



CPS: 1652538 CAREER: Internet of Wearable E-Textiles for Telemedicine

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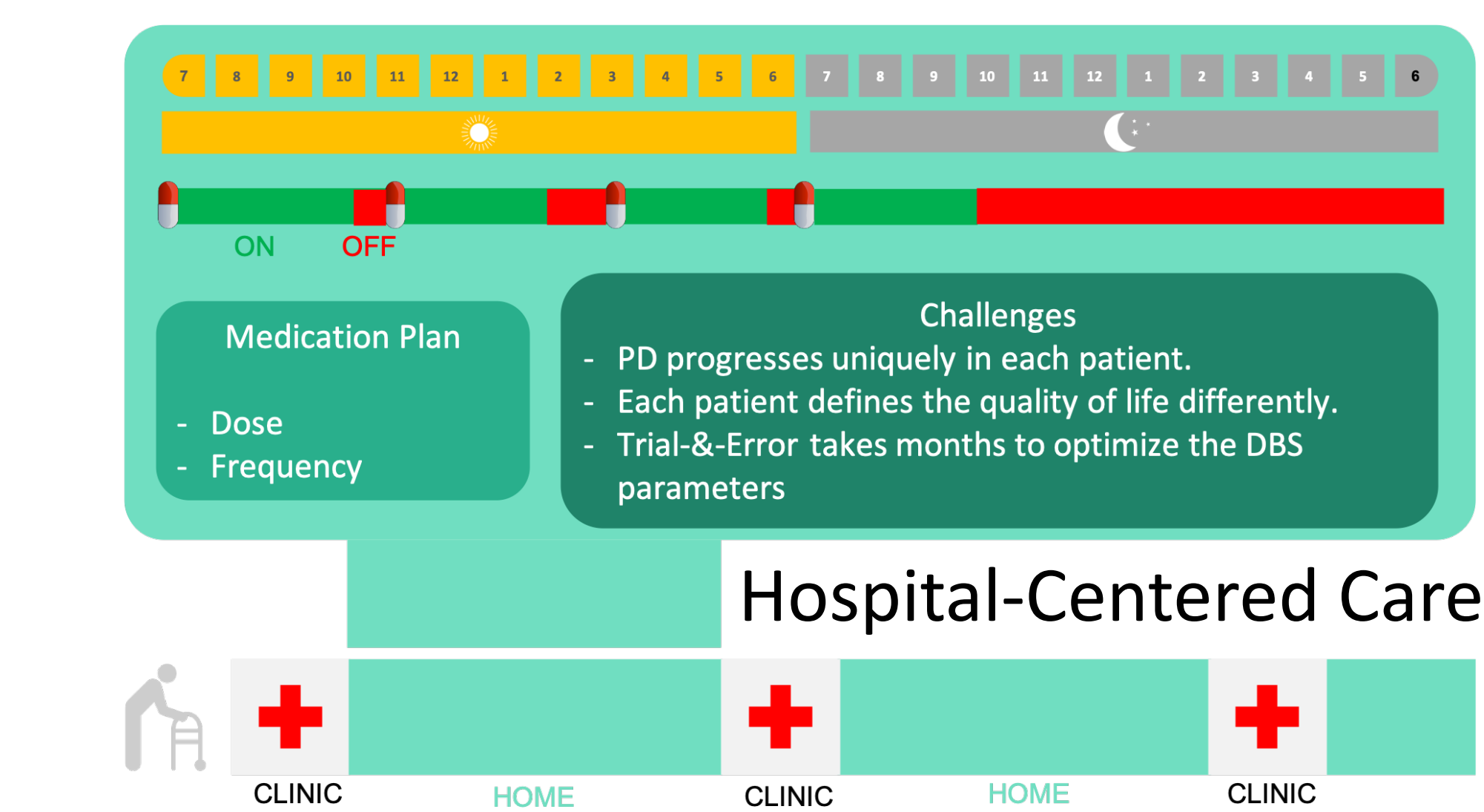
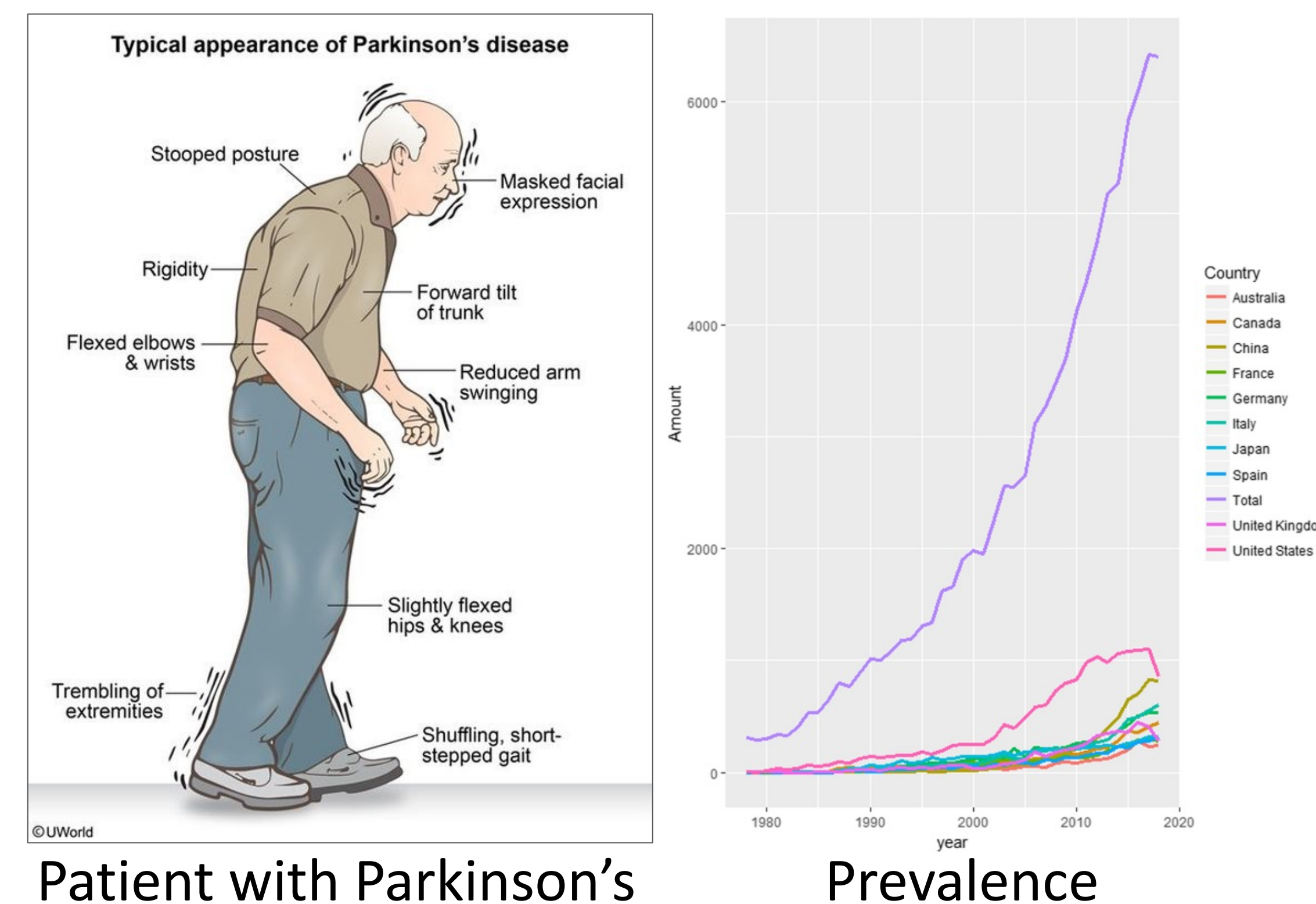
Challenge

