INTELLIGENT MATERIAL SYSTEMS LAB

ZeMA

UNIVERSITÄT DES SAARLANDES

Textile integrated sensor analysis for biometric data collection and processing - human digital twin in reality.

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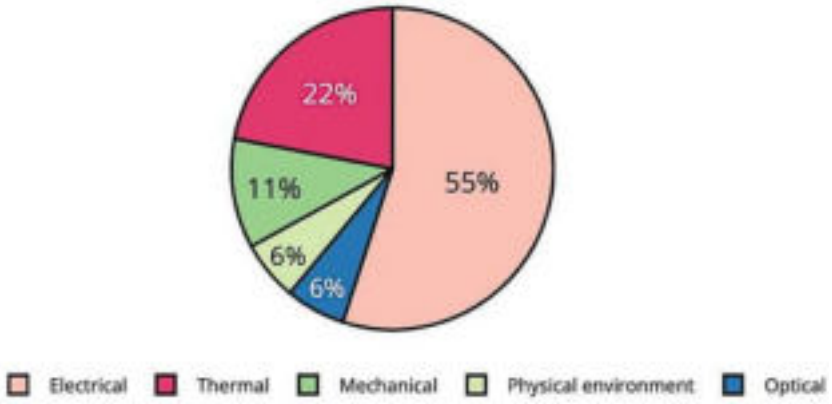
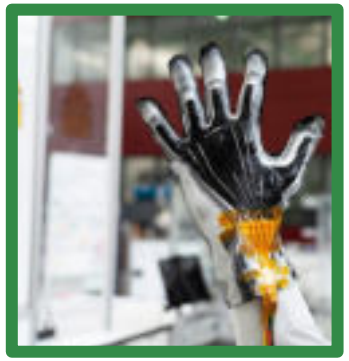
Smart Textile and Sensors

