A tactile sensor device.

KEYWORDS

- ARTIFICIAL SKIN
- FIBER BRAGG GRATINGS
- FBG SENSORS
- COLLABORATIVE ROBOTICS
- HUMAN-LIKE ROBOTS

AREA

- BIOMEDICAL

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Patent Type
Patent for invention.

Co-Ownership
Scuola Superiore Sant'Anna 55%, Sapienza 15%, Fondazione Istituto Italiano di Tecnologia 10%, Università Campus Biomedico 5%, Università Ca' Foscari 15%.

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Industrial & Commercial Reference
The present invention refers to the fields of Robotics, specifically to Collaborative Robotics.

Time to Market
TRL 4. TTM 1 year for DEMO in Museum and Augmented Reality Context; 3 years for Co-robotics context for Industry 4.0; 5 years for healthcare/surgery.

Availability
Licensing, Research, Develop-ment, Experimentation, Collaboration and Spin-Off.

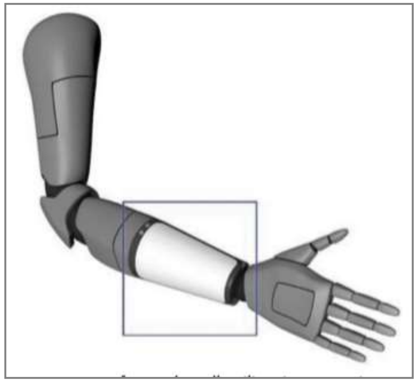

Fig. 1 Human-like robotic forearm with the silicon skin based on FBG technology applied on it.

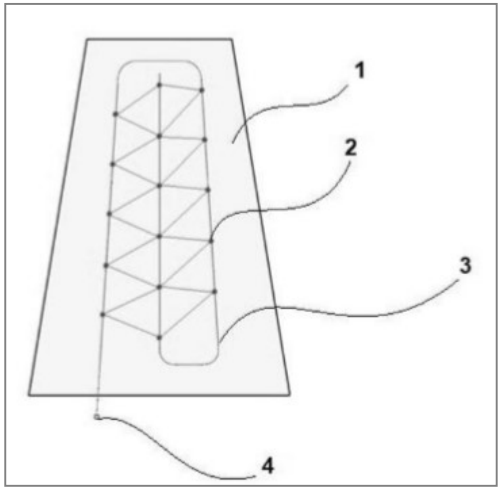

Fig. 2 Embedded artificial skin.
1) Silicone matrix;
2) Fiber Bragg Grating sensors;
3) Path of the fiber optic embedding the FBGs;
4) End tail of the fiber linked to the connector.

Abstract
Subject of the present invention is a large area sensor device based on Fiber Bragg Gratings technology, which represents an artificial sensing skin mimicking the human sense of touch in perceiving intensity and point of contact of an orthogonal force applied externally. Such device is lightweight, flexible and adaptable to any type of surface, such as robotic prosthetic forearms and collaborative industrial or assistive robot surfaces. A further subject of the present invention is the training neural network used to assess both intensity and point of application of an orthogonal external force and the mold used to create the polymeric skin.

Pubblicazioni

- Conference paper "Design and development of large-area FBG-based sensing skin for collaborative robotics" presented during the MetroInd 4.0 conference in Naples (June 2019).

Fig. 3 External mold covers for the silicone skin.
52) smooth external cover;
53) external cover with the path design for the fiber.

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Technical Description

The device consists of a curved polymeric matrix (surface of 6000-9000 mm2 and 6-10 mm thick) embedding an optical fiber concentrically fixed in its middle. Along the fiber, Fiber Bragg Gratings (working at different wavelengths) are placed in known positions. FBGs have a rhomboidal-shape disposition along the surface of the skin. The flexible silicone matrix transmits to the sensors the strains applied by orthogonal external forces. The FBGs detect intensity and positioning of the forces. A double-casting process using a custom-made mold is used to create the silicone skin. To make the device able to recognize intensity and positioning of external forces applied upon the skin surface, three neural network (feedforward) were created.

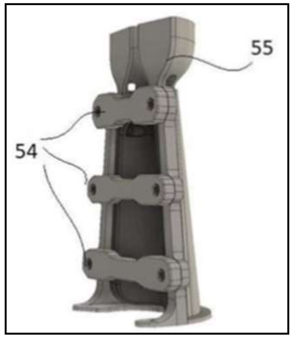

Fig. 4 Silicone skin mold.
54) rod and screw to tighten the mold;
55) casting channel.

Technologies & Advantages

The developed device is composed by a trapeizoidal polymeric matrix embedding an optical fiber in which 16 Fiber Bragg Grating sensors are held. The device has shape and dimensions of the human forearm. Compared to other artificial skins, the proposed one is very light, adaptable to the surface to be coated and deformable, able to preserve the sensors placed inside it. Through a double-casting process of silicone using a custom-made mold, an integrated skin is produced without imposing pre-strain to the FBGs. Thanks to the FBG technology, it is possible to have a highly distributed array of sensors (multiplexing capability), thus avoiding the encumbrance given by power and reading cables. The FBGs are distributed rhomboidly along the surface of the skin and guarantee at least 3 FBGs reading (crosstalk) for each point of the skin. A neural network algorithm was then developed; by receiving the sixteen sensors outputs, it permits to recognize the intensity of the applied vertical forces and the relative points of application.

Applications

Museum and Augmented Reality Context; Co-robotics context for Industry 4.0; Healthcare/surgery.

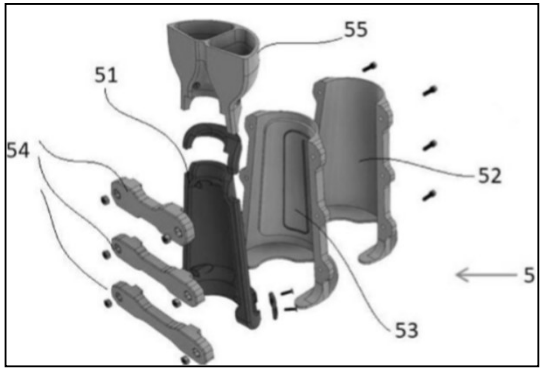

Fig. 5 Silicone skin mold.
51) support for the silicone skin;
52) smooth external cover;
53) external cover with the path design for the fiber;
54) rod and screw to tighten the mold;
55) casting channel.

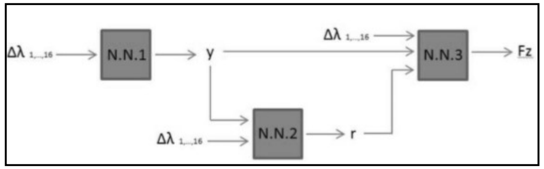

Fig. 6 Feedforward neural network designed to make the sensing skin able to recognize intensity and positioning of external forces applied upon the surface of the skin.

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