ASSISTANT FOR ONBOARD APPLICATIONS

Abstract

Over the years, robots are evolving to collaborate with humans sharing the same workspace. In space missions, human and robotic partnership is essential especially in onboard activities. Collaborative robots have the possibility to work in strict contact with the humans, thanks to their lightweight structure, their gentle design and the limitations on the speed. They can be the optimal solution to be implemented in limited working areas. In this context, soft robots are considered an interesting option because the intrinsic feature of softness of their structure allows to work with operators. Inflatable robots fit with these requirements: they are light and can be stored when deflated in a compact configuration; when inflated they are ready to execute tasks. Moreover, their compactness when deflated and weight are great advantages in space missions. In this paper, the concept of an inflatable and deployable onboard robotic assistant is proposed. The robot consists of inflatable links and actuated joints. It can be stored in a relatively small package if compared to its extended configuration, in order to be deployed on demand for working activities. The deployment and withdrawing stages can be controlled by using strategies that take advantage of the specific joint design. The material flexibility of the links allows them to be wound around the shaft of the joint, so that the resulting volume is essentially the one of the joints. The links are supposed to be connected to a pressurized tank during the inflation until they are completely deployed. Then, the air supply is disconnected, and the robot is ready to work. The inflatable links behavior is described through a pseudo-rigid body model, considering non-linearities introduced by the presence of possible wrinkles. Evaluations about achievable payloads, weights and volumes are carried out. A prototype of the link is realized and experimentally characterized, underlining the influence of the provided air pressure level on the overall performance. In addition, simplified control algorithms are presented using a quasi-static approach. Results suggest the feasibility of the project, putting the basis for the development of the system. Further works imply the development of the robot prototype, a topological optimization of the joint structure, the enhancement of the existing control algorithms, the implementation of collision avoidance and hand following algorithms.