Smart Textile Building Blocks



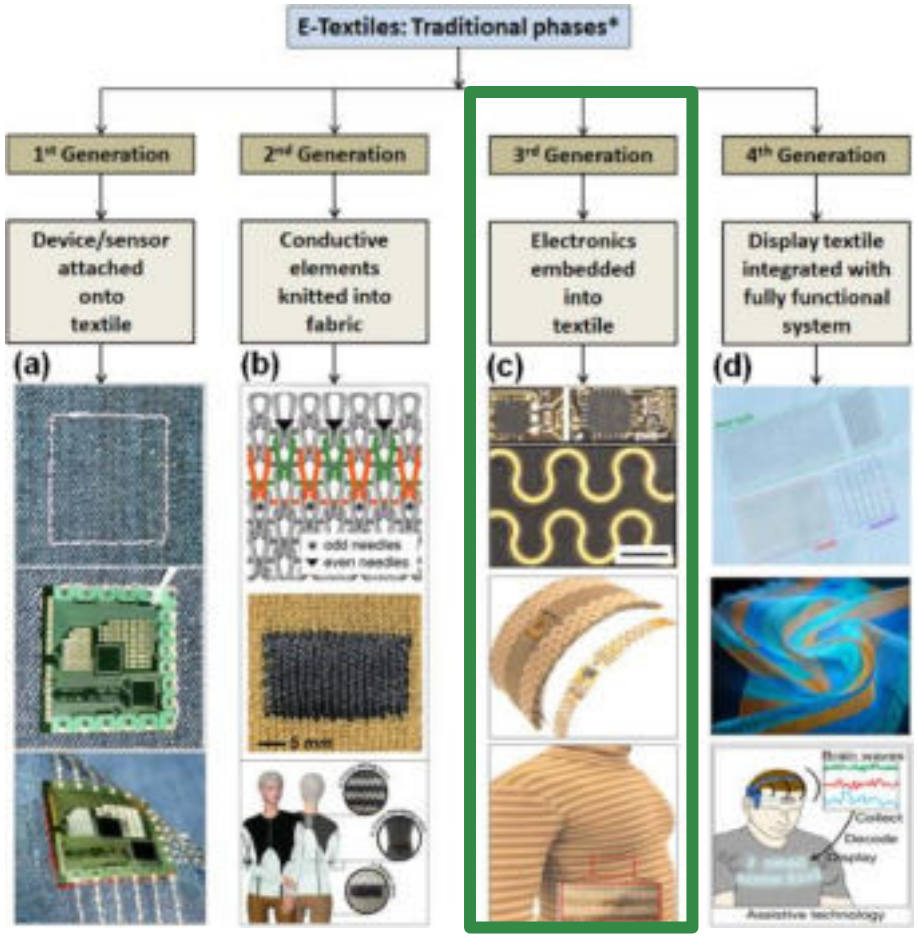
Types of Textile Integrated Sensor



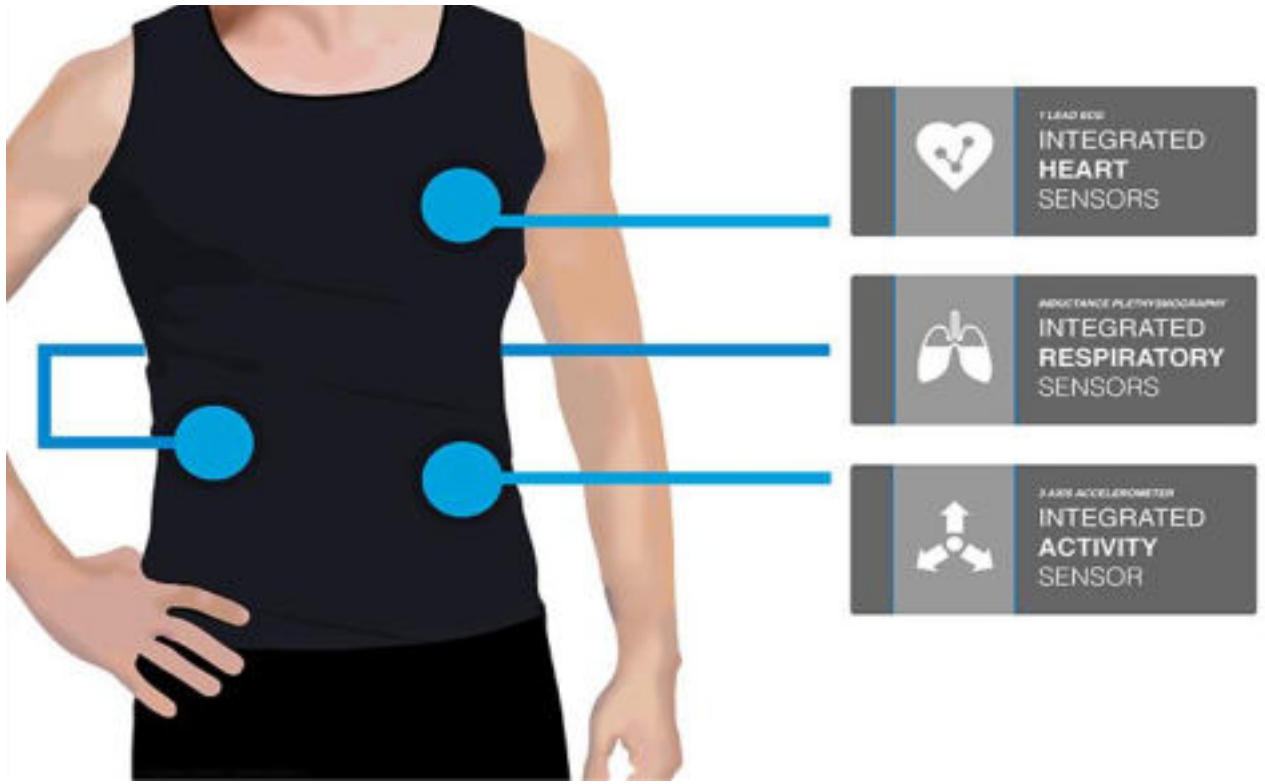
Smart Glove

Smart Vest

Smart Vest Sensor Analysis



Textile Integrated Sensor Phases



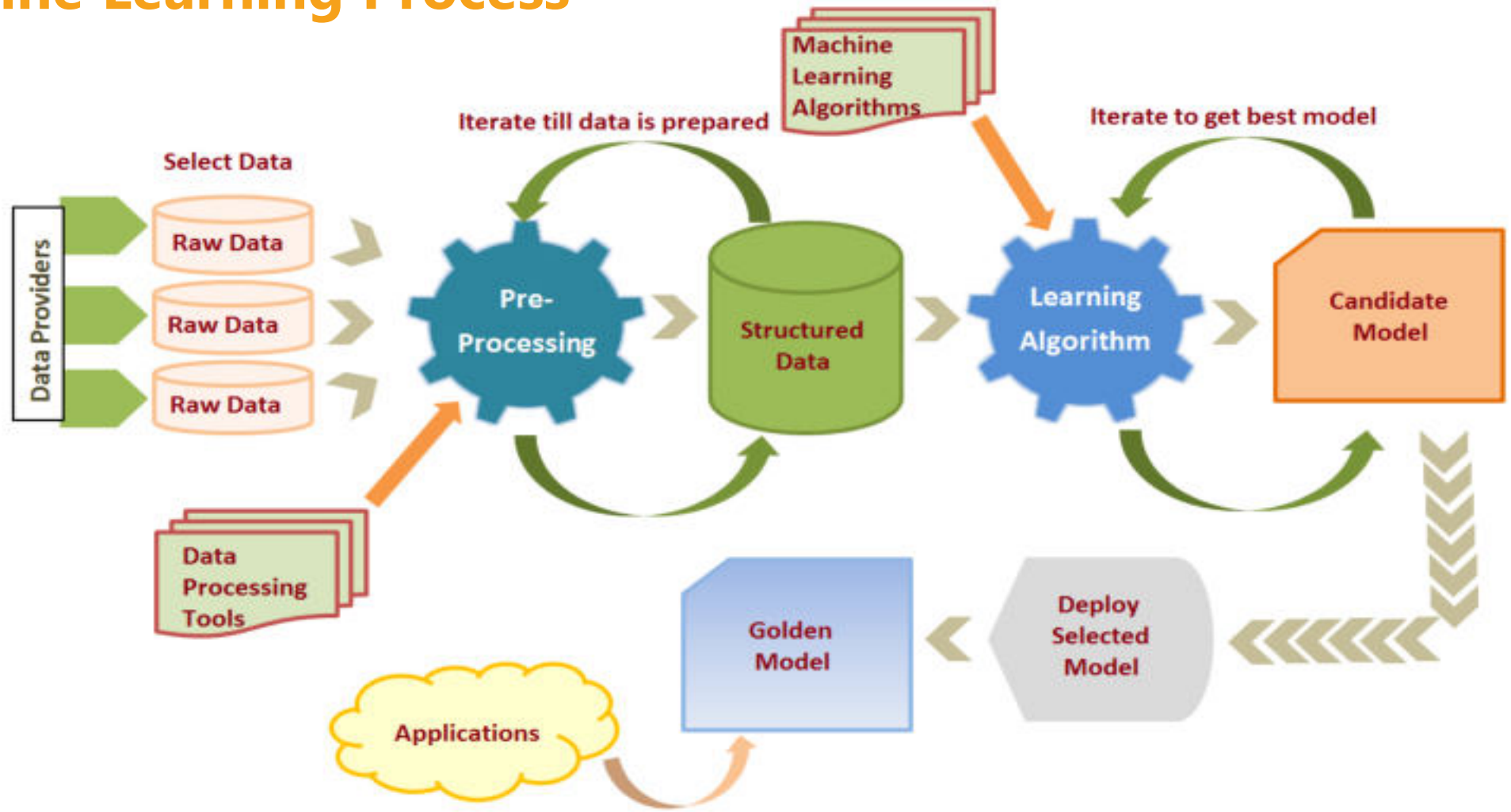
Smart Vest: 3 Sensors

Data Analysis

Dashboard Visualization

Real Time Visualization

Machine Learning Process



Life Cycle of Machine Learning Model

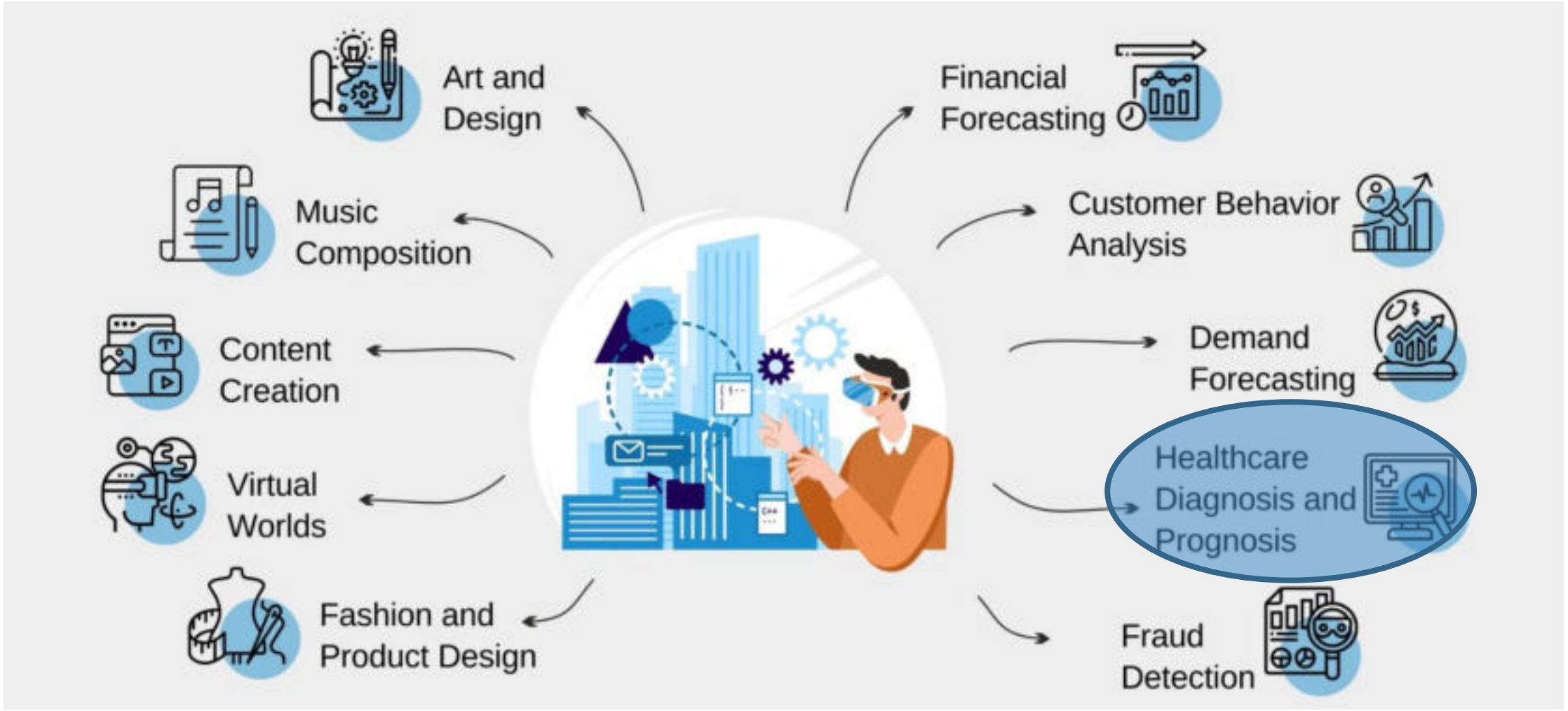
Data Processing

Data Processing

Data Collection	Data Preparation (Wrangling during Interactive Data Analysis) Leverage Visualization for Exploratory Data Analysis (EDA)	
Data Collection	**Data Preprocessing**	**Feature Engineering**
Label	Clean (Replace, Impute, Remove Outliers, Duplicates)	Feature Selection
Ingest (Streaming, Batch)	Partition (Train, Validate, Test)	Feature Transformation
Aggregate	Scale(Normalize, Standardize)	Feature Creation (Encoding, Binning)
	Unbias, Balance (Detection & Mitigation)	Feature Extraction (Automated in Deep Learning)
	Augment	

