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TEXtile integrated HYbrid Printed Electronics

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Background and study rationale

Ageing of population is one of the main problems that European population is facing today, raising the question on the future sustainability of the social health system [1].

TEX-Hype aims at the development of novel technologies for smart textiles enabling seamless integration of electronics and vital sensors into garment and subsequently develop a remote patient monitoring system and predictive early warning system which will be applied in nursing homes.

To improve the quality of life of elderly people and still provide for their medical safety, convenient sensor systems are essential.

Primary objective of the clinical investigation:

- To evaluate the ability of the device to measure the physiological parameters with sufficient accuracy by comparison with the gold standard and to assess the optimal positioning on the body
- To analyze the usability of the device in the nursing home setting

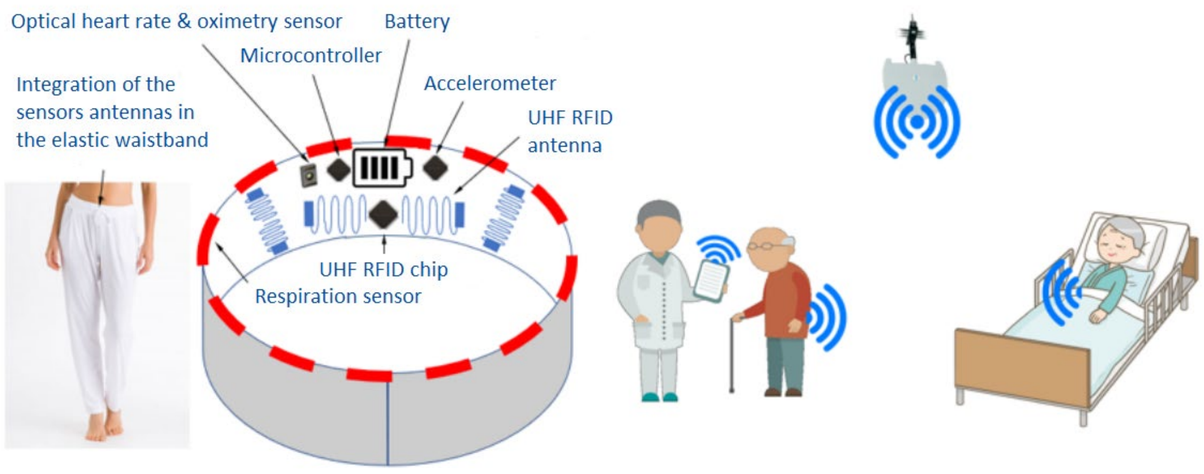

Figure 1: Integration of sensors

Methods

Design of the clinical study

Cohort 1: Validation of the measured values using healthy young subjects (n=22) on the basis of predefined exercises. A Philipps monitor and an Apple Watch will serve as comparison.

Cohort 2: Continuous data collection over 5 days from nursing home residents (n=50).

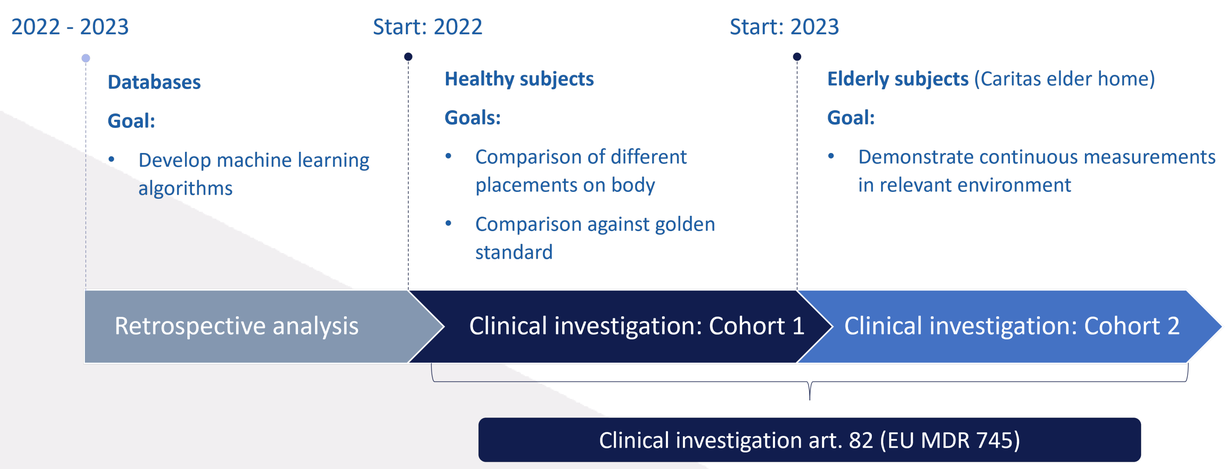

Figure 2: Clinical investigation timeline

The following parameters are measured by the sensors:

- Heart rate
- Respiratory rate
- Oxygen saturation
- Activity tracking

Machine learning models will be used to predict the activity of the volunteer. This is accomplished by applying a supervised deep learning algorithm based on neural networks

References

[1] European Union, 2020, The 2021 Ageing Report Underlying Assumptions & Projection Methodologies

Technical implementation of the prototype

To facilitate the clinical testing of TEX-Hype, a prototype was developed, which was reduced to the most essential components.

