

D-SENSE

Digital Manufacturing of 3D-Printed Wearable Sensors

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Motivations

■ Digital Manufacturing of 3D Printed Structural Electronics

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20 G1 F9000
21 G92 E0 ;once more
22 G1 F1500 E-6.5 ;retract?
23 M400
24 M107
25 G0 F3600 X135.187 Y76.906 Z0.2
26 ;START
27 M87 B9 D0 ; lower extruder head
28 ;TYPE:SKIRT
29 G1 F1500 E0
30 G1 F900 X135.451 Y76.506 E0.01395
31 G1 X135.778 Y76.156 E0.02789
32 G1 X136.158 Y75.865 E0.04182
33 G1 X136.582 Y75.641 E0.05577
34 G1 X137.037 Y75.491 E0.06972
35 G1 X137.709 Y75.411 E0.08941
36 G1 X161.691 Y75.412 E0.78735
37 G1 X162.169 Y75.452 E0.80131
38 G1 X162.633 Y75.571 E0.81525
39 G1 X163.071 Y75.765 E0.82919
40 G1 X163.471 Y76.029 E0.84314
41 G1 X163.821 Y76.356 E0.85708
42 G1 X164.112 Y76.737 E0.87103
43 G1 X164.336 Y77.16 E0.88496
44 G1 X164.486 Y77.615 E0.8989
  
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Digital Production File

Design of system with all parameters included



Additive manufacturing infrastructure

A set of computer driven tools



D-SENSE Tech platform

3D- Printed electronic system by printing

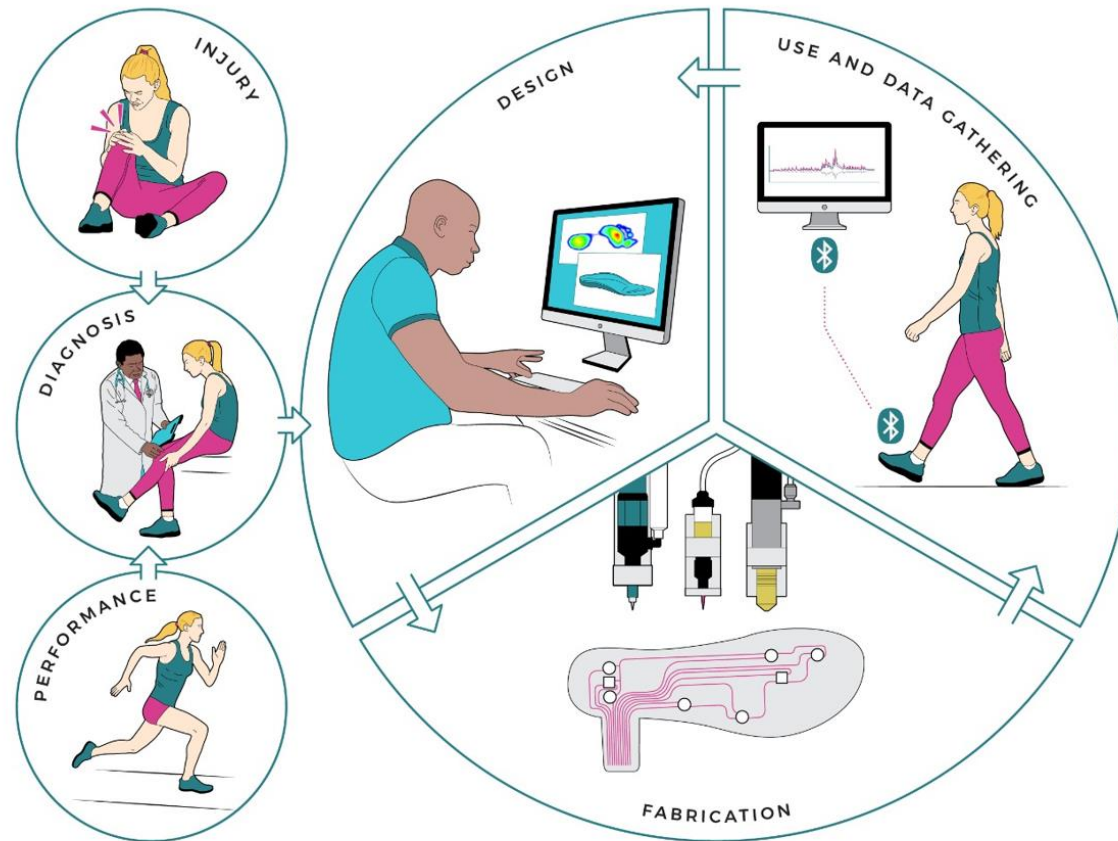
Systems produced through digital manufacturing

CAD to part, Shape complexity, Fully automated, Multiple materials, Maskless, Minimal waste

- Printing intelligence on and within objects and products
- Provides personalisation and customisation
- Strong interest for soft robots, implants, wearables

Motivations

Ultimate goal: Develop an integrated manufacturing platform that allows for the **multi-material 3D printing** of complex geometries and functional materials for embedding **sensing** in customized **wearables**.

