Medical Cyber-Physical Systems: IoMT Applications and Challenges

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Overview

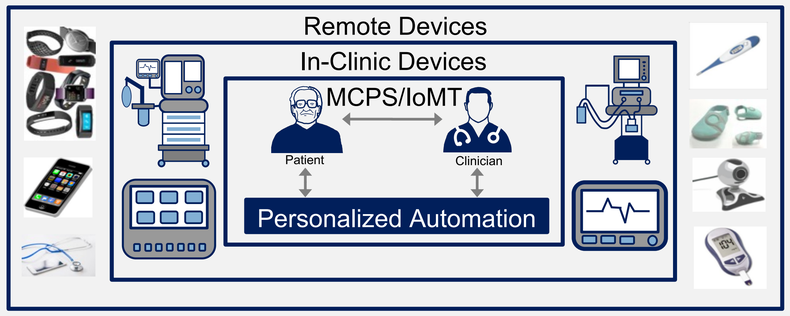
MCPS is the lens that provides clarity to the overwhelming volumes of information contained in medical data collected by **IoMT systems**. As clinicians become increasingly dependent upon the guidance from these systems, their safety and reliability becomes imperative.

IoMT Infrastructure → MCPS → IoMT Applications

Motivation and Challenges

1. IoMT/MCPS should be implemented in such a manner to reduce clinician load, not add to it.
2. Because of the reliance on high-quality data the first and often the most time-consuming step in many research endeavors is to build a data collection system.
3. Medical applications require high quality data from reliable, human-safe devices. Further, they present data storage issues and need ample processing and analysis to create useful applications.

IoMT Research



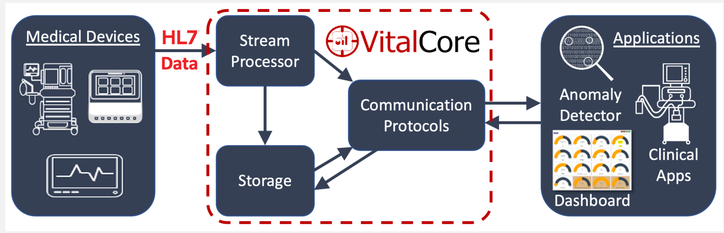
Medical Device Interoperability
"How to collect/exchange the RIGHT data?"
- OpenICE-lite: medical device plug-and-play and wearable platform
- VitalCore: platform for medical device dashboard, anomaly detector, clinical alert apps.
- Raproto: Rapid prototyping platform for data collection via smartphone

Clinical Decision Support
"How to interpret data for clinicians?"
- *Suppressing events:* smart alarms/alerts
- *Detecting events:* shunt detection
- *Estimating state*: T1D patient behavior
- *Predicting outcomes: ACL Retear*

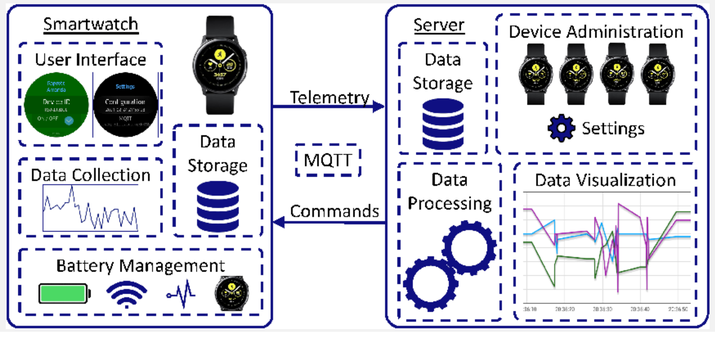
Device Coordination
"How to automatically adjust clinical care?"
- Mechanical ventilator weaning
- Fall prediction
- Motion detector using PulseOx

Infrastructure

VitalCore
Analytics & Support Dashboard for Medical Device Integration



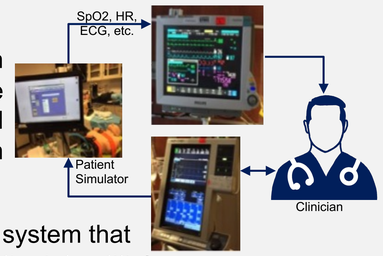
Raproto
Open-source, rapid prototyping platform for data collection via smartwatches



IoMT Applications

RT-ACL: a system that enhances patient outcomes by reducing their risk of an ACL re-tear by providing personalized recommendations of modifiable risk factors that can be altered during the patient's recovery process.

Autowean: prediction of extubation outcomes in real time to enable clinician decision support and autonomous mechanical ventilation weaning

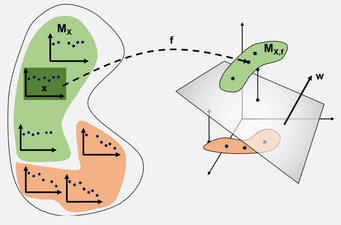


Opiod Sensing: wearable sensing system that continuously monitors opioid levels in the interstitial fluid enabling remote and monitoring of opioid medication adherence

Glucose Monitoring: noninvasive change in glucose monitoring for prediabetes

TremorSense: tremor evaluation device to prevent falls in Parkinson's patients

Fall Risk: fall risk prediction for an inpatient hospital setting



SmartAlarms: Clinical alarm suppression system

Conclusion and Future Work

We are pushing towards a vision of the future in which technology autonomously provides comprehensive medical care. As we strive towards this reality, we have developed the IoMT and MCPS, but we still have many more challenges to surpass.

Autonomous Medical Care

No Autonomy	Technology Assistance	Task Autonomy	Conditional Autonomy	High Autonomy	Full Autonomy
Caregiver(s) performs the task	Caregiver(s) is involved in the task and technology aids and enhances it	Caregiver(s) initiates a task and has discrete control over technology that executes it	Caregiver(s) defines and initiates a task and technology executes the task with caregiver supervision	Technology decides the course of action and executes it with caregiver supervision	Technology decides course of action and executes it without supervision

Increasingly Human-performed Tasks → Increasingly Machine Performed Tasks