Interaction Design Case Study - 2

Tweeting Bottles and other stories

Outcomes of Case Study - 1

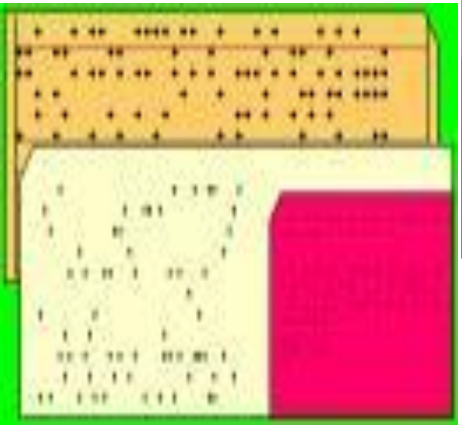
Literal and Stylised Representations

- Focal and Peripheral attention
- Detailed and Abstracted representations
- Intended audience: technical / non-technical

Outcomes of Case Study - 2

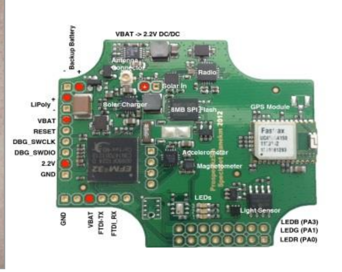
- Primary site of interaction: Virtual or Physical world
- Nature of Interaction: explicit or oblivious to the user
- Personal v/s Social v/s Public

I/O devices



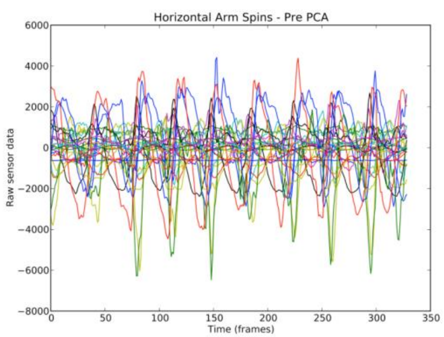


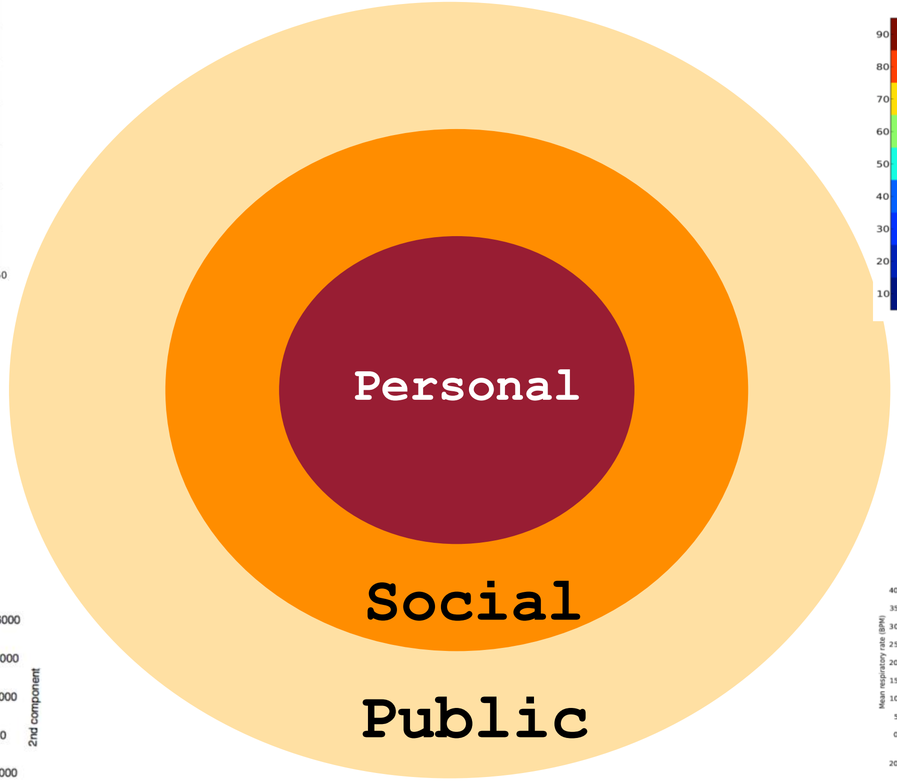


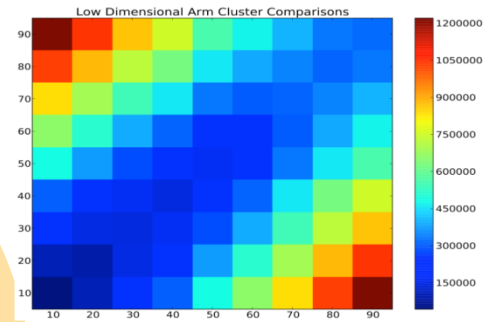



Integration of Computation, Communication and Control to provide time-bounded decisions and actions