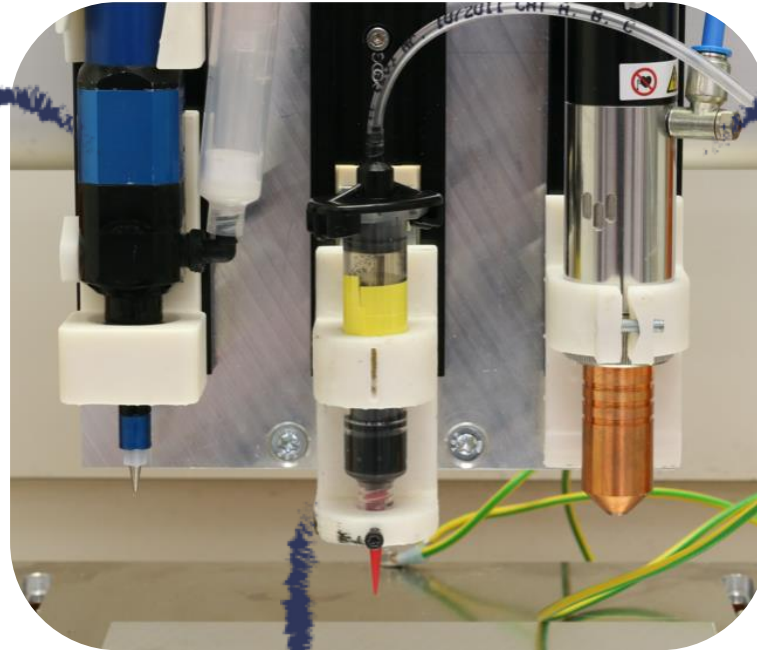


3D multi-material printing platform

A multi-tool head was developed for performing the fabrication on a single machine

Silicone-nanocellulose composite ink

- Provides a flexible material with tunable mechanical properties



Integrated plasma treatment

- Improved interlayer adhesion

Silicone-carbon black piezoresistive ink

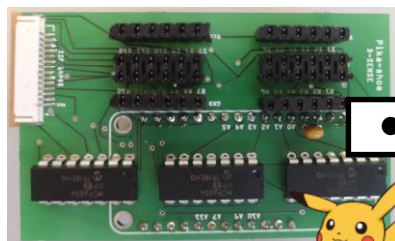
- Normal and shear force sensors

Wearable smart insole

3D printed smart shoe insole

Customized to patients and athletes in terms of shape and sensors location

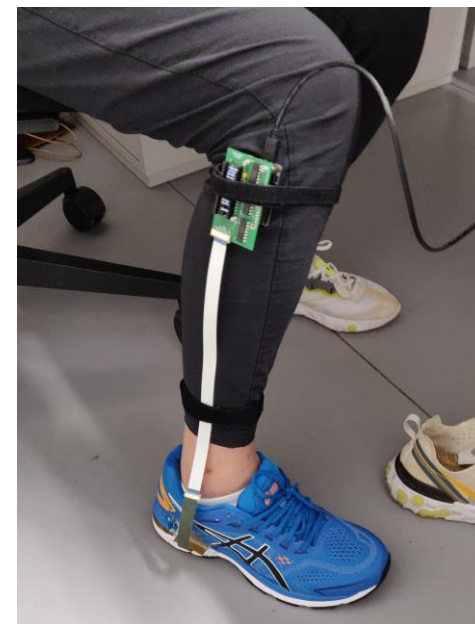
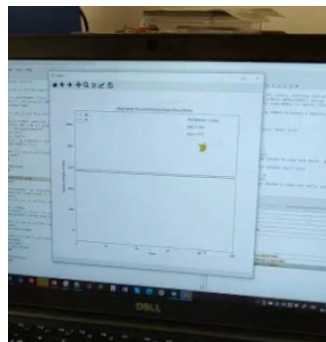
- Detection of gait using fully 3D printed piezoresistive sensors
- Monitoring of normal and shear forces for a number of activities



Custom-made electronics



Real-time signal



Outputs by Month 48

■ Scientific output

12 presentations at conferences / workshops, 3 conference proceedings
1 Scientific publication + 3 under preparation

■ Materials

Silicone / CNC composite formulations for truly 3D printing topologies
⇒ Of interest for our industrial supporter Hylomorph

■ Printing platforms

Multi-material digital 3D printing platforms with activation and curing
Pick and place of discrete components (e.g. SMDs)
⇒ Available at ETHZ and EPFL for interaction with industrial partners

■ Devices and demonstrator

3D printed mechanical sensors and their embedding in customized insoles
⇒ Biomechanical studies and rehabilitation at CHUV
⇒ For athletes gait analysis and orthotics by NUMO System AG

A blue-tinted image of a 3D printer's extrusion heads. The heads are arranged in a row, and some are actively extruding material. In the background, there is a grid of binary code (0s and 1s).

Printed electronics goes 3D !

THANK YOU ALL

Questions are warmly welcome !