- Parkinson's disease (PD) is a progressive neurodegenerative, movement disorder causing motor and non-motor symptoms causing difficulties in living quality life for patients.
- Currently, clinical evaluations are conducted by a neurologist through visual screening. The in-clinic evaluation is prone to inaccuracies due to interrater variability, subjectiveness, and sparse data samples. The progressive nature of PD makes it harder to implement a personalized treatment plan.
- Therefore, there is a strong need for systems which would allow for a continuous in-home evaluation of movement and other symptoms in patients with PD.

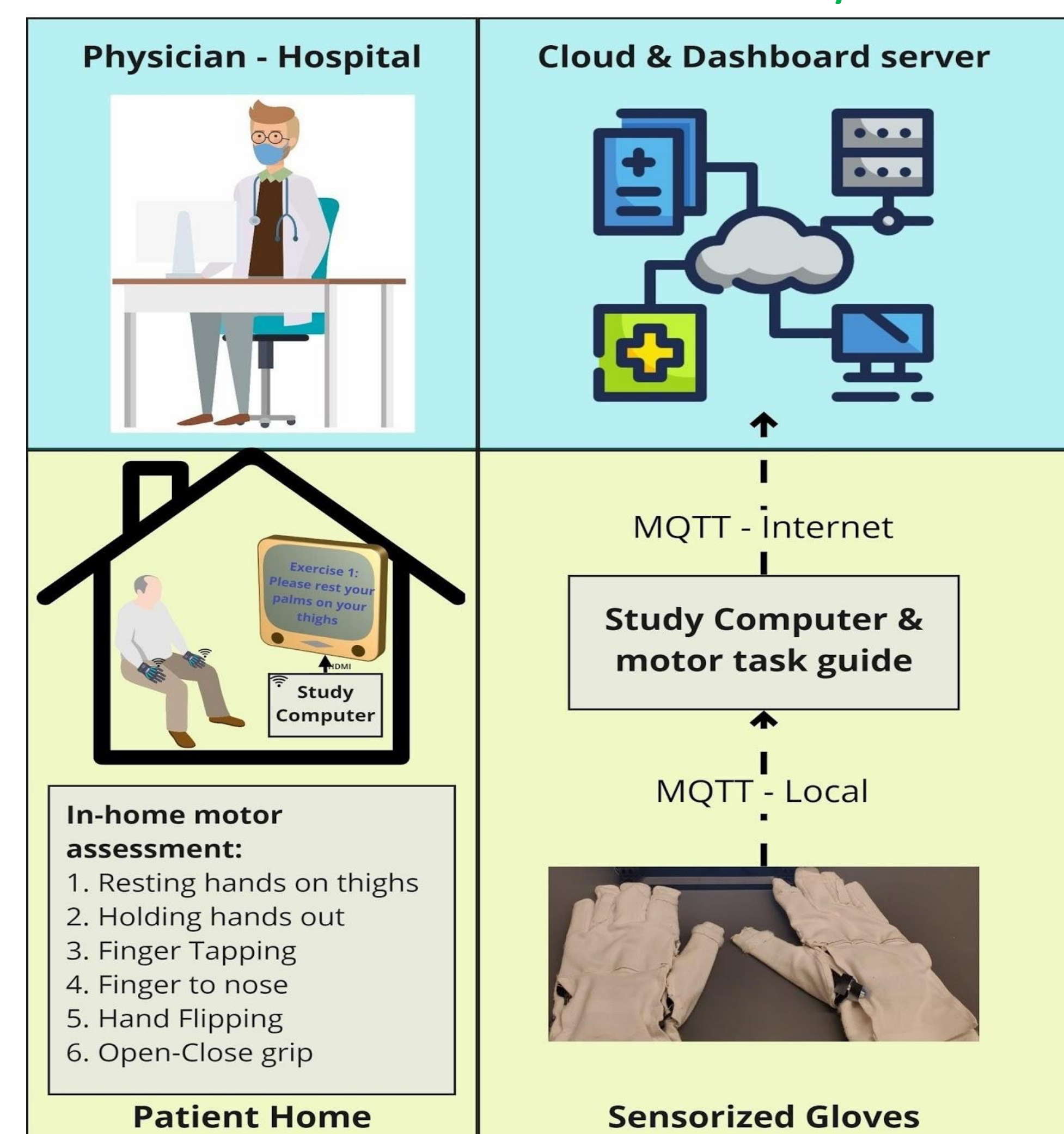
Solution

We have designed a Smart Textile IOT Kit called "KAYA" consisting three interconnected elements:

