FDM-printed device for medical assessment and diagnosis of finger strength

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Sector: Biomedical
Challenge: Replicate a medical device for the diagnosis of force in the fingers of the hand using FDM 3D printing maintains its functionality.

Solution: Integration of piezoresistive sensors through a dual extruder 3D printer and strain gauge integration in the printing process to validate the printed sensor.

CHALLENGE

Device printed by FDM that allows the evaluation and medical diagnosis of the strength available in the fingers. The strength that we have in the fingers of the hands varies depending on whether we are left-handed or right-handed, gender (men and women) and most importantly it varies with age which allows us to know how we age and also its decrease can be a foretaste of others major diseases. In addition to diseases of the hands, hand injuries can occur by accident, or bad habits in the use of the hands during work or sports.

Currently, there are devices available to measure the strength of the hand and fingers, so that abnormalities can be detected, and their evolution monitored during their treatment.

These devices are metallic and have measuring elements such as force and pressure transducers whose cost varies depending on their weight, complexity, precision and data service.

Current devices to measure the strength of the hand and fingers.

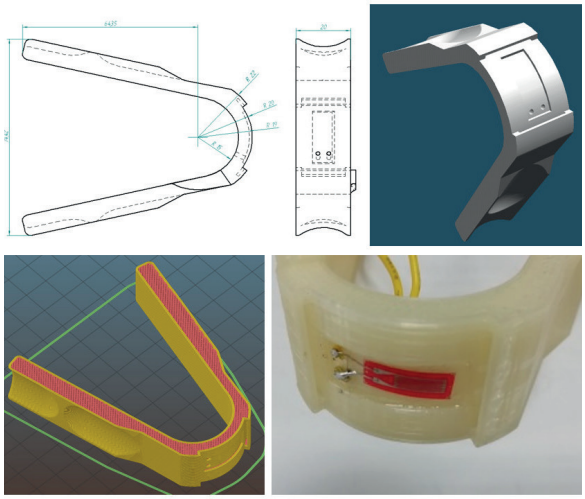
SOLUTION

First, it was necessary to design the new device considering:

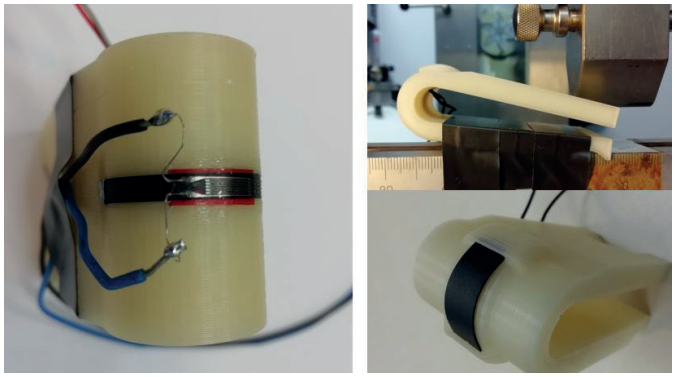
- The different ways of being able to measure the pinch depending on the position of the fingers.
- Males had higher pinch strength (right-8.3±2.7kg, left-7.6±2.5kg) than females (right-6.3±1.5kg, left-5.8±1.5kg).

The design has been validated thanks to the collaboration with the doctor Belén Sancho, specialist in hand diseases at the concept level, but it has not yet been tested with patients.

- Given its ease of use and its biobased properties, the device was printed based on polylactic acid (PLA), using a double head. A standard PLA for the structural part of the device and a conductive and piezoresistive PLA for the sensing functional part.
- Once the device was printed, an electromechanical test was carried out to calculate the Gauge Factor (FG) of the piezoresistive printed sensor material and correlate the value measured in the piezoresistive material with the strain measurement.
- As a validation reference, a reference gauge was placed on the piezoresistive material itself, in order to compare the deformation and force measurements using both measurement systems.



First designs and integration of strain gauges to measure deformation.



PLA sensor device and control gauge

ADVANTAGES

The proposed solution is a good demonstration of the opportunity represented by having functional materials suitable for 3D printing technologies. Being able to combine the different functionalities from the design, optimizing the geometries to achieve the highest possible efficiency of each functionality and providing the material only where and in the quantity that is needed.

3D printing allows through multi-head printing to be able to integrate sensor elements from the printing process itself so that subsequent assembly operations, sensor adhesion, and even cables and other elements are avoided, reducing the complexity of the final product. This reduction in the complexity of the materials is of great interest in terms of their final recycling, if the polymeric base of the different materials present is common.

In the case of the pinch demonstrator, the simplification of the product is evident, reducing weights and costs. For this reason, it is important to bet and continue with research in advanced materials for printing with electrical, magnetic, dielectric functionalities, in favor of a new printed electronics and less complex solutions that allow more competitive products and facilitate a more sustainable future.

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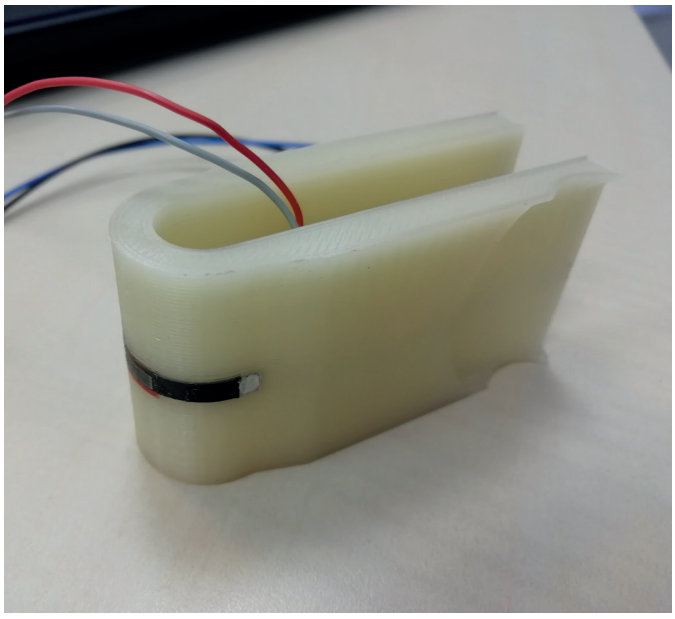

Sensor integration in the printing process.