Data Processing Cycle

Generative Artificial Intelligence



Predictive Simulation

Timestamp	Heart Rate	Breathing Rate	Cadence	Minute Vent.	Energy	State/Type	Resting Heart Rate	Steps
11.28.23 12:40:32	72	23	12	36	6	Movement	65	25
....	....	....	....	....	...	...	....	....
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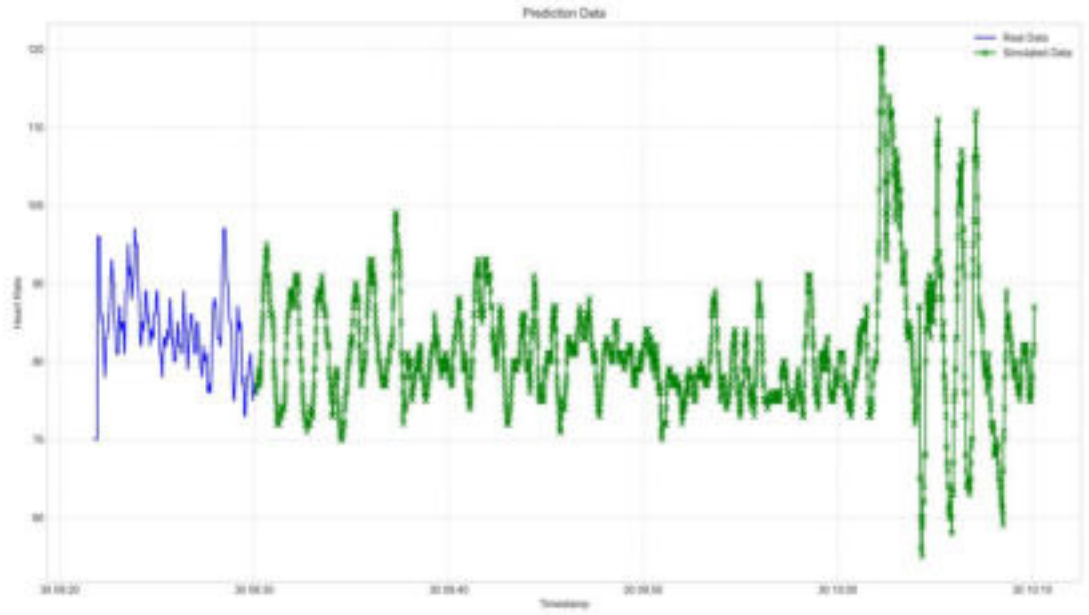
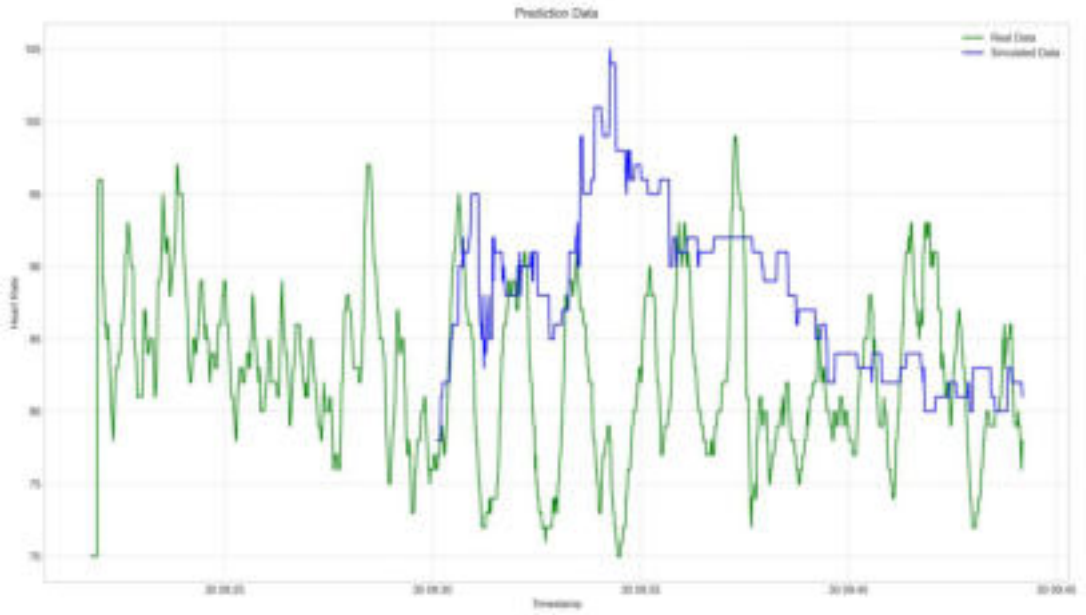