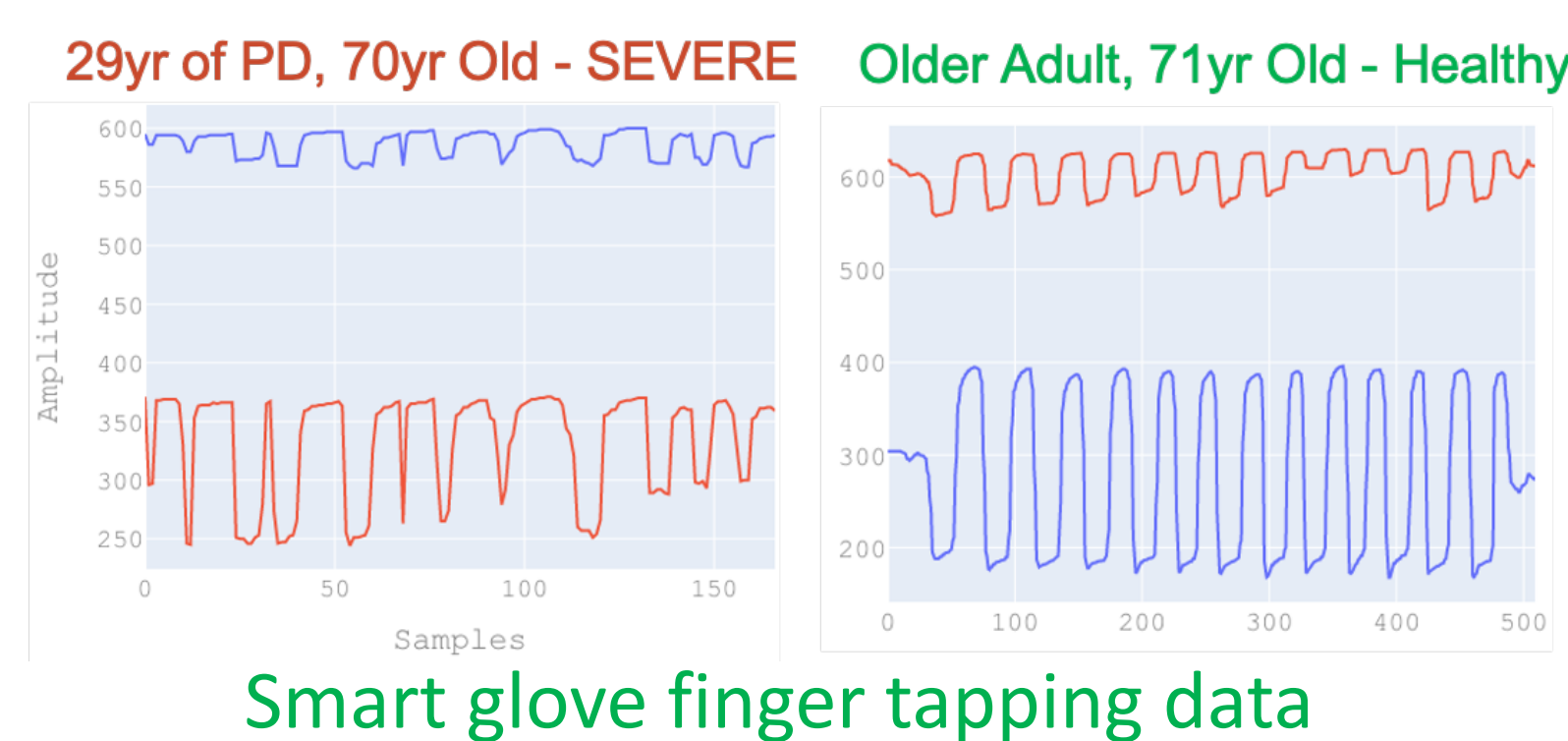
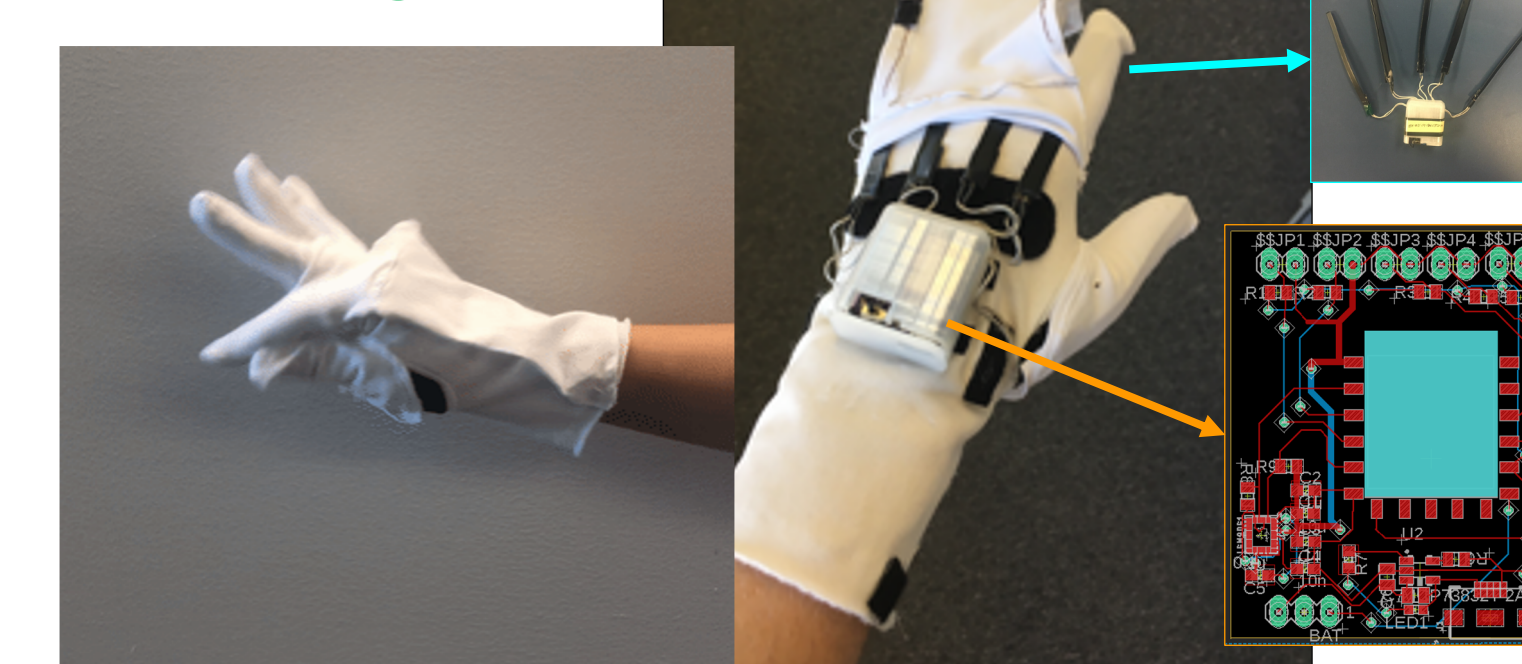
- **KAYA e-textile wearables (smart gloves and insoles)** are embedded with pressure and flex sensors, IMUs, edge computing module, and a rechargeable battery. They run event-driven protocols for sensing the movement activities and for offering feedback to the patients on the screening protocol.
- **A Patient Interface Device** is a touchscreen-based fog computing device offering orchestration of clinical screening movement exams through MQTT-driven body sensor networks.
- **Data Analytics Pipeline** is divided into (i) *edge computing* for real-time monitoring and feedback of screening exams; and (ii) *fog computing* for clinical-grade analysis to score the motor exams.



