

wPEM: wearable Vital Sign and Pulmonary Edema Monitor

Ben Cobb, Alec Miller, Michael Warren

Mentor: Dr. Emil Jovanov

Department of Electrical and Computer Engineering (ECE)

System Design

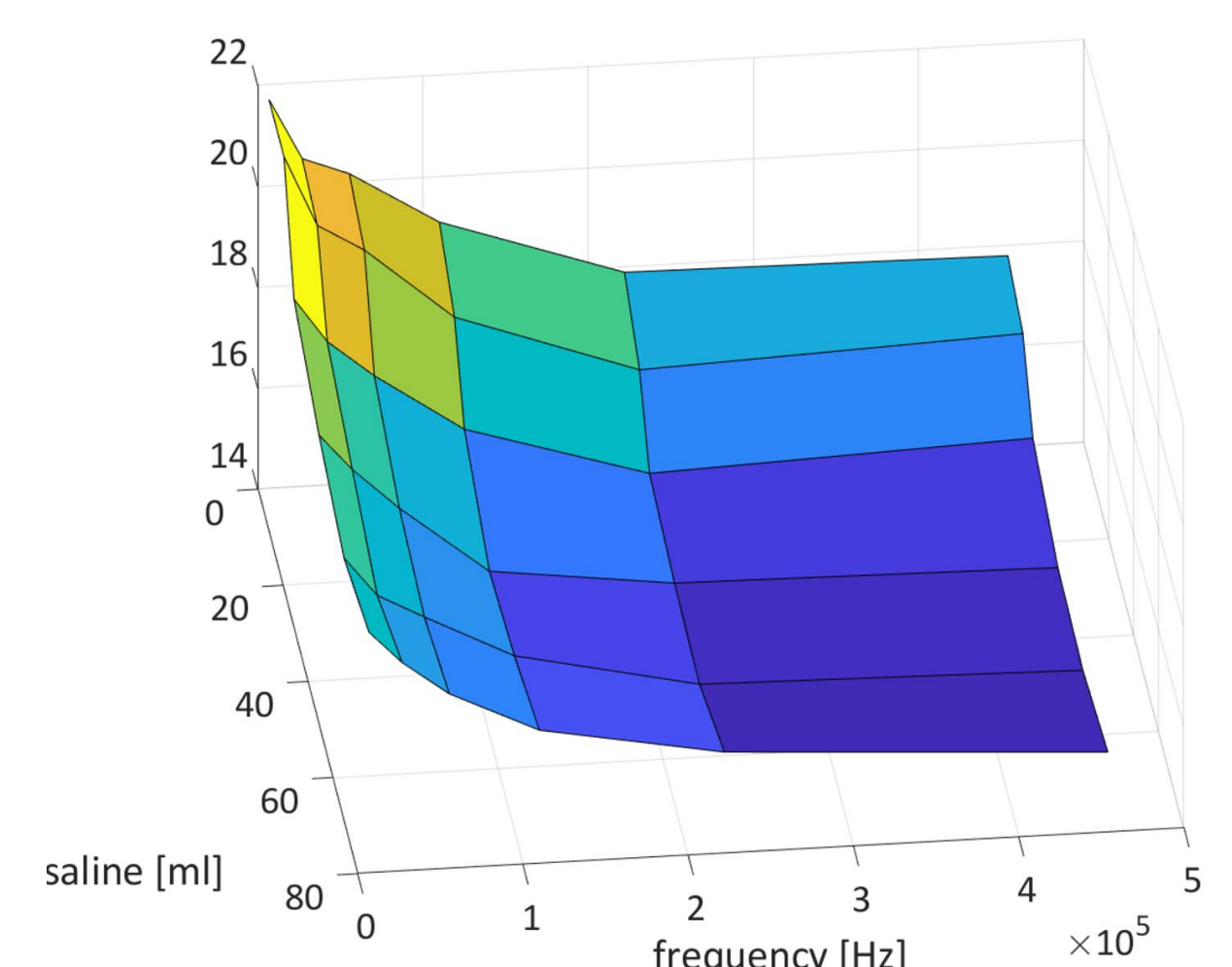
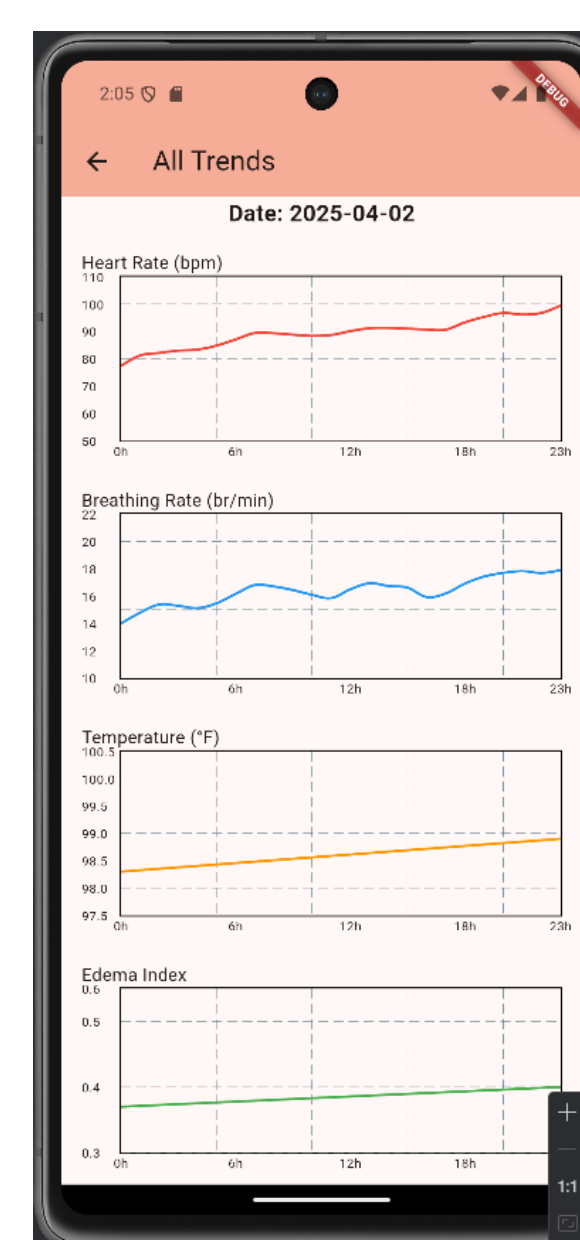
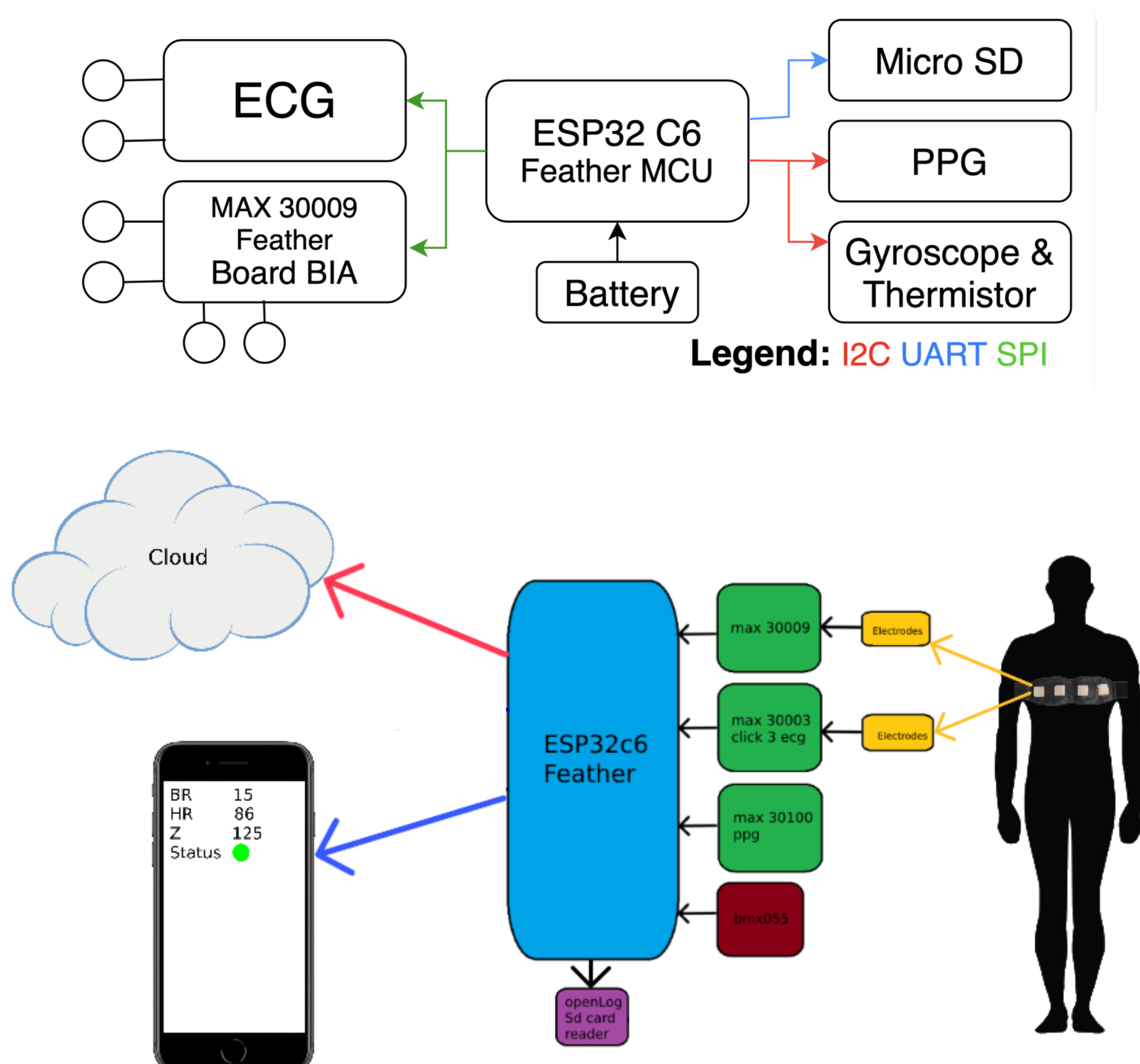
- Pulmonary edema, the abnormal accumulation of fluid in the lungs, can develop rapidly and lead to severe respiratory distress, heart failure, and death if not detected and treated early
 - Currently monitored only in hospitals (X-ray, examination)
- Bioimpedance based assessment of edema index [1]
 - $EI = \text{extracellular_water} / \text{total_water} > 0.394$
- Continuous real-time monitoring [2] can:
 - Provide early detection and prevention
 - Monitor disease progression and treatment response
 - Reduce hospitalizations

