SMARTLIFE

Insight to live better, every day

E-Textiles for Healthy Ageing

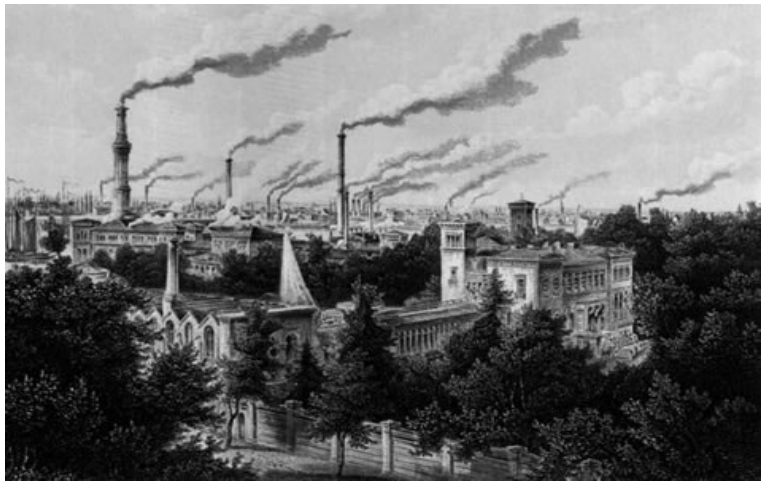
smartlifeinc.com

E-Textiles for Healthy Ageing

14th February 2019, Manchester Metropolitan University

- OVERVIEW - Smartlife and our involvement with textiles sensors and garment wearables
- Show you a bunch of cool stuff

OUR BUSINESS – WHY MANCHESTER?



- **Smartlife is a new generation in wearable technology.**
- We were founded in Manchester, home of textiles, and in 2019 it's the home of the new textile revolution - advanced textiles
- Now we focus on market driven applications (currently high intensity sports), talking to companies about exciting, challenging opportunities and even considering the 'it's impossible to do' ideas - then adapt and develop our tech to fit.
- Smartlife has invested heavily in Innovation and our technology is protected by 36 patents (25 granted, 11 pending) with further patent applications in the pipeline.
- Key is working use-cases alongside companies to ensure they have as much ownership of the developments as we are – that makes for easier & more profitable collaborations

OUR BUSINESS - INNOVATION

- **What it takes to do what we do… it takes smart people to make smart products and we make smart garments**
- Innovative textile sensors and electronics which can be integrated into any close-fitting garment and are capable of detecting the body's biophysical signals (e.g. ECG, EMG, respiration), and mechanical forces on the body.
- Innovate with smart materials measuring clinical quality outcomes such as HR which are derived from a full clinical ECG; Breathing from a ambulatory respiratory sensor measuring both EDR and IP inputs; contextualizing those outcomes using accelerometers and gyrometers to understand where, when, why and importantly.. 'so what'
- Smartlife has development in the Sport, Military, Health, and Medical markets.

The key to meaningful data is validation

INSIGHT

to live better

EVERY DAY

- A garment wearable needs to Recognise, Control and Understand motion artefact and drive that to create the ideal garment for each application
- Universities partnerships - testing & validating our garments and data e.g. St Mary's, Salford, Kent, University of Manchester – all of whom are working to validate the quality and quantity of data to make it useful
- Usefulness for SL is actionable insights. Smartlife has a stand alone Insights program shared with customers / licensees so that they can be specific with their customers about the methods and benefits of adoption
- Our garments are comfortable to wear, discreet to wear, inexpensive to produce, and provide accurate data - it's around those deliverables where we believe the future is for our technology licensees and their customers.

