

CPS: Small: Inkjet Printed Flexible Electronic CPS with Context-aware Events of Interest Detection

2022 NSF CYBER-PHYSICAL SYSTEMS PRINCIPAL INVESTIGATORS' MEETING



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CPS Challenges:

- The next generation of CPS incorporating trillions of sensors will need to:
 - utilize resilient and reliable cyber-physical interfacing, while being economically viable
 - process this large data automatically and reliably for real-time event monitoring at smart edge devices that are ever more popular, affordable, and pervasive
- Seamless integration of computation and physical domains along with meaningful interpretation of multimodal and multigrain data of scalable CPS remain major technological barriers.

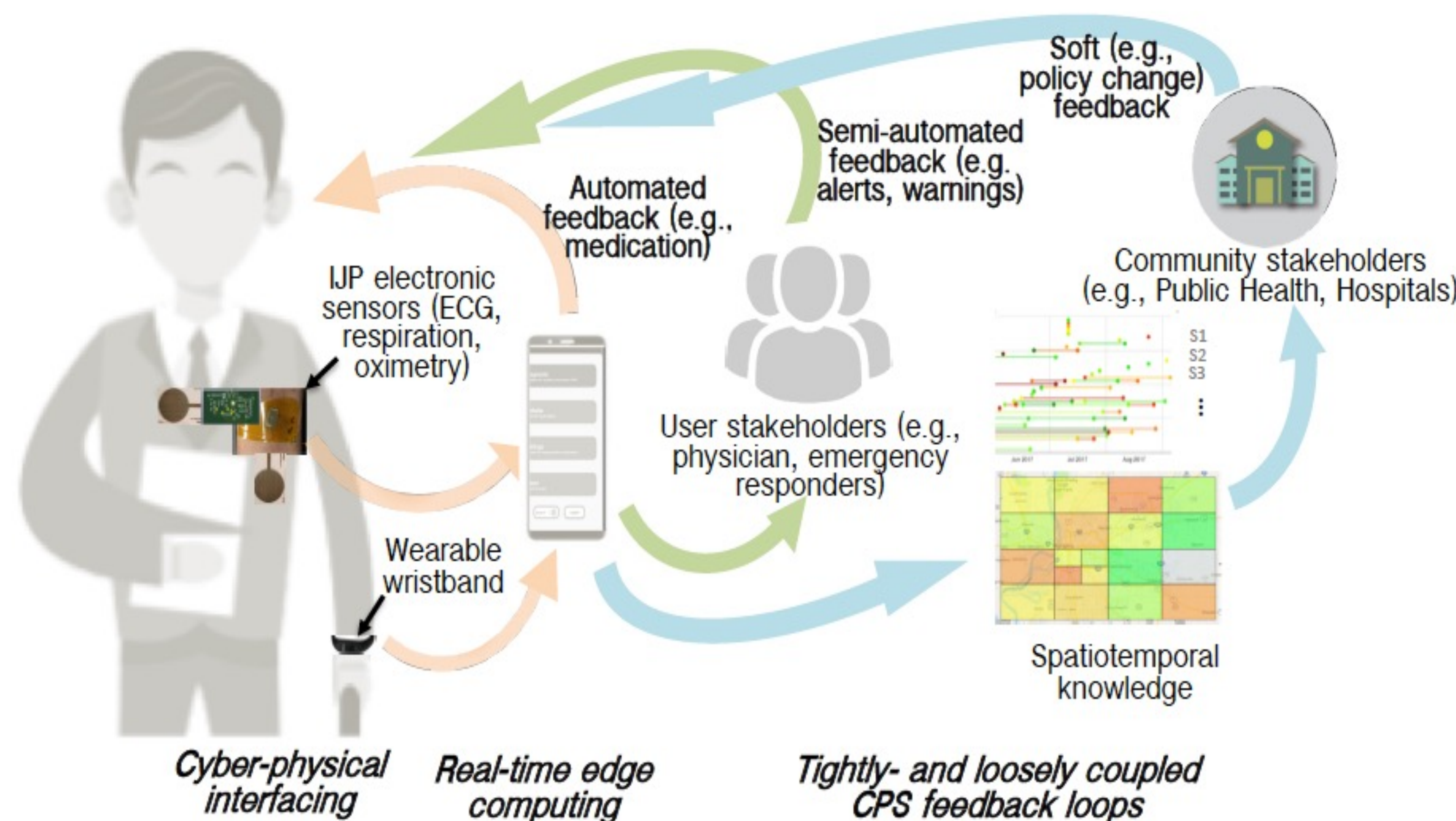


Figure 1: The proposed CPS architecture with practice components.

