

Workshop on Actuation & Sensing in Robotics

Session A - Actuation

A2

Enhanced Flexible Fluidic Actuators for biologically inspired lightweight robots with inherent compliance

Immanuel Gaiser, A. Kargov, S. Schulz, and G. Bretthauer

Karlsruhe Institut of Technology (KIT), Eggenstein-Leopoldshafen, Germany

Compliance, small impact, a wide range of possible pay loads, and a good power-to-weight ratio are eligible characteristics for manipulators, service robots, prosthetics, orthotics and a lot of automation applications. The newest developments in the field of Flexible Fluidic Actuators (FFA) push these characteristics. A new two-step fabrication process results in FFAs with outstanding dynamic and static properties: 1. vulcanization of the inner rubber boot; 2. internal pressure vulcanization of the rubber boot to the metal connectors and the fiber reinforcement. A cross-section of the actuator including the retraction spring is shown in Figure 1a.

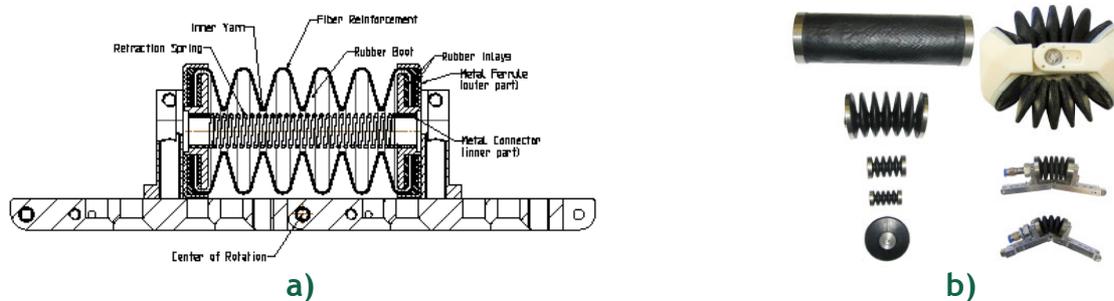


Figure 1 - Flexible fluidic actuators: a) mounted in joint, b) series of FFA and joints.

Operating pressures up to 20 bars and over 1,200,000 load cycles are possible. The new process also allows shape variation and optimization as shown in Figure 2. Current versions include FFAs with effective diameters between 12 mm and 40 mm and also inflatable structural elements with variable stiffness. The torque characteristics for each size actuator were determined. Current applications are in the fields of prosthetics, orthotics, and humanoid robotics (Figure 2a and 2b).

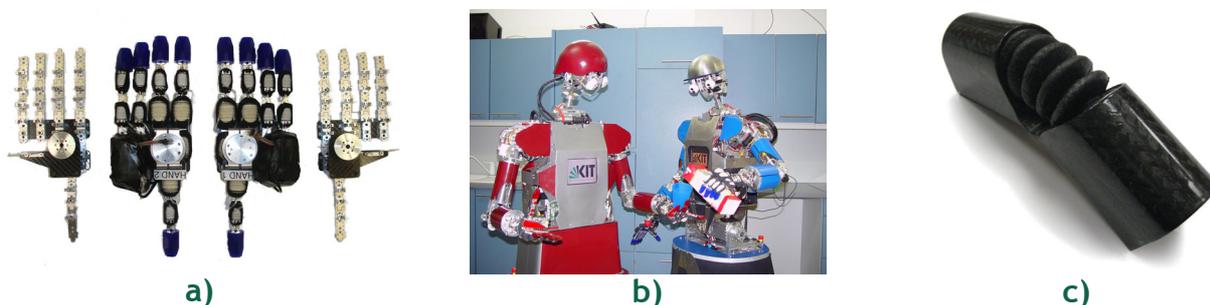


Figure 2 - a) the latest artificial hand FRH 5, b) application on humanoid robot ARMAR III, c) composite finger joint for FFA

In order to complete the lightweight approach for robotic hands a finger joint as shown in Figure 2c was developed. The joint consists of a carbon composite structure in combination with a fiber reinforced flexure with an integrated position sensor. It can carry transverse loads up to 100 Newton and is suitable for actuators with an effective diameter of 18 mm.