LSL for Wearables: Direct Hardware Integration on a Miniaturized Platform

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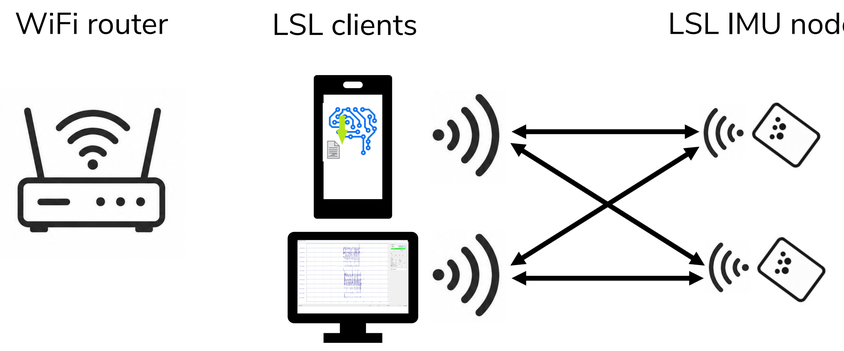
INTRODUCTION

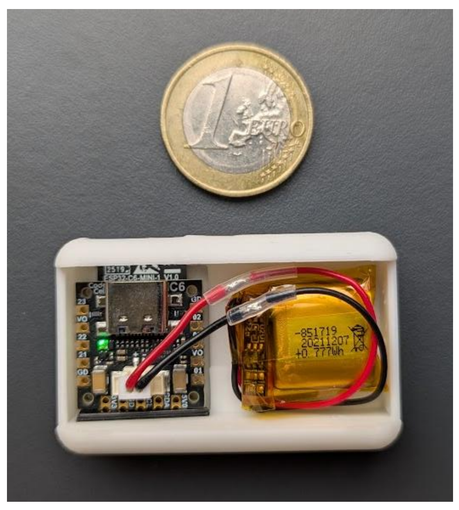
Multimodal studies require precise temporal synchronization across heterogeneous devices. Lab Streaming Layer (LSL) is a de facto standard for synchronized streaming. In low-cost sensor setups, microcontrollers are commonly connected via a host/bridge computer running liblsl, which introduces additional latency, complexity, and cost. We have developed a native LSL implementation running directly on a low-cost wireless sensor node. This eliminates the need for a host while preserving full compatibility with standard LSL clients.

