E-Textiles for Healthy Ageing
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Classification and assessment of movements from inertial sensors.

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Classification and assessment of movements from inertial sensors.

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We consider how to collect movement data away from the laboratory, in particular for healthcare and agricultural applications. The concept can extend to many activities of daily life.

The talk will discuss why *n* sensors are better than 1 (where *n* might be approximately the number of major limbs we have). Given a multiple sensor system we introduce new complications that, if resolved, can give a much clearer insight into the activities we do as well as quantify useful metrics such as step counts, levels of sway, poor postures etc.

SPHeRE

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- SPHeRE a Sensor Platform for Healthcare in a Residential Environment
- Led by the University of Bristol
- Goal: to record data relevant to healthcare from 100 homes in the Bristol area
- Funded by the EPSRC for the period 2013-2018

EPSRC Engineering and Physical Sciences Research Council

University of BRISTOL

IBM

Bristol City Council

University of Southampton

University of Reading

TOSHIBA Leading Innovation

KWMC Knowle West Media Centre

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SPHERE research project

- SPHERE - Sensor Platform for Healthcare in a Residential Environment.

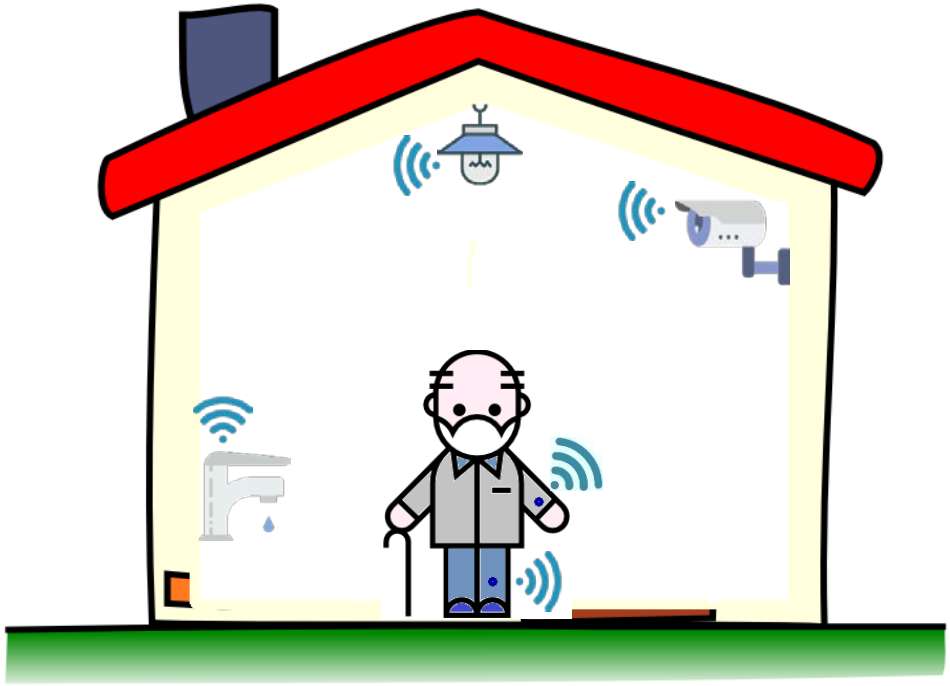
aims:

1. Deploy, collect and analyse data from a range of sensors in a 100 residential homes in the Bristol area.
2. Consider the data analysis and data mining techniques that can be employed to enable this data to be used by the individual, their carers, and researchers to monitor healthcare related problems.

SPHERE research project

The project is nonspecific but healthcare issues range from COPD (chronic obstructive pulmonary disease), Recovery following orthopaedic surgery, Parkinson's disease, stroke, frailty,

Could be extend to depression, sleep disorders, and obesity



Sphere wearable

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- Self contained
- Qi inductive charging
- Time between recharge 3 days to 6 months
- local storage or transmit to house via bluetooth low energy (BLE)
- 3-axis accelerometer and gyroscope

The end of the world

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Devils Pool

Victoria Falls

(credits devilspool.net)