Sense – Learn -- Act

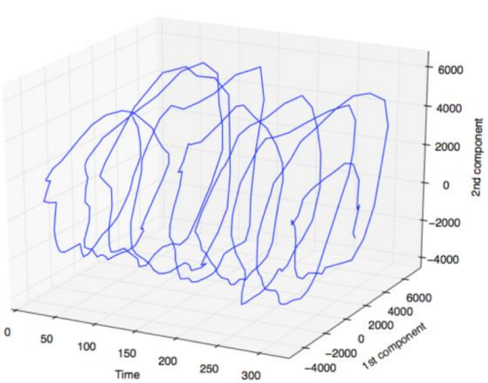


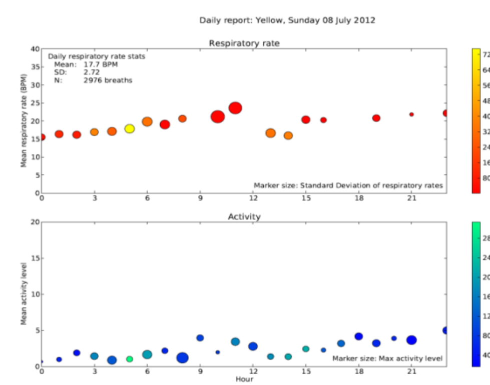




Computation

"Intelligence"





Communication

Speckled Computing

Tweeting Bottles

- Category : Consumer
- Requirements: Recognise predefined actions such as pouring, squeezing and shaking when using consumer products
- Users: Consumer behaviour analysts; Enhance user experience
- Sensors: 3-D Accelerometer
- Actuators: None
- Data Analysis: Clustering techniques to identify pouring, shaking and squeezing.
- Wireless protocol: 2.4GHz Bluetooth 4.0 radio

Sensing Daily Rituals

How do consumers use FMCG products?

Current methods

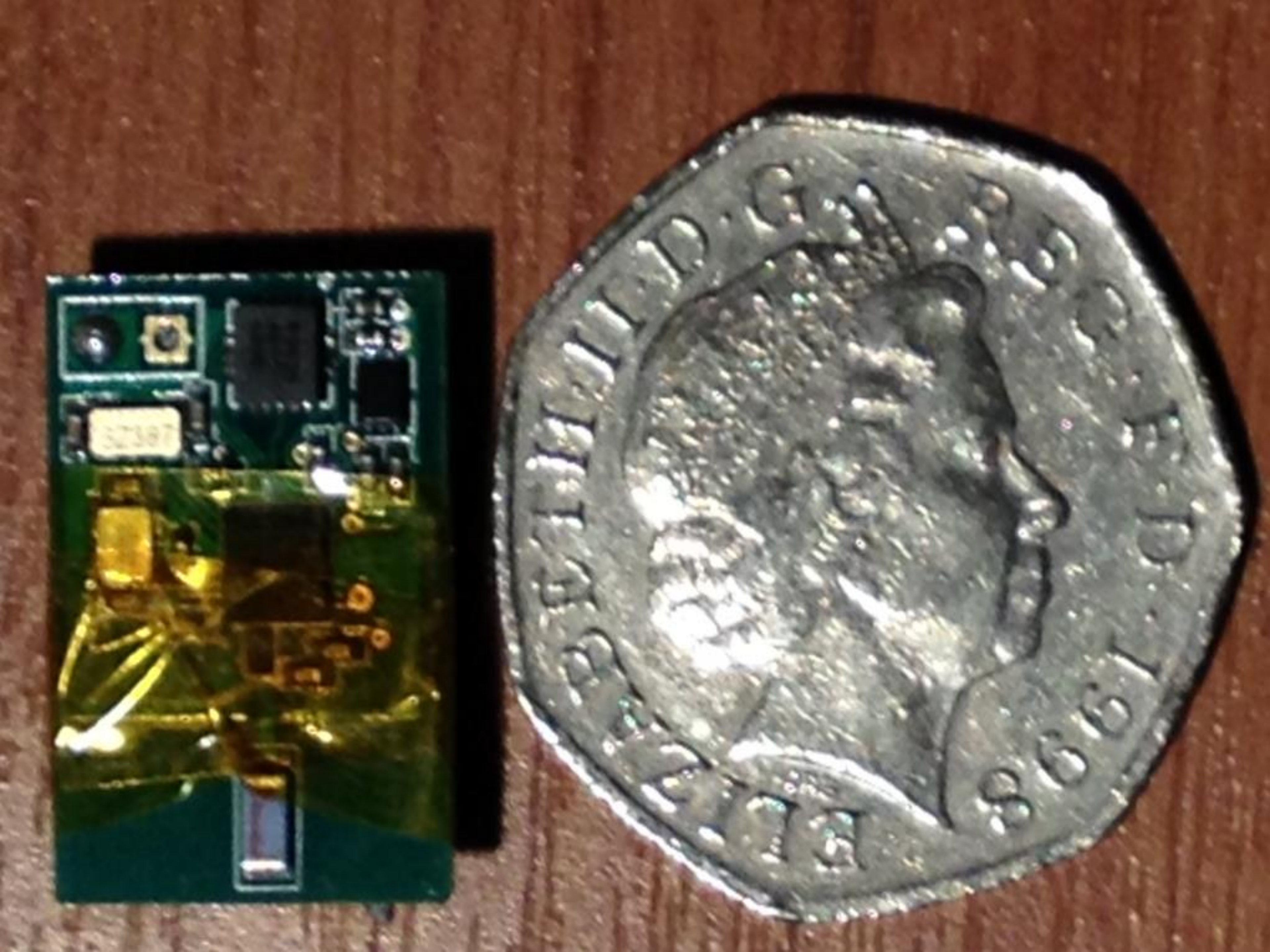
- Interviews
- Diaries
- Questionnaires

Advantages

- Low-tech

Disadvantages

- Error-prone, Inaccurate, Intrusive, Overhead, Unreliable (noisy data)
- Time-consuming - what's in it for the consumer?


1998

Tweeting bottles

Sensors recognise usage of FMCG products