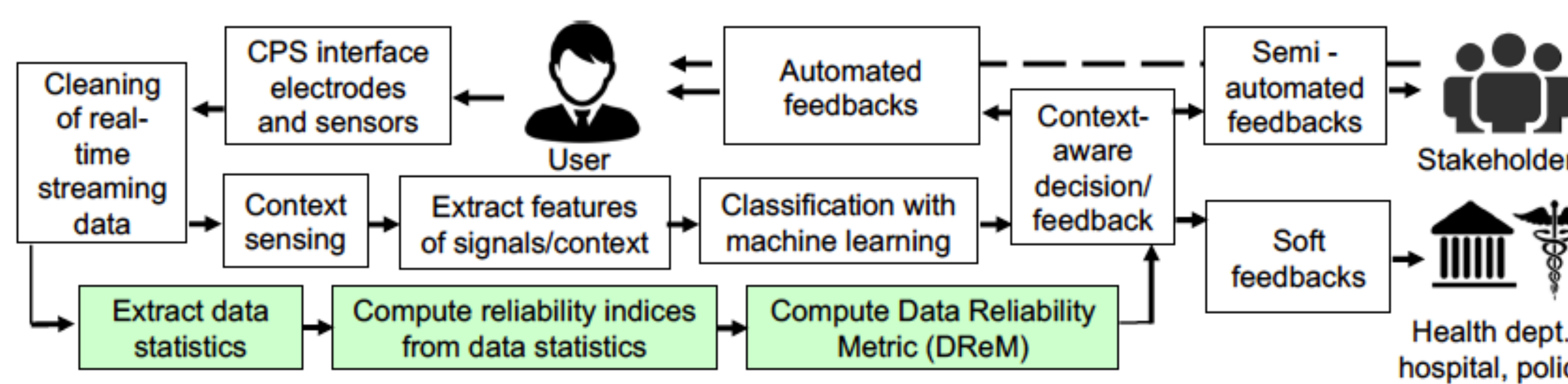
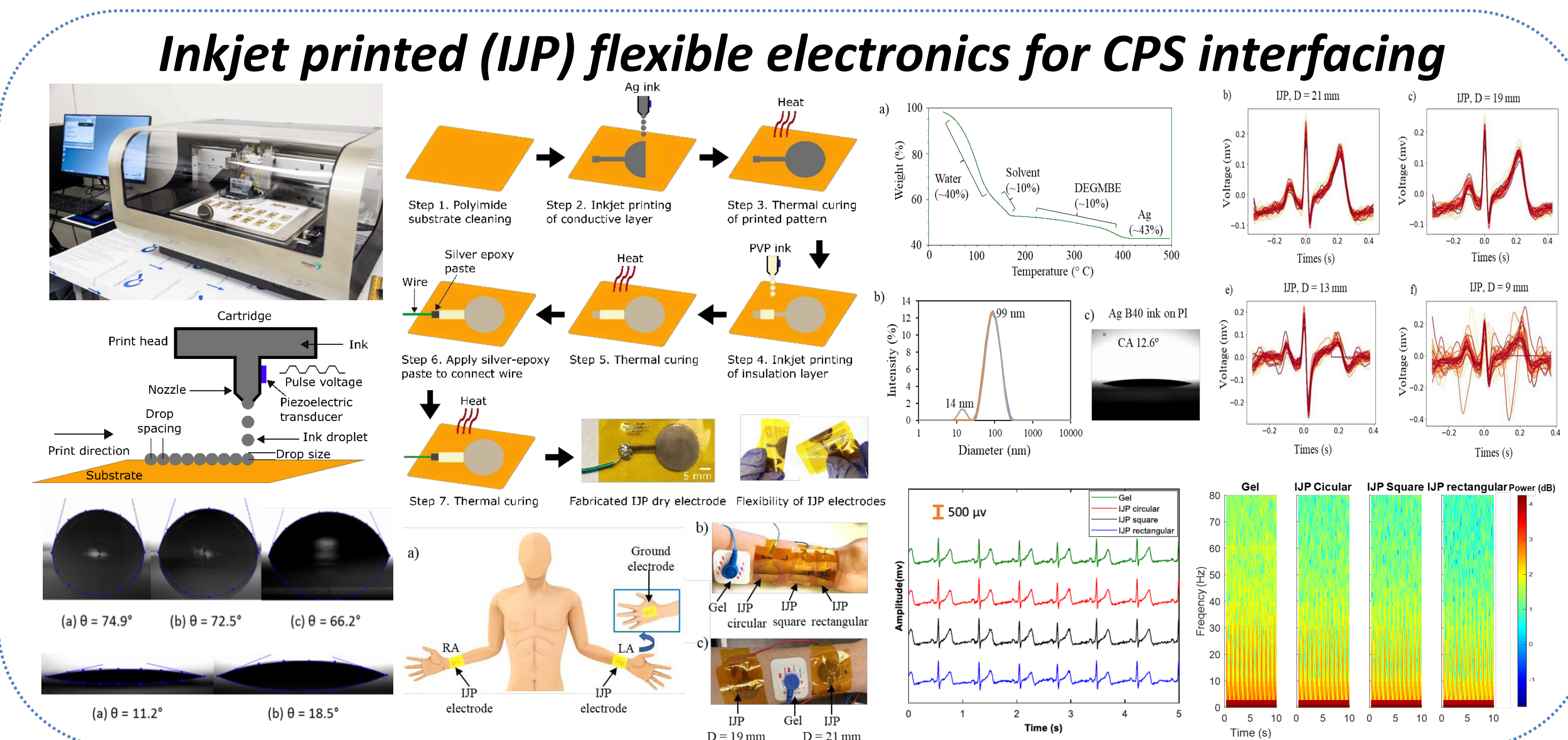