Minimal configuration of the prototype

Sensors

- Respiratory rate sensor
- Plethysmograph
- Accelerometer

Electronic system

- Partly integrated
- External data storage
- Medical grade battery (min. 1 day)

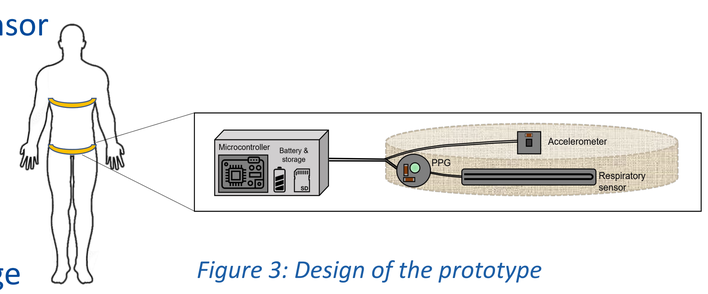

Figure 3: Design of the prototype

Concept of the printed electronics

The contemplated concept involves the use of multi-layer inkjet printing technologies to deposit the functional materials needed for the integration of electronic components.

Stretchable electronics is highly desirable for electronic textiles, as it would not hinder the natural feeling of the garment. In TEX-Hype approach, this limitation will be overcome by

(1) printing the interposer islands in a gradient of rigid (next to rigid components) and elastic TPU (in the periphery of the island)

(2) electrically connecting rigid islands via stretchable interconnections achieved by special patterning (horseshoe- or meander-like) of silver ink

(3) electrically interconnect islands over longer distances by embroidery conductive yarns in the fabric

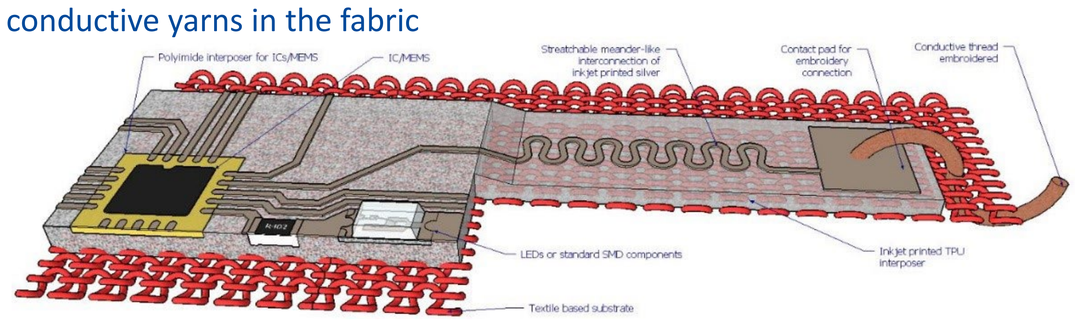

Figure 4: Concept of printed electronics

Respiratory rate sensor

The respiratory rate sensor is developed within the TEX-Hype project. The functionality of the sensor is based on the stretching during the breathing process: Since the body circumference varies during breathing, the textile fibers are stretched differently. Hence, the dielectric properties of the sensor printed on the textile change proportionally to this stretching. Therefore, the respiratory rate can be inferred from the change in resistance induced on the sensor.

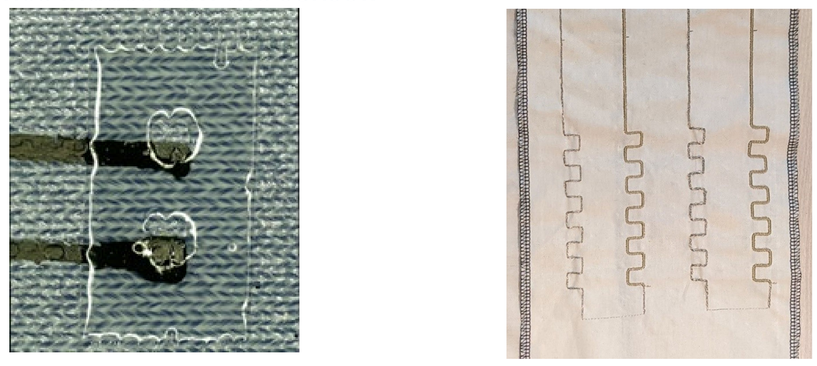

Figure 5: a) inkjet printed island on pad of dispensed respiratory rate sensor b) design of the embroidery

Acknowledgements

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