

## **Stretchable sensors for manipulators working in wet conditions**

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The I-SUPPORT soft arm is a manipulator based on soft and flexible materials, conceived to serve as a robotic shower to support elderly people in personal hygiene tasks. Soft robotics represents the most suitable approach to build a new generation of soft modular manipulators for assistive robotics that can safely come into direct contact with humans in challenging scenarios (for example, during bathing activities). The design of the robot took into consideration all the constraints imposed to guarantee frail user safety in a wet scenario, but while soft mechatronics technologies intrinsically possess mechanical safety, electrical compatibility becomes a major issue. Moreover, this affects not only the actuation system, but also sensing. In particular, the manipulator needs reliable position and contact information as feedback for the control loop, which is fundamental for an effective interaction with the user. To the best of our knowledge, currently there exist no sensing technology that can work in wet conditions and guarantee enough reliability, thus a first approach was based on completely waterproofing the manipulator, which allowed integrating stretch sensors based on dielectric elastomers. Despite sensing performances were satisfying and could allow a spatial reconstruction of the manipulator configuration, they remarkably increase the stiffness of the manipulator module, reducing the working space of the system. This approach demonstrated to be ineffective and to introduce undesired mechanical constraints, thus it was discontinued. A more ecological approach considered the use of only fluidic-based technologies. Instead of fighting wet conditions, we decided to move towards an approach that is not influenced by the presence of water. For the spatial configuration, external cameras and colour markers were used, while for the contact information a simple solution based on pressurized fluids has been integrated on the tip of the manipulator. Despite this solution provides only basic knowledge, it is enough for ensuring a correct interaction with the user and influences neither the workspace nor the dynamics of the manipulator.