Figure 2: Proposed context-aware event detection with DReM

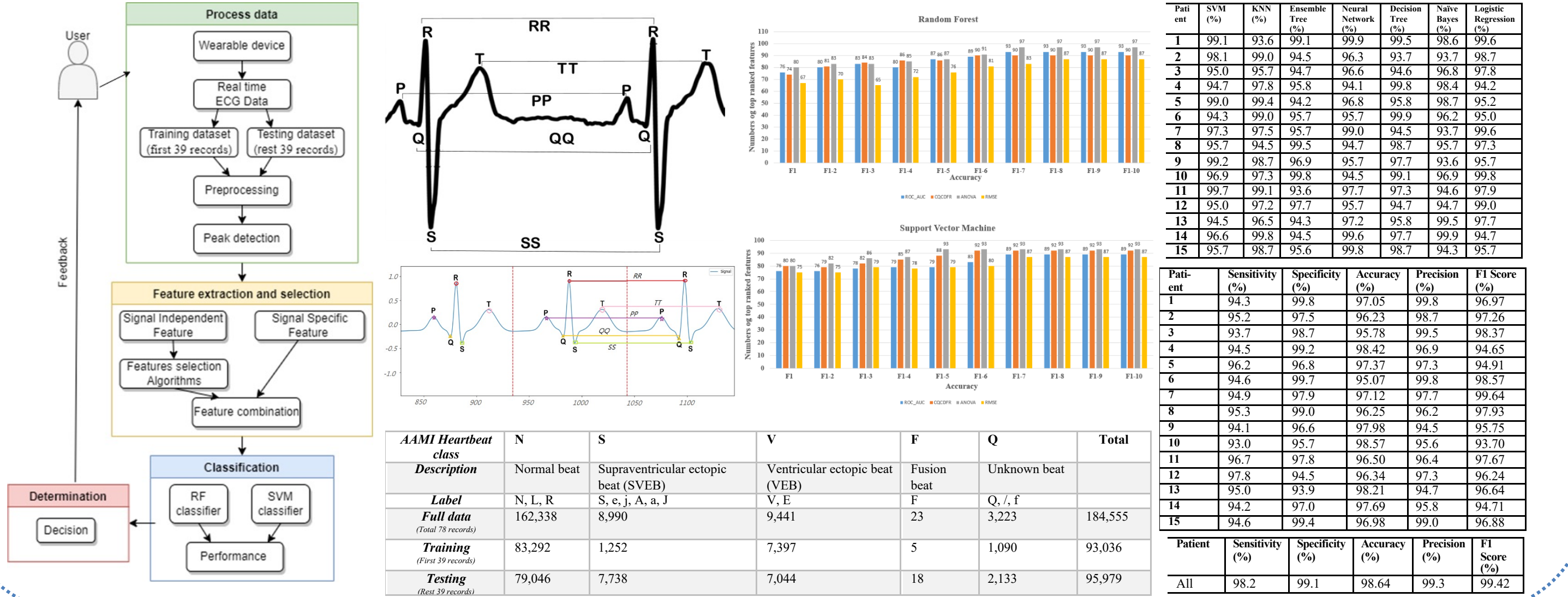
Proposed Objectives:

- The overriding aim is to develop a novel CPS interface using additive inkjet printing (IJP) to produce low-cost flexible thin-film electronics and new AI algorithms (Fig. 1) for context-aware detection of events with data reliability metrics for closed-loop CPS using real-time machine learning implemented at edge (Fig. 2).
- The project has three objectives:
 - To create foundational engineering process for CPS interface with thin-film flexible electronic electrodes and sensors fabricated with IJP manufacturing
 - To develop new algorithms for autonomous processing of sensor data to detect context-aware events of interest and data reliability metric
 - To deploy CPS practice components for a real-life pilot study to explore detection of cardiac episodes and various closed loop feedback approaches