Sensor nodes stream LSL directly

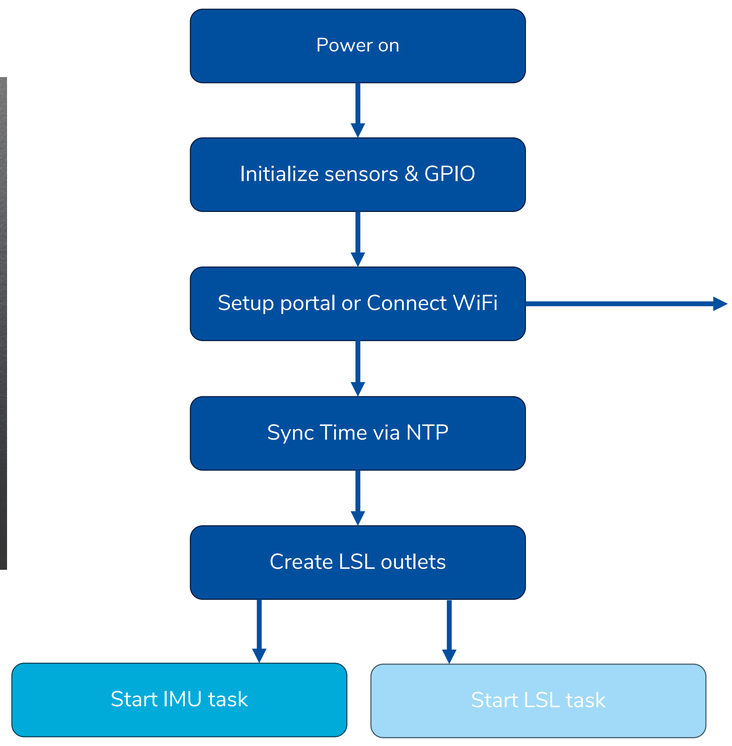


METHODS

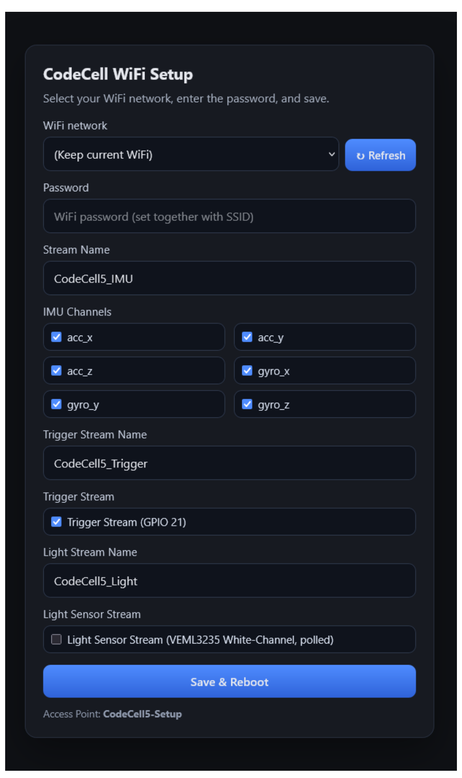
CodeCell C6 as hardware base



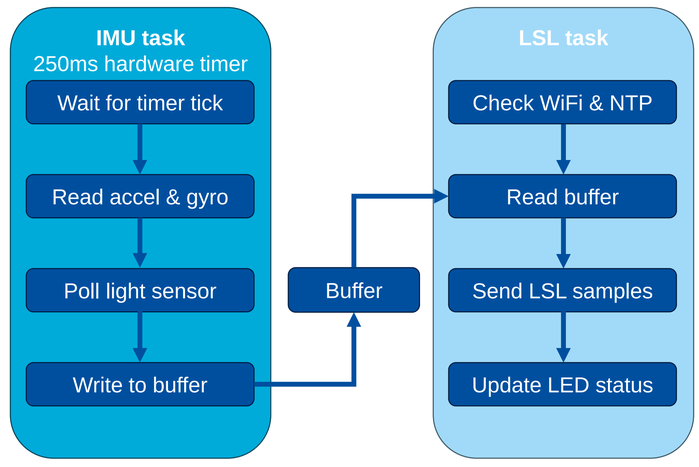
Program flowchart



Portal setup page

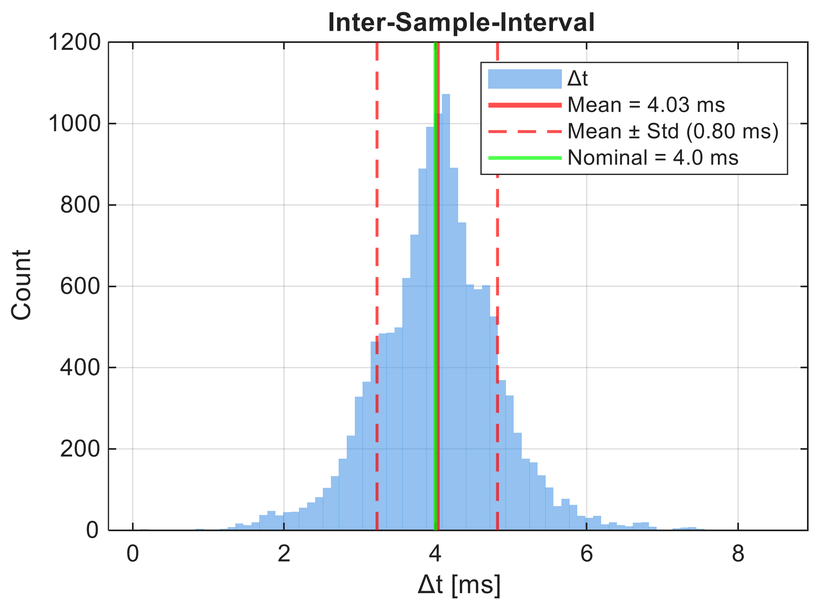


LSL connection flowchart



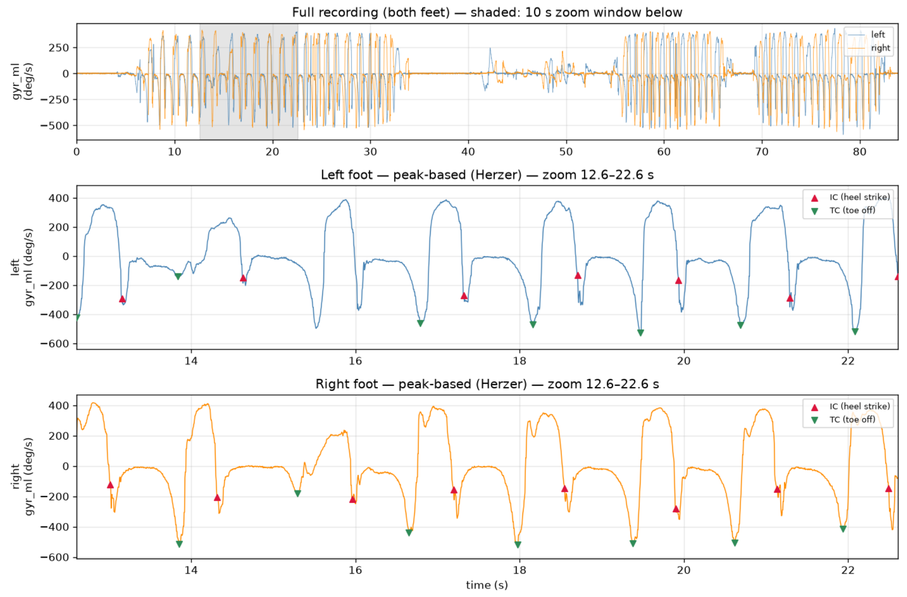
RESULTS

Jitter (0.8ms) and delay (0.03ms) over 60 sec.



Exemplary use of sensor nodes

Data acquisition with two IMU nodes



DISCUSSION

Summary

- reliable LSL discovery in standard client environments
- stable stream transmission at 250 Hz (acc/gyro)
- consistent timestamps suitable for multimodal synchronization
- Concurrent data acquisition from several nodes

Conclusion

- Native LSL on low-cost embedded hardware demonstrates that wireless microcontroller nodes can operate as first-class synchronized LSL publishers
- This enables practical, robust, and scalable mobile data acquisition pipelines for psychology and neuroscience

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Hardware base: https://github.com/microbotsio/CodeCell
LSL: Kothe et al. (2025). The Lab Streaming Layer for Synchronized Multimodal Recording. Imaging Neuroscience, 3, IMAG.a.136. https://doi.org/10.1162/IMAG.a.136
Two IMU setup: Küderle, et al. MobGap [Computer software]. https://doi.org/10.5281/zenodo.14035833
URL: https://github.com/mobilise-d/mobgap/

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