Development of a Novel Distributed Wearable Sensor Platform

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Wearables

Are devices full of sensors that take the shape of normal clothing items

- Miniaturization of sensor technologies and increases in computational power
- Explosion in wearable technologies
- Development of devices for new applications
- Need for sensor exploration tools

*Projected increases in wearable markets by Statista*
Consumer Devices

Off the shelf devices, usually targeted towards health and fitness

**From Factor:** Small

**Complexity:** Intuitive and easy to use

**Cost:** Low

**Monolithic:** Single point of measurement

**Sensor Selection:** Limited

**Data Access:** Limited

**Features:** Limited

*The Polar chest strap, Apple Watch, and FWD Powershot 2*
Research Devices

Advanced instrumentation systems, targeted towards researchers

**Form Factor**: Often large and bulky

**Complexity**: Complex and hard to operate

**Cost**: High

**Monolithic**: Often a single large unit

**Sensor Selection**: High

**Data Access**: Access to unfiltered raw data

**Features**: Advanced features and analytics tools
Current Landscape

Cost

Features
Goals

An ideal system would aim to bridge the gap between the two extremes

Form Factor: Very small and wearable
Complexity: Intuitive and easy to use
Cost: Low
Distributed: Multiple units creating a body area network
Sensor Selection: High
Data Access: Access to unfiltered raw data
Features: Advanced features and analytics tools

The Apple Watch and BioRadio
Overview
Hardware

- Very small 13 x 18mm PCB footprint
- On board motion sensor
- Connector-less programming interface
- Green and red LED status indicator
- Analog node variant with two 12 bit ADC
- Output node variant with two digital output

Stages of hardware development of the node
Mechanical

- 3D printed enclosure
- Minimal form factor
- Magnetic docking station
- Versatile anchor points
- Modular connection modules

*Node and Hub enclosures designed in the Fusion360 CAD software*
Software

- Simple, easy to use GUI
- Real-time visualization
- Low latency, high throughput
- Bidirectional Bluetooth comm.
- Multi-camera synchronization
- Custom output node sequences
- Cloud integration

The Application’s Main Menu and Visualizer
Validation

- Application Validation
- Battery Life
- Physical Robustness
- Magnetic Connector
- Range
- Synchronization
- Data Loss
Experimental Setup
Node Positions

Three nodes attached to various body parts using the anchor points
Experiment: Analysis
Achievements

- Distributed
- Modular
- Extendable
- Small and lightweight
- Easy to setup and modify on the spot
- Raw sensor data
- Low latency, real-time communication
- Simple and intuitive
Challenges

- Bluetooth
- Range
- Battery

The inside of a node

Custom board used to program the nodes
Future Work

- Better Radio Protocol
- Increased Runtime
- Increased Range
- Additional Sensor Modules
- Conclusion