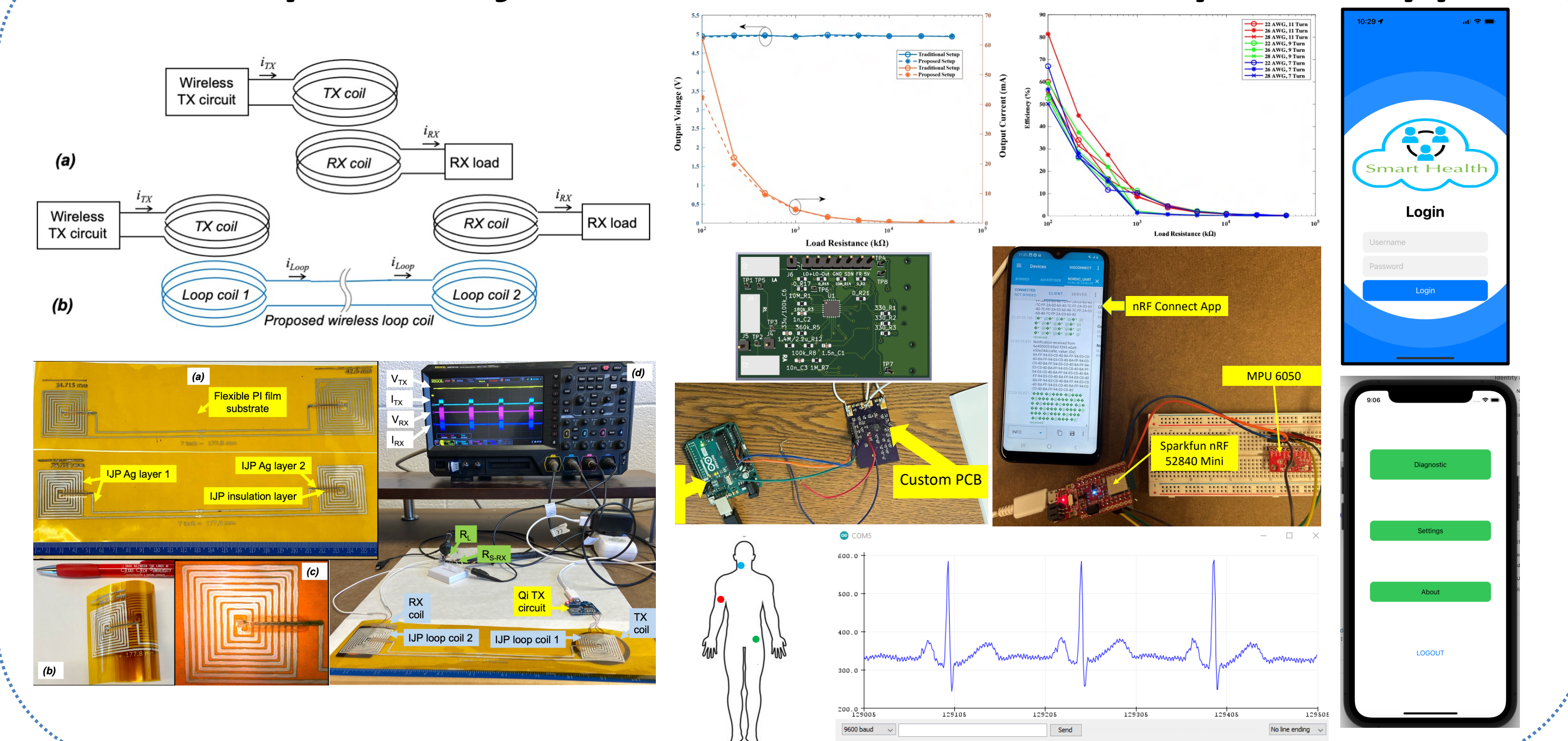
Summary of progress and key results:



Machine learning algorithms for edge-implementation



Development of the wearable & the smartphone app



Innovation, Significance, and Impact:

- Flexible IJP thin-film multilayer sensors for CPS interfaces.
- Real-time algorithm for Data Reliability Metric (DReM) computed from the statistics of streaming data itself.
- Context aware episode detection with machine learning.
- Impacts will extend beyond wearables and medical devices to a host of systems that involve closed-loop feedbacks with sensors and automated data processing.

Broadening Participation in Computing (BPC):

- Developed ten 2-hr synchronous-asynchronous modules for a 2-week-long Virtual Code Camp (VCC)
- This free-to-enroll program was offered in June 2022 to a cohort of 22 high school students from Texas & Tennessee



Award ID#: **CNS-1932281** Project Duration: Jan. 2020 - Dec. 2023
 Project portal: http://myweb.ttu.edu/bmorshed/NSF_CPS.html