The accelerometer's view

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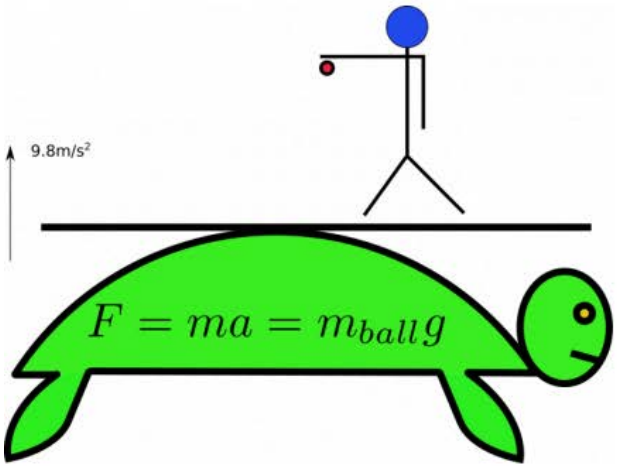
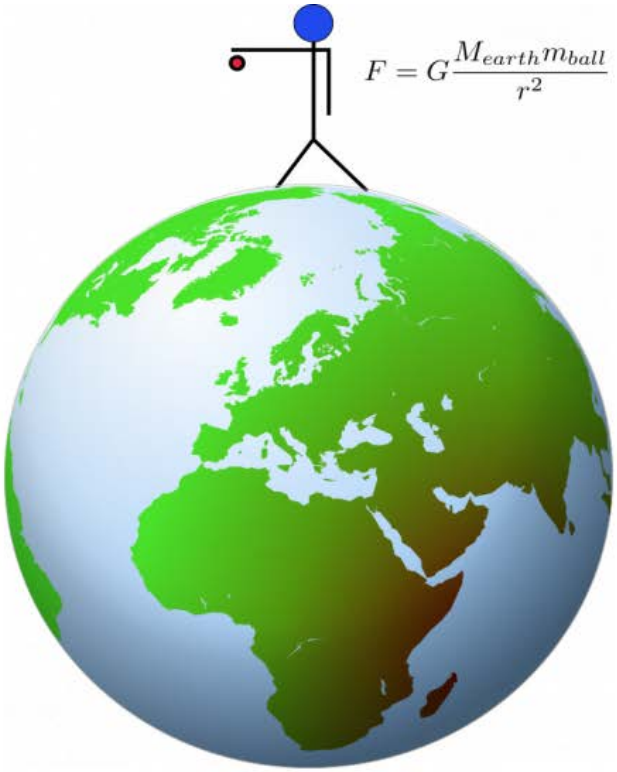


The turtle catches up with the ball.

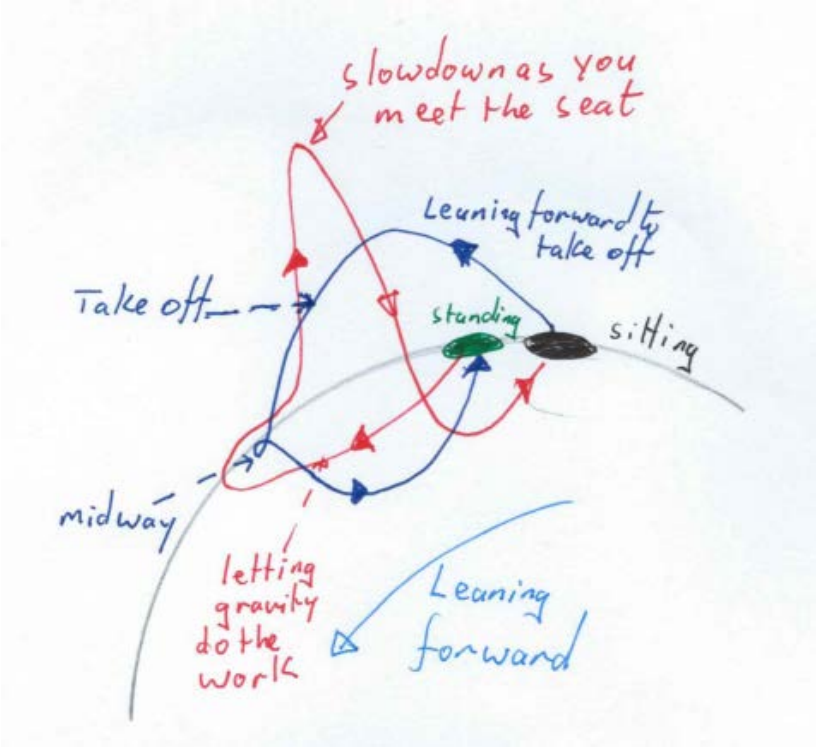


Gravity pulls the ball towards the ground

$$F = m_{ball}g = G\frac{m_{ball}M_{earth}}{r^2}$$

https://tinyurl.com/GravityStory

Sit to stand on a sphere: acceleration at the waist



- Orientation of the sensor when it is not moving is a point on a sphere
- Movement needs to be either above or below the surface of a sphere