Heart Rate Simulation of Jogging

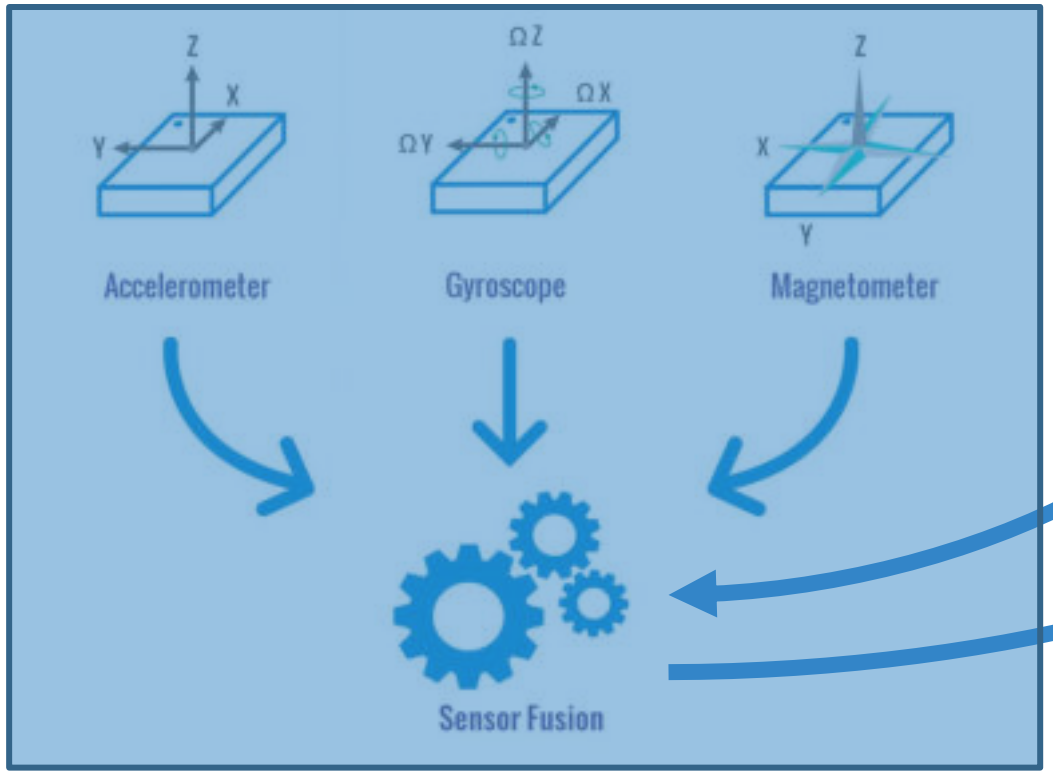


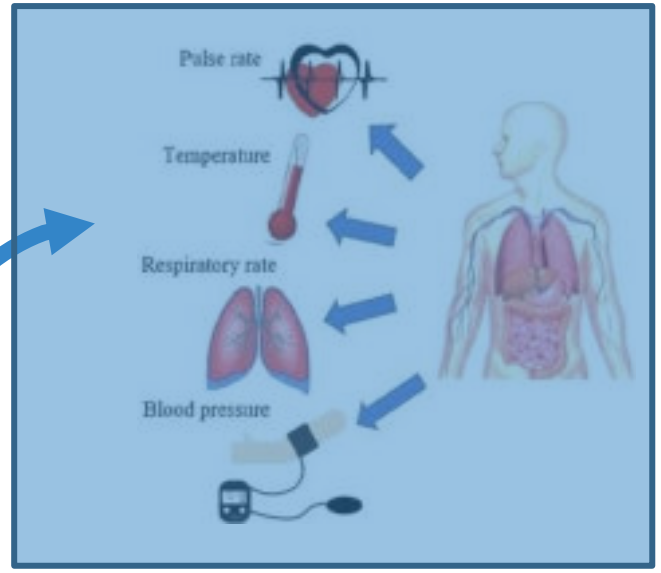
Random Activity Simulation

Sensor Fusion

Stereo Camera with Sensors

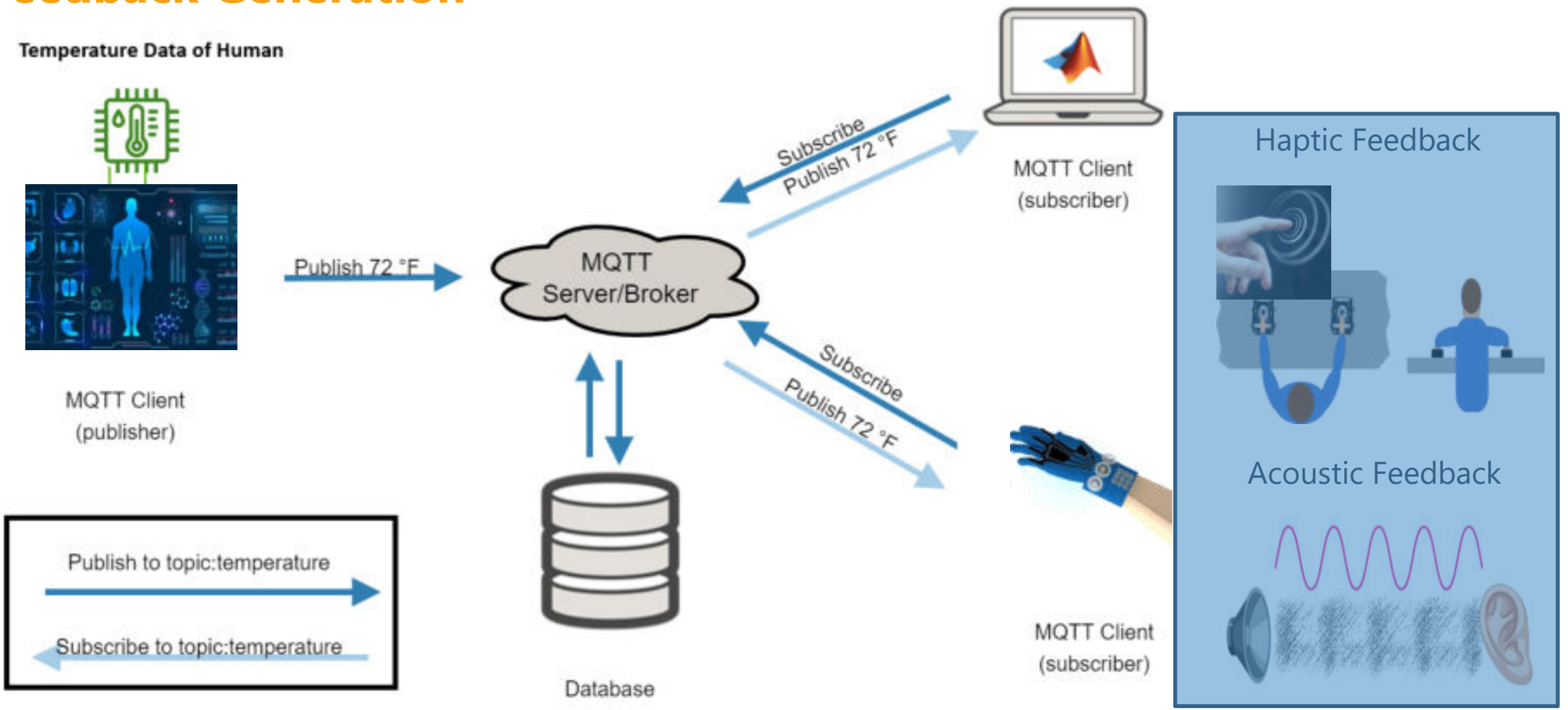
Smart Vest with Sensors





Human Model with Biometric Data

Feedback Generation



Digital Twin

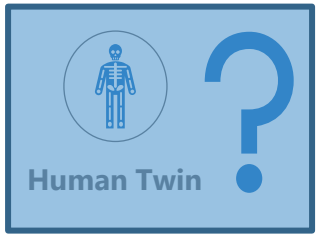
Defining a Digital Twin

- Represents assets in the physical world with a digital model
- Is NOT just a data model. It must include relational interaction
- Looks and feels like the real environment
- Connects with relevant time data to ensure the model mirrors reality
- Simulates models forward with varying degrees of fidelity

