

Pool Deck Time Tracker



- Designed by Team C0 - Haowen Huang, Matthew Kwee, Jeffrey Liu
- Will help competitive swim teams gather insights into swimmers' performance via a wearable attached to each swimmer + central compute unit (FPGA)
- Seamlessly collects data about each swimmers' position, average/live speed, stroke rate
- Presented on live web dashboard for coach to manage swimmers more efficiently and for swimmers to view their performance over time.
- Coverage: **Signals** and Systems, Circuits, **Hardware** Systems, and **Software** Systems.

Use Case



- Many existing solutions use multiple cameras.
- However, not all teams have the budget or technical knowledge to use higher-tech solutions.
- We want a solution to **plug and play**, then **forget** about 99% of the time - low/no maintenance is critical
- Wristbands should be comfortable, easy to use, and non-intrusive on the swimmer

Use Case Requirements



- Wearable comfort: enclosure design must keep wrist pressure under 9 kPa, informing material and form-factor choice (thickness, weight, contact area)
- Concurrency: must support signal transmission from **up to 50 wearables** without data loss or unacceptable delay
- **3 hour minimum battery life** (based on typical swim session length)
- **1 second delay** from wearable to dashboard (Nielsen threshold for uninterrupted user experience)
- Time accurate to 100 ms (better than human with stopwatch)

Technical Challenges



- Device MUST be waterproof!
- Cannot transmit signals underwater...
- Power consumption!
- Concurrency risk
- Processing latency of FPGA
- Trade-off between comfort requirement signal requirement

Solution Approach



- **Wireless module:** low-power short-range module (e.g., BLE or nRF24L01) selected for fast connection setup, given brief above-water transmission windows
- **Buffer-and-sync design:** device logs data locally underwater, transmits in short bursts when wristband surfaces
- **Enclosure: plastic/polycarbonate housing** with silicone sealing: RF-transparent, waterproof, and lightweight enough to meet the 9 kPa comfort target

Solution Approach (cont)

- **FPGA to perform concurrent computation** of consistent, deterministic algorithms on high number of data streams, traditional CPU needs to switch between tasks, adding latency.
- **Collision handling: retry-based transmission** so momentary collisions don't result in permanent data loss.
- If necessary: **Multi-base-station layout** along pool deck to ensure full-range coverage and reduce number of devices contending for any single receiver at once.

Ethical Considerations



- Wearable safety: Enclosure material must be skin-safe.
- Data privacy: Swimmer performance data should be accessible only to coaches.
- Equitable access: As a low-cost alternative to expensive camera systems, the product helps close the resource gap for the average team.

Testing, Verification, and Metrics



- Range/reliability test: measure packet loss rate vs. distance in air, establishing baseline before underwater/enclosure testing
- Enclosure impact test: compare signal strength with and without candidate materials to quantify attenuation added by housing
- Concurrency test: simulate multiple simultaneous transmissions to measure packet loss and delay as device count scales toward 50
- Accuracy: Compare data from test swimming sessions (speed, location, stroke metrics) with data gathered from device
- Latency: Time delay between movement of device and update on live dashboard

Tasks and Division of Labor



Haowen - **Signals:**

- Material Selection
- Wireless Module Selection & Testing
- Range & Reliability Testing
- Multi-Base-Station Layout Planning

Jeffrey - **Hardware:**

- Finalize FPGA decisions/setup
- FPGA communication with wearable
- FPGA data pipeline
- FPGA export to Linux core/dashboard

Matthew - **Software:**

- Design and implement web app
- Plan/design PCB (if necessary)
- Assist manufacturing hardware devices
- Gather motion data for wearable device

Schedule