Sit to stand on a sphere, healthy

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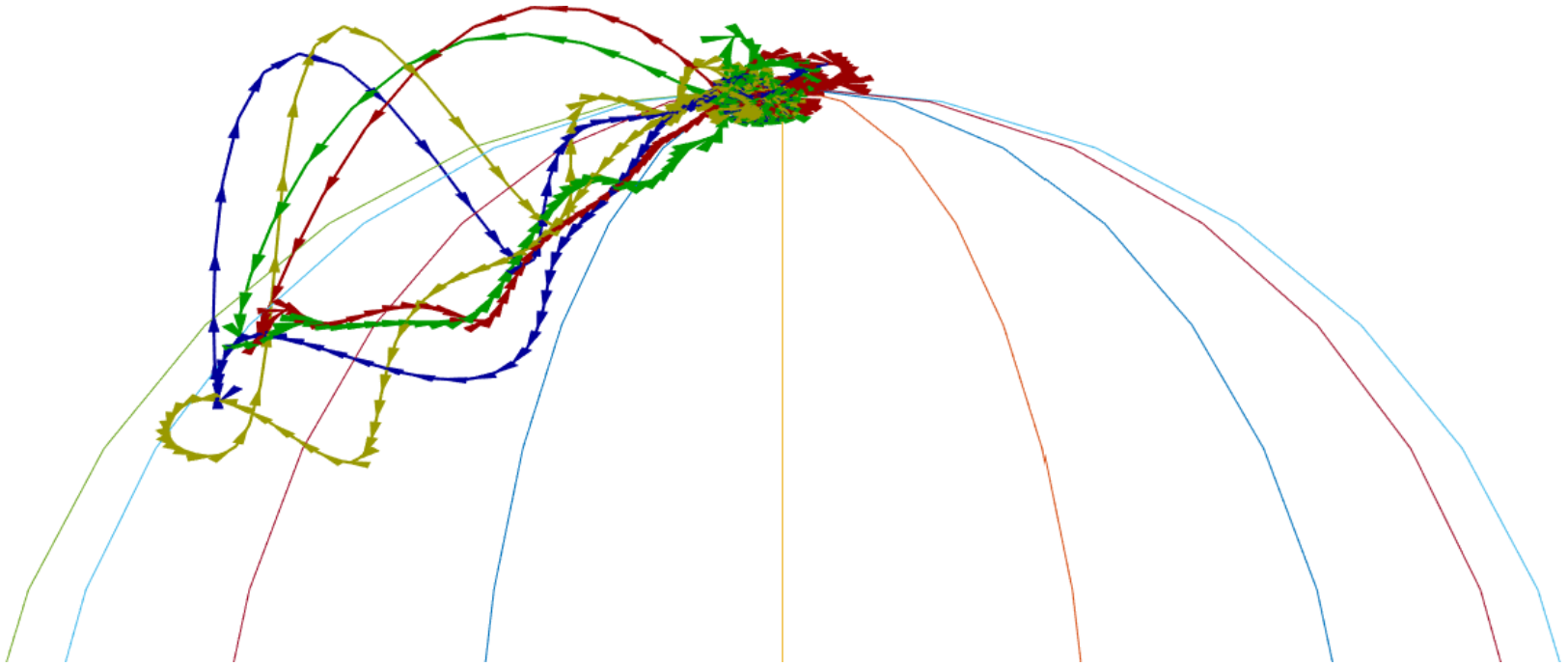