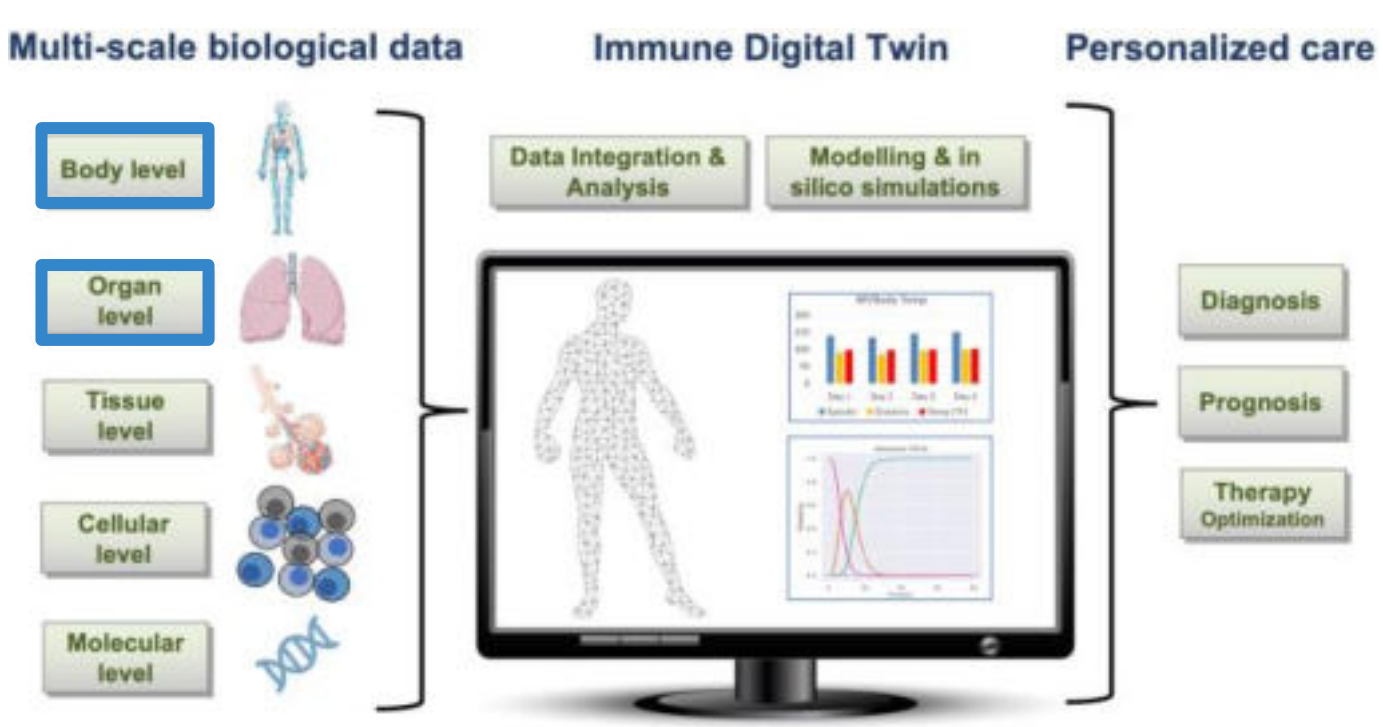
Digital Twins: The 4 types

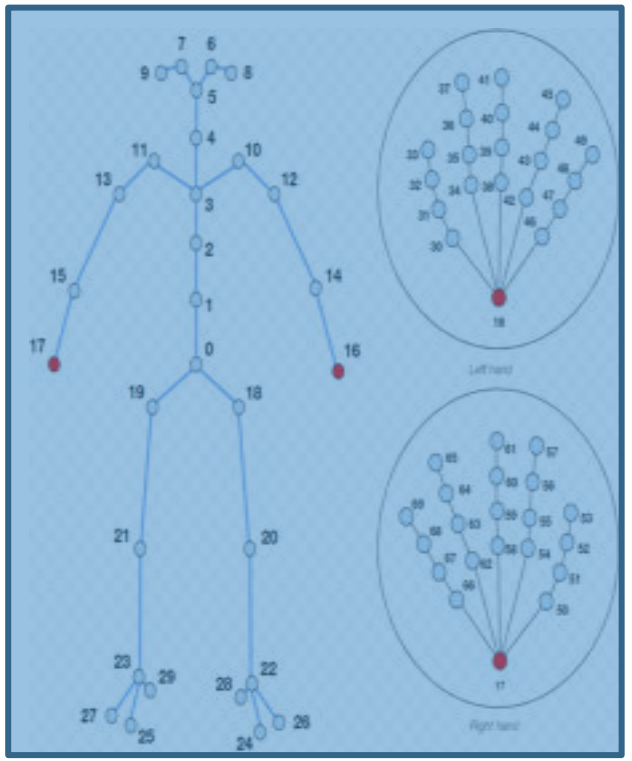
Example: Car factory

Component/Parts Twins	Asset Twins	System/Unit Twins	Process Twins
E.g. rotor, bulb	E.g. engine or pump	Combines all production units	E.g. entire manufacturing process