System Design

- Wearable physiological monitor
 - ESP32C6 microcontroller with WiFi
 - Bioimpedance MAX 30009 using tetrapolar electrode configuration
 - ECG MAX 30001 HR and HRV
 - Inertial sensor BMX055
- Cloud server InfluxDB
- Mobile Android application

Results

- Integrated system for continuous real-time monitoring
- Real-time notifications and alarms
- Simulated edema in biological tissue
 - adding saline to chicken breast
 - change of bioimpedance as a function of the volume of extracellular fluid



Conclusions

- The first wearable sensor for real-time monitoring of pulmonary edema
- Small, affordable solution for real time monitoring at home with real time access to patient's medical health record
- Improved quality of life and empowering patients and caregivers

References

- [1] Sunki Lee et al. "Assessing lung fluid status using noninvasive bioelectrical impedance analysis in patients with acute heart failure: A pilot study, Int Journal of Cardiology, Volume 409, 2024, 132205, ISSN 0167-5273, <https://doi.org/10.1016/j.ijcard.2024.132205>
- [2] Robert Joe Mathews, "Bioimpedance-based Real-time Wearable Physiological Monitoring," PhD Dissertation, The University of Alabama in Huntsville, October 2023.

Acknowledgements

Special thanks to Dr. Jovanov for helping guide us throughout the project.