Sit to stand, Parkinson's disease

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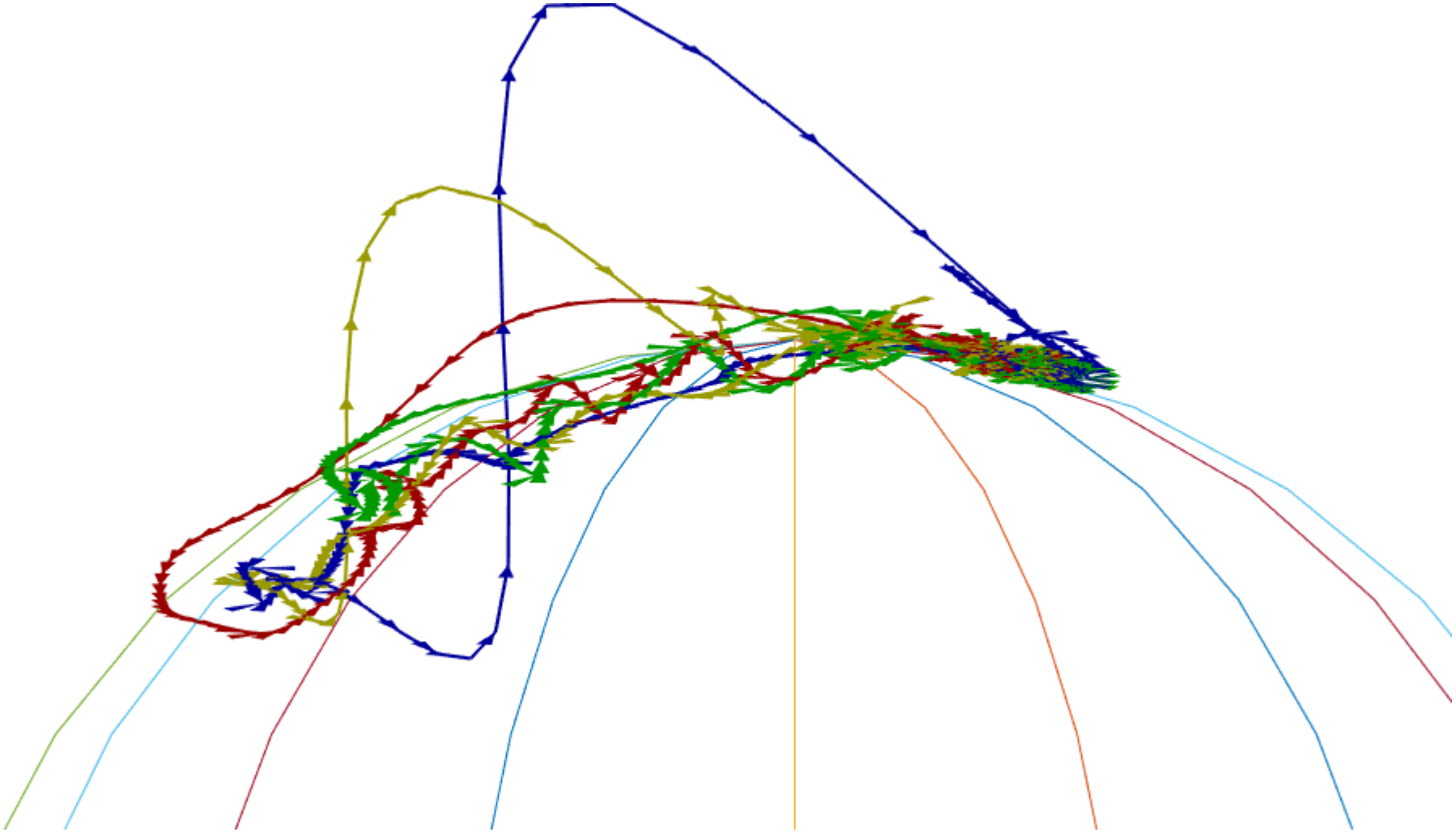