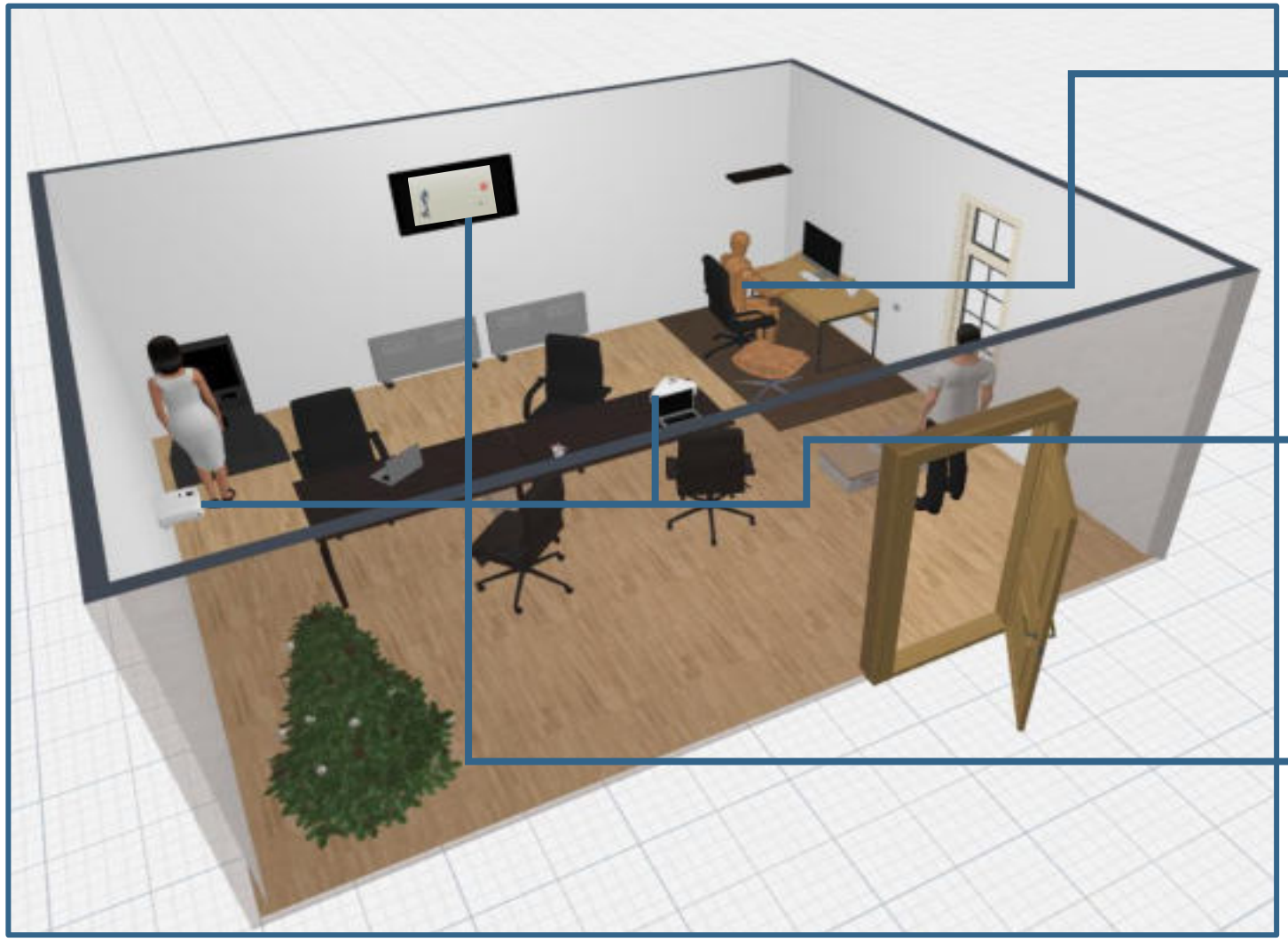
Human Digital Twin





72 Joint Data of Skeleton Structure

Application Setup



Smart Vest

- Real-time biometric data tracking
- Simulation of biometrics
- Prognosis
- Feedback