KAYA: A Smart Textile IOT System



Smart glove



Scientific Impact

- **BODY SENSING:** Our works offer deeper insights into how to integrate sensors into daily life objects (gloves and insoles) for improving accuracy and sensitivity of movement symptom monitoring.
- **CLOSE-LOOP CONTROL:** Our edge-to-fog computing model allows to give feedback to patients in real-time if they carry the motor exams correctly or not. The patient-centered interface enables patients to run screening independently.
- **SIGNAL PROCESSING & ML:** The analytics pipeline allows the automation of the data preparation, sorting, feature extraction, and motor scoring classification.
- **PILOT STUDIES:** Our pilot studies on patients with PD are allowing us to make iterative design improvements in hardware, firmware, software, and interfaces.
- **IN-HOME STUDY:** We plan to deploy the KAYA kit in the patients' homes to measure the clinical feasibility and overall system performance.

Broader Impact

- **Societal:** We regularly engage with patients with PD, neurologists, and other clinicians who get their feedback and suggestions.
- **Workforce Development:** 1 Postdoc, 4 PhD Students, 5 MS Students and 20+ Undergraduate Students have been trained.
- **HealthHack RI** serves as a platform to train and impact college students from various majors who conceptualize med-tech solutions for specific problems.
- **K-12 Outreach Activities** (Paper circuits, E-Fabrics, and Micro:Bit) are offered to inspire young minds for STEM with design and arts.