Wearable Tech: Where can it take us?

NOVEMBER 2017

Jono Neville

AUT SPORTS PERFORMANCE RESEARCH INSTITUTE NEW ZEALAND
Introduce self (Jono Neville) Background in Engineering and IT with transition to Sport Tech PhD

The Sports Technology Research Centre

Sits within SPRINZ

Combination of Engineering / Sports Science

Purpose to support other research streams by providing knowledge and assistance on all things technology in sport.
Core technology:
Low cost inertial measurement and GPS Unit
  Cricket bowling workload and intensity tracking
Isometric force measurement using wireless load cells
  Isometric midthigh pull
Effects of wearable resistance on sprint kinematics and kinetics
  Team went to Japan measuring 50m sprints
    Force plate, IMU, motion capture, radar, image / video
Development of a lightweight expandable material force mat.
Goal of this workshop

Identify current technology in primarily a S&C space
Will look at some tangential technology
Will be limited due to the sheer quantity of new products
It’s a workshop! So please I encourage you to raise questions, discuss and chip in

Today’s Goal

• Overview of research technologies
• Identify current wearable technology with focus on S&C applications
• Will look at some supporting technology trends

However:
• We will be limited due to the sheer quantity of new products
• It’s a workshop! Ask questions, discuss and contribute throughout
Overview

- Background
- Gold Standard Tech
- Introduction to Wearables
- Examples from research
- Gym wearables
- Sport specific wearables
- Possible future developments
Benefits
- Elite
- Sub-elite
- Public / social

Risks
- Drowning in data

Solutions
- Smarter sensors
- Automation and data mining
- Communication / understanding
Adapting technology from the research environment will have ideally already answered the question of what we are trying to answer. The approach will change from a research environment to a practical environment.
Best practice Measurements

- Motion capture systems
- Force plates
- Video analysis
- Linear position transducers (LPT)
Optimal fitting of silhouettes with 3D-model allows extraction of 3D joint positions and joint angles. Significant differences between the SiMi and marker tracking, especially during rotations.

**SiMi Validity**


Lack of peer reviewed publications on Kinetisense.
Force plates

Common Use

Vertical forceplates
  Jump assessment (squat, counter movement, drop, single leg)
  Isometric vertical strength tests

3D forceplates
  Gait
  Change of Direction

Practical applications of force plates

Gym settings
  Racks / Free weights
  Cable weights
LPT Validity to Video coded data

LPT Reliability


Perch is looking for strength and conditioning coaches, gyms, and athletes to demo our product. (still in beta trials) no publications on accuracy yet.
Wearable Technology (for sport)

- What is wearable technology
- Common (and not so common) sensors
- Gym specific wearables
- Sport specific wearables
- Trends in future wearable technology
What makes up wearable tech
   Computer system
   Communications
   Sensors
Limitations
   Processing speed
   Software
   Size / shape / weight
Impact on sport
Considerations

Design:
- Hardware is important (Speed, power)
- Software is important (OS, Apps)
- Interfaces are important (How do we use it?)
- Implementation is important (Meets needs of user?)

Application:
- Size
- Weight
- Design
- Battery life

Just a few of the smart watch options
Different systems range from 1->25 Hz

The Data

- Position
- Displacement
- Speed
- Acceleration

Algorithms to calculation

- Bouts of acceleration
- Velocity intensity thresholds
- Synchronize with video

GPS for personal or individual activities

- Garmin / Tomtom / Polar / Apple
- Smart phone apps
- Samsung Gear2
Heart Rate Sensors

- **Measurement Location**
  - Chest strap -> gold standard, most inconvenient to use.
  - Wrist -> smart watch.
  - Inner ear -> smart headphones.

- **Brands**
  - Polar – many options
  - Garmin – many options
  - Wahoo - chest sensor
  - Samsung Gear Icon X – in-ear wireless activity and heart rate

AUT SPORTS PERFORMANCE RESEARCH INSTITUTE NEW ZEALAND
XSense Accuracy

[1] Xsense has shown good flexion / extension measurements but decreased accuracy in the other two axes.
Accelrometers (example)
Gyroscope (example)
If you can measure it, you can improve it!

Outside the box applications:
If you can measure it, you can improve it!

Outside the box applications:

AUT SPORTS PERFORMANCE
RESEARCH INSTITUTE NEW ZEALAND
If you can measure it, you can improve it!
Outside the box applications:

Method
- Sample an athlete running at a range of speeds
- Model athlete running speed with step frequency
- Use model on continuous running data to estimate running speed

Benefits
- Light weight
- Small form factor
- Low power
- No external dependencies
Application Specific Wearables

- Gym wearables
- Sport specific wearables
Huge range of research projects on IMU in specific sport / gym activities. A few of these (if in enough demand) make their way into the commercial space.

Beast, full imu, design for athletes and coaches, max 50Hz
Beast Valid for low intensity squats but not high intensity or bench press against LPT

No known validation papers on Moov

Cricket is a brand new product that allows for electro-muscle measurement and has won several early business awards and featured on TED ideas worth sharing blog.

**Beast**
Push Validity to Motion Capture

Gym Specific Wearables

- Garmin Vivosmart ($200 NZD)
- Atlas – machine learning, strength training ($200 NZD)
- Jabra elite sport – headphones with heartrate ($400 NZD)
- Moxy Muscle Oxygen Tracker (different approach, using muscle oxygenation via light pulse oximetry, more research focused) ($1300 USD)
- Skulpt – Body fat percentage measurement – hold the device on specific muscle locations to measure body composition. ($100 USD)
X2 Biosystems—massive acceleration and angular acceleration over-estimates due to sensor—skin coupling

A review by Patton, and a systematic review by O’Connor have shown these systems to have limited utility due to error rates, designs, and low specificity in predicting concussive injury.

Validity of X2 Biosystems concussion monitoring

A review of a wide range of concussion measuring wearable sensors.

**Tennis Babolat POP Validity**

Wearable Technology Trends
Superflex is a compression exoskeleton suite designed by SRI International. Potential for eccentric load training in the field, during dynamic activities, game simulations. Adapts to movement patterns with the potential to target specific lower limb and back movements.
Superflex is a compression exoskeleton suite designed by SRI International. Potential for eccentric load training in the field, during dynamic activities, game simulations. Adapts to movement patterns with the potential to target specific lower limb and back movements.