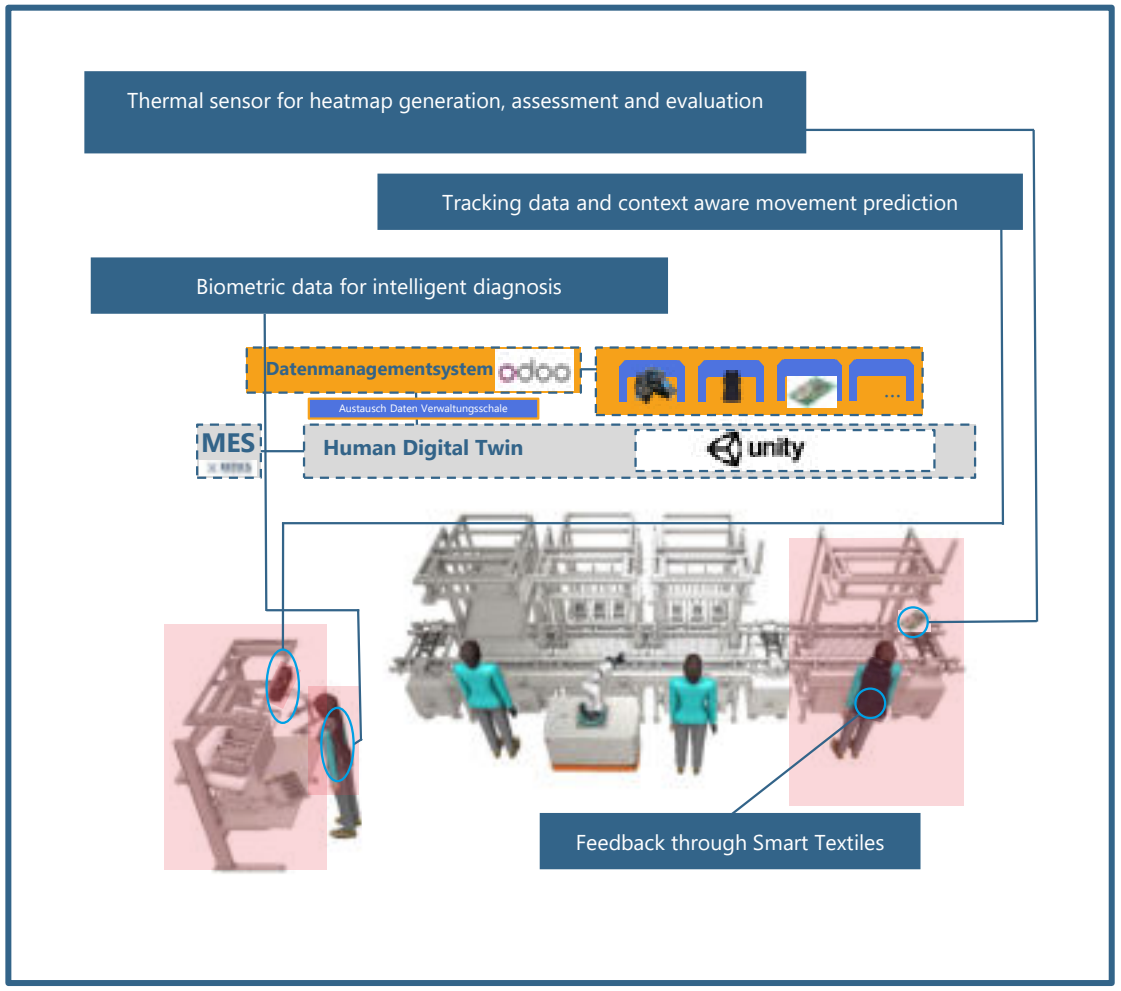
Stereo Camera

- Real-time movement tracking
- Movement prediction
- Action classification

Human Digital Twin

- Virtual replica
- Simulated action/task
- Feedback, Prognosis, Optimal Performance

Application Setup

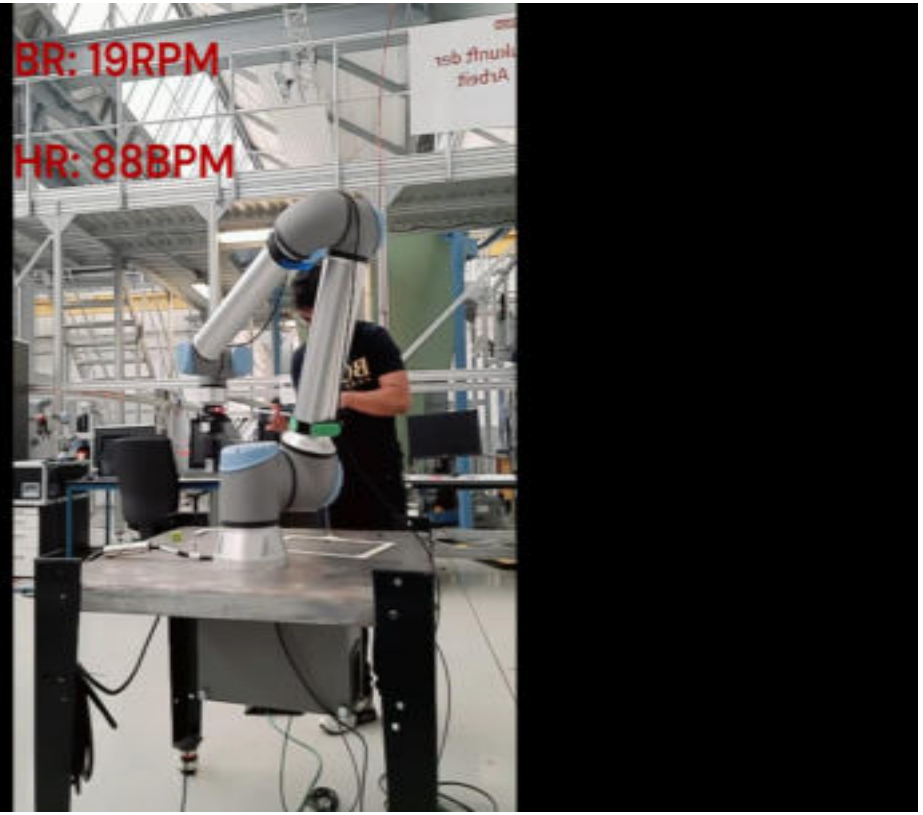


VProSaar - Verteilte **P**roduktion für die **S**aarländische Automotivindustrie: Nachhaltig, Vernetzt, Resilient

- **Aim:** To research the foundations and technologies for distributed, networked and human-centered production.
- **Ensuring:** Greater adaptability in the economy.
- **Transferability By:**
  1. Standardization of interfaces, data exchange formats.
  2. Adaptability and resilience of production resources handling and organization of changed production system structures and **employee competence profiles**.
  3. Modeling of partial and overall systems to ensure transparency and to identify optimization potential.

Preliminary Human Digital Twin

Integrated Biometrics with Movement Tracking



Simulated Vitals Based on Action

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THANK YOU.
QUESTIONS?

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