More sensors are better: Inferring the thigh angle

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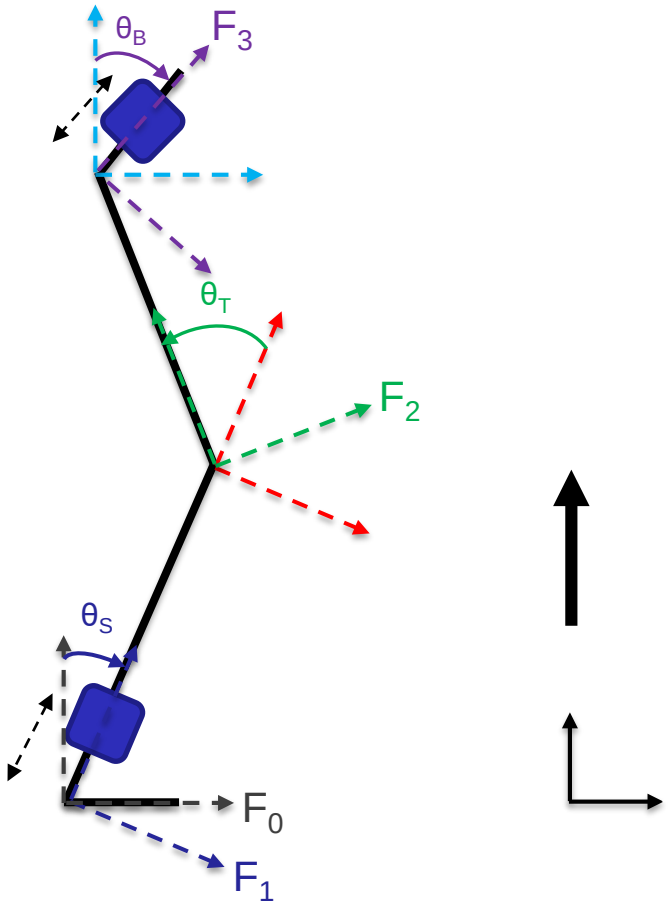

Example: Estimation of Trunk Kinematics using EKF

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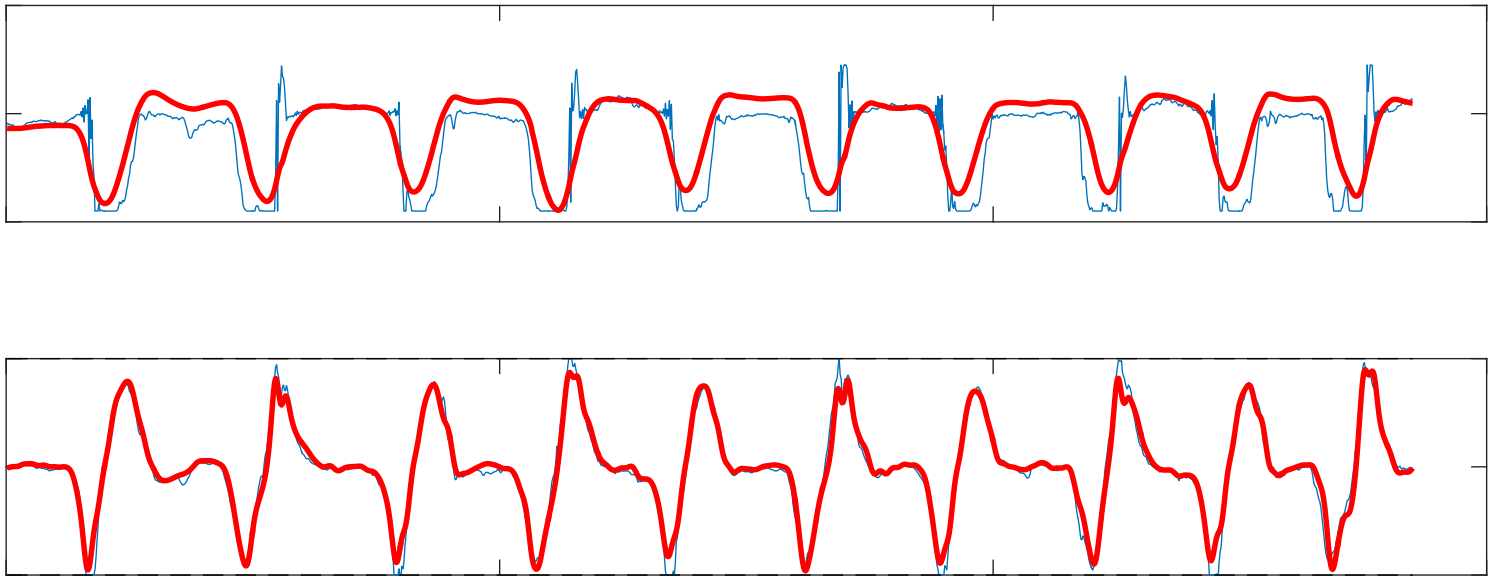