OUR TECHNOLOGY
and some cool stuff

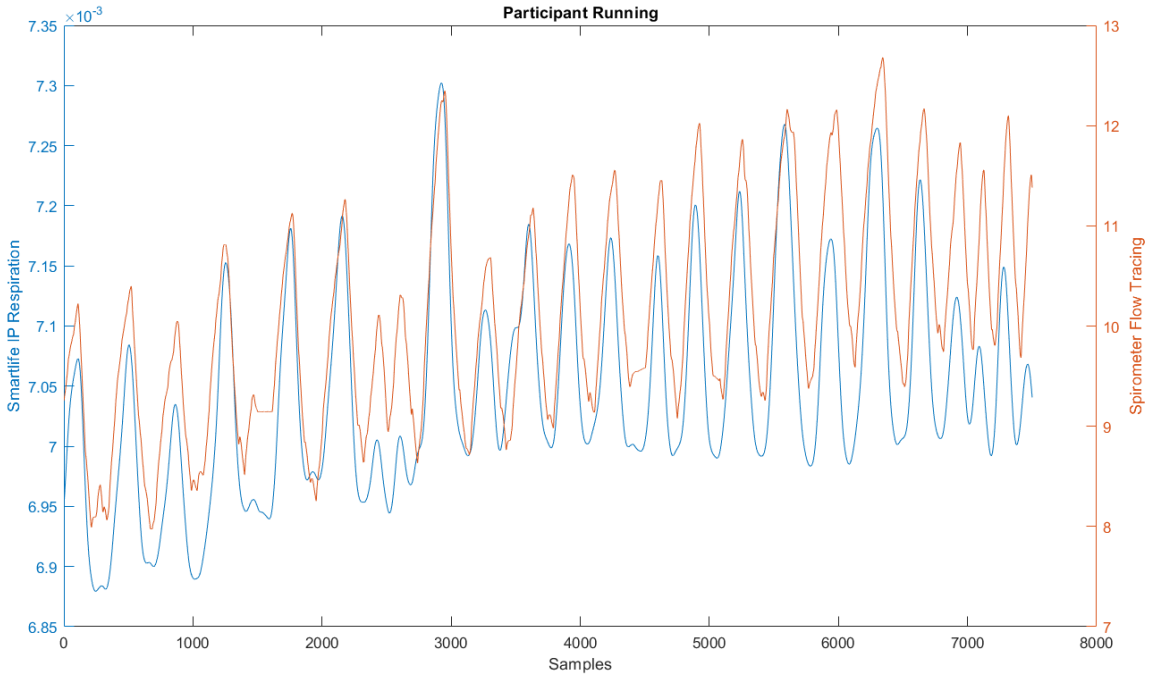
SENSING CAPABILITIES

	GARMENT	BRAIN	RECEIVING DEVICE
			
SENSORS	SoftSensor™	Accelerometer Gyroscope	GPS Altimeter
CABABILITIES	Electrocardiography Impedance Pneumography Electromyography Resistance Measurement	Acceleration Orientation Rotation	Latitude Longitude Altitude
EXAMPLE OUTPUTS	Heart Rate & Heart Rate Variability Breathing Rate & Breathing State Muscle Activation Strain	Activity Index Gait Parameters	Location Speed/Pace Distance Elevation

NB Further biophysical capabilities (e.g. temperature, sweat analysis) can be added by integrating additional sensor components with the existing Smartlife system

BREATHING FREQUENCY VALIDATION

Smartlife vs Spirometer Breathing Signal

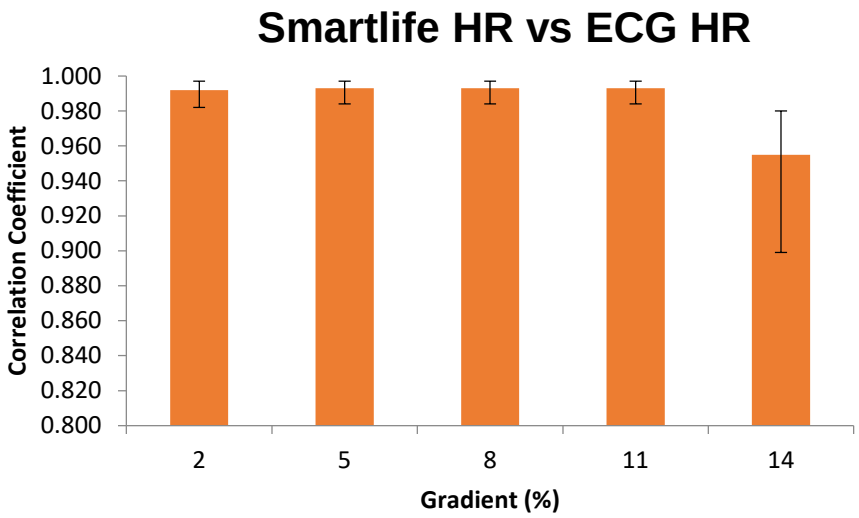


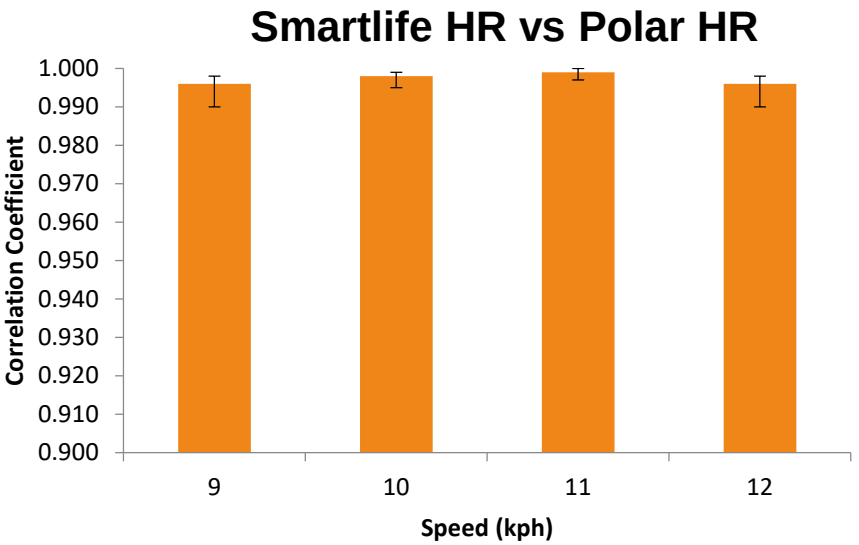
Smartlife's breathing frequency validation study is currently in progress.

The study is comparing outputs from Smartlife's breathing signal, measured using impedance pneumography, with the flow trace from a spirometer and lung volume measured using optoelectronic plethysmography.

The image shows Smartlife's impedance pneumography signal overlaid with the flow trace from a spirometer during high intensity and high impact exercise (treadmill running).

HEART RATE VALIDATION





Smartlife's validation study in May 2018 proved that our technology provides an accurate measure of HR during exercise. Smartlife HR strongly correlated with ECG HR (r >.95) and Polar HR (r >.95) during graded walking and running, respectively.

Twenty-five healthy adults (18 males, 7 females) who were accustomed to regular (>=75 mins/wk) vigorous exercise. Mean ± SD for age, height, body mass, and body mass index were: 27 ± 8 years, 80.3 ± 18.6 kg and 1.75 ± 0.8 m, respectively.

Test 1: Smartlife vs ECG[1] Incremental walking protocol (6kph) whereby the gradient was increased by 3% at 3 minute intervals to a maximum of 14% (5 stages). HR manually recorded from the Smartlife app on a smartphone and ECG[1] exactly 10 seconds before the end of each stage.

Test 2: Smartlife vs Polar[2] Incremental running protocol consisting of 4 x 3-minute stages at 9, 10, 11 and 12 kph. HR from each device was manually recorded from the Smartlife and Polar[2] apps on separate smartphones exactly 10 seconds before the completion of each stage.

Pearson correlation coefficients (r) and standard error of estimates (SEE) were calculated to determine the validity of Smartlife. Previous HR devices have been considered valid if the correlation coefficient between the criterion instrument and HR device was ≥0.90, with a corresponding SEE ≤5 b·min– 1 (Leger & Thivierge, 1988).

1) Vyntus ECG, JAEGER, Würzburg, Germany
2) Polar H7, Polar Electro Oy, Kempele, Finland

INSIGHT DEFINITIONS – HEALTHY AGEING

Insight	Definition	Action
Activity Intensity	An indication of how hard the body is working during an activity. In sport this is indicative of the resulting training effect of the activity.	Adjust effort to reach desired training effect.
Energy Expenditure	An estimate of the energy demands of an activity. Energy balance is the net result of energy intake (food) minus energy expenditure.	Increase or decrease food intake or adjust intensity / duration of activity.
Cardio Health	Ability of the CV system to supply oxygen to the muscles. Related to athletic performance and risk of cardiovascular disease or stroke.	Implement programme of activity to improve heart health.
Stress / Fatigue	Level of strain resulting from demanding mental or physical activity and how ready the body is to cope with ongoing demands.	Assess risk of continuing with a planned activity.
Body Load	A measure of the cumulative amount of stress on the body due to physical activity. Good predictor of injury and illness.	Adapt workload to maximise productivity while minimising injury.
Dysfunctional Breathing	Identification of dysfunctional breathing patterns which inhibit performance/ability by reducing airflow and limiting oxygen supply.	Learn techniques to breathe more efficiently.
Gait Analysis	Identification of gait or muscular firing patterns that are inefficient or indicative of poor techniques that could lead to injury.	Gait re-training to improve efficiency and reduce injury risk.
Fall / Impact Detection	Detection of an event such as a hard impact to the body or a fall.	Alert coach / supervisor / carer.
Arrhythmia Detection	Detection of an irregular heart beat which can increase risk of stroke.	Prescribe full medical ECG check.
Sleep Quality	Estimate of how much restful sleep the body has had. Recovery is critical for physical health, cognitive function, and athletic performance.	Prescribe interventions that might improve sleep quality.