Sitting posture is best inferred using an accelerometer located on the thigh

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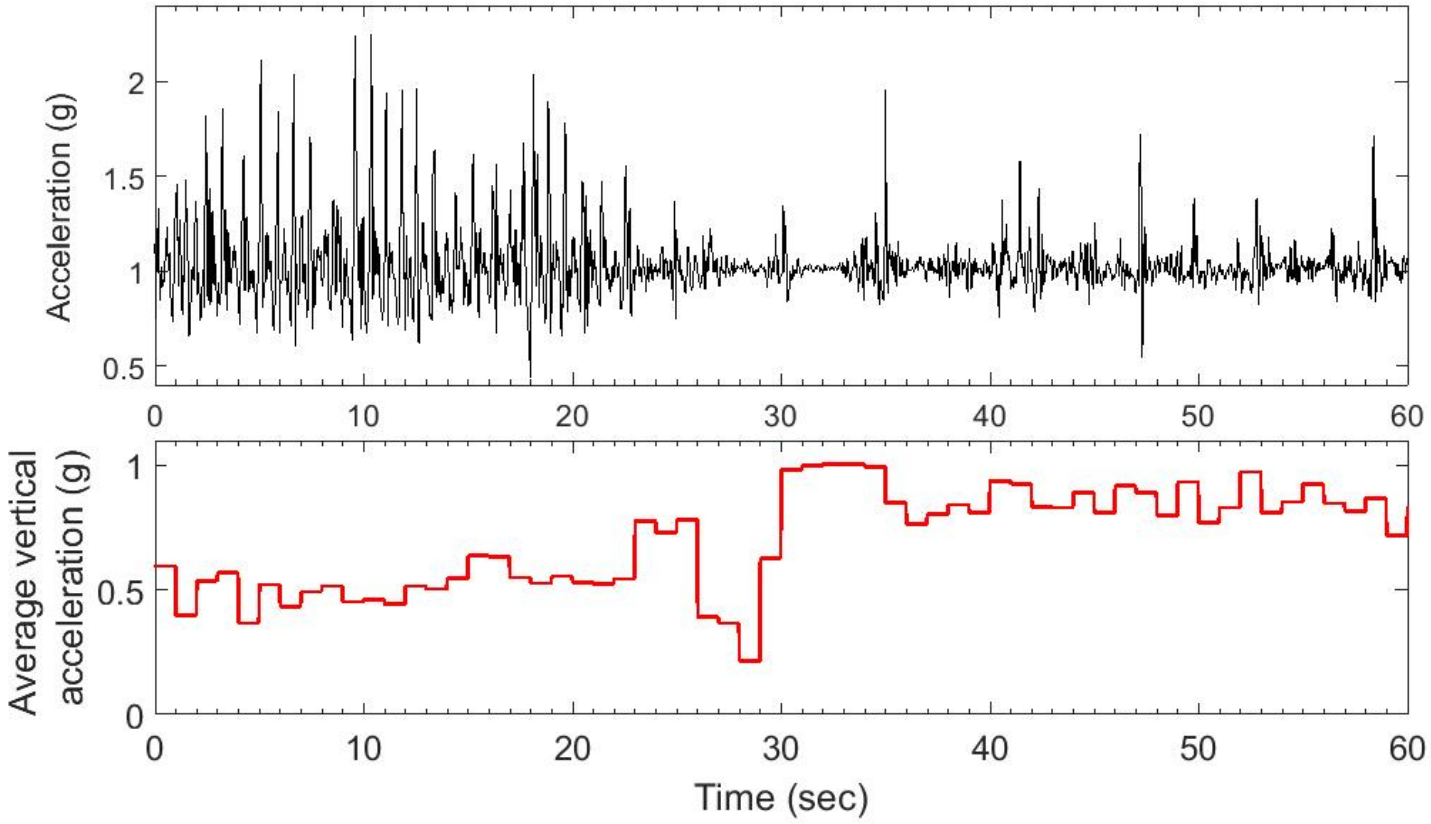
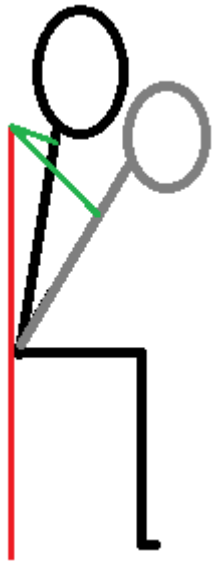
Sit to stand and stand to sit are more dynamic, and idealised 2D

- In practice young people and healthy adults turn and sit
- In Parkinson's disease stand to sit may transition between pseudo static and falling into chair

Rough estimation of inclination from the waist using 1st component of the transformed acceleration (Ghana farmer data)





Likely effect of clothes on posture classification.

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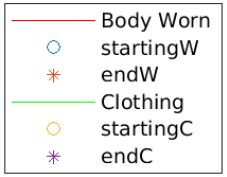

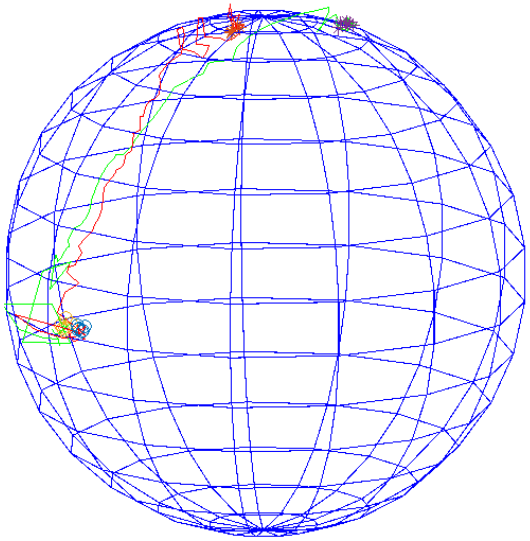

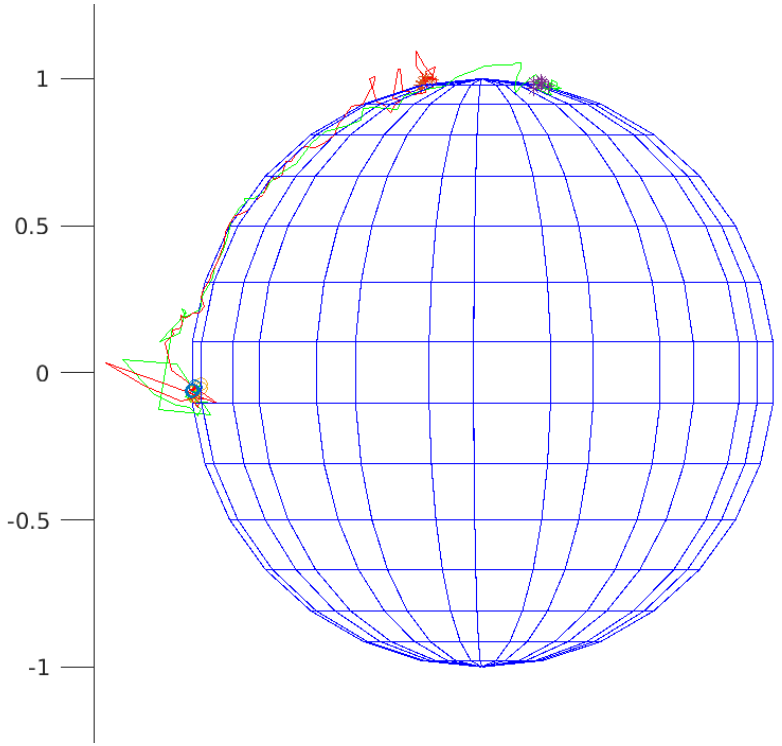

Sensors in clothing

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Inertial measurements and their use in healthcare

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1. Separate worn sensors need time and orientation calibration – much simpler if they can be put into the clothes.
2. More sensors are better, typically sampled at 30-50 Hz
3. Sitting is best inferred using an accelerometer located on the thigh
4. Locate the direction of `up' and the Sagittal plane
5. Disparate sensors need to be time synchronised
6. Sensors need low power management.
7. Data management needed on both sensor and cloud.
8. Sensor needs facilities to transmit and log data
9. Energy available via harvesting insufficient to provide data transition at an acceptable bandwidth.

Conclusion

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Posture based classification of activities of daily life provides a simpler yet useful way of accessing nature and quantity of movement

Increasing the number of sensors improves specificity of the classified posture and may allow identification of the activity

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