INSIGHT CAPABILITIES

CARDIO (ECG)

- Real Time Heart Rate (HR)
- Resting & Max HR
- HR Recovery
- Orthostatic HR
- Heart Rate Variability (HRV)

cardio age

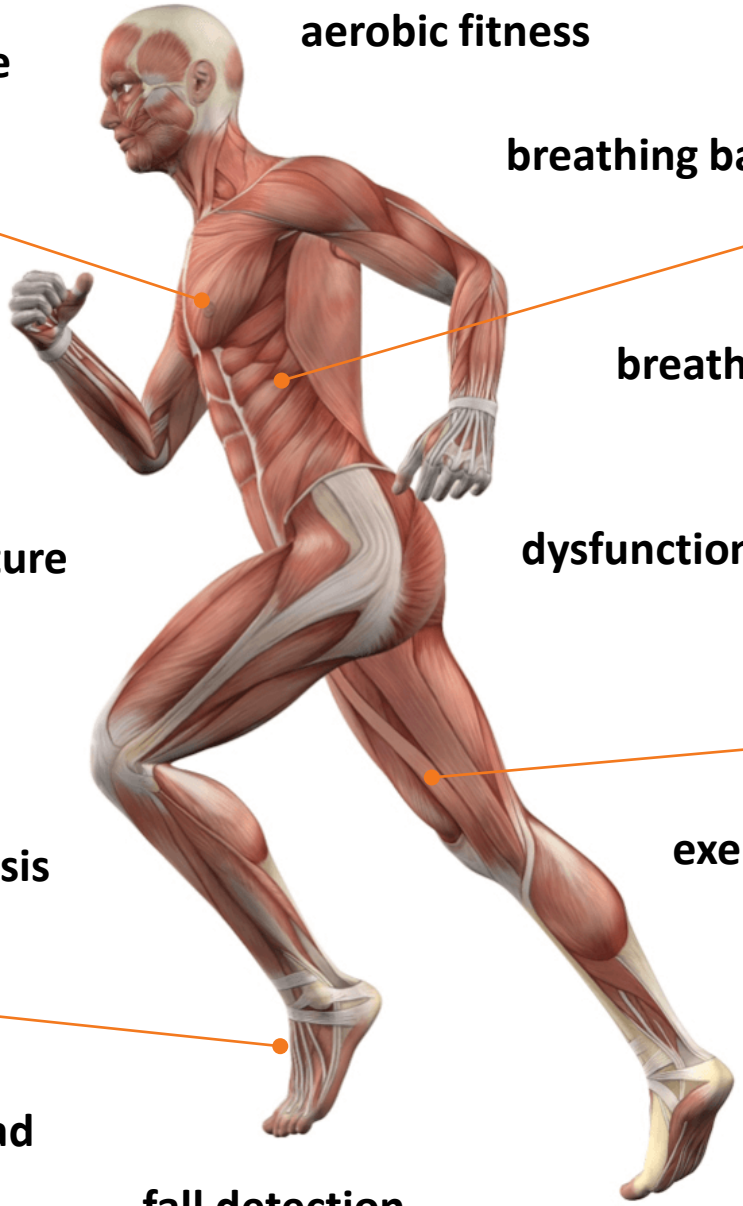
aerobic fitness

fatigue

exercise intensity

energy expenditure

running economy



RESPIRATION (THORACIC IMPEDANCE)

- Breathing State (in/out/held)
- Breathing Frequency (BF)
- Tidal Volume
- Minute Ventilation
- Ventilatory Threshold
- VO2 Max

breathing balance

breathing rhythm

dysfunctional breathing

MUSCULAR (sEMG)

- Real Time Muscle Activation
- Muscle Contribution
- Muscle Symmetry

exercise form

MOVEMENT (ACCELERATION)

- Steps
- Cadence
- Stride Length
- Ground Contact Time
- Vertical Oscillation
- Speed
- Activity Index

gait analysis

training load

fall detection

OTHER (CLIENT-DRIVEN)

- *Location Tracking*
- *Strain*
- *Temperature*
- *Blood Pressure*

Capabilities displayed are sports-focused but can be adapted to multiple verticals

SPORTS GARMENTS

SPORTS BRA

SEAMLESS T

COMPRESSION T

CHEST STRAP

Our smart garments are:

manufactured with integrated soft sensors

wire-free with no metal fastenings for electronics

machine washable like any other sports clothing

made from technical, wicking fabrics

designed by leading garment technologists

configurable to meet bespoke design requirements

*NB Smartlife's sensors and electronics can be integrated into **any** close fitting clothing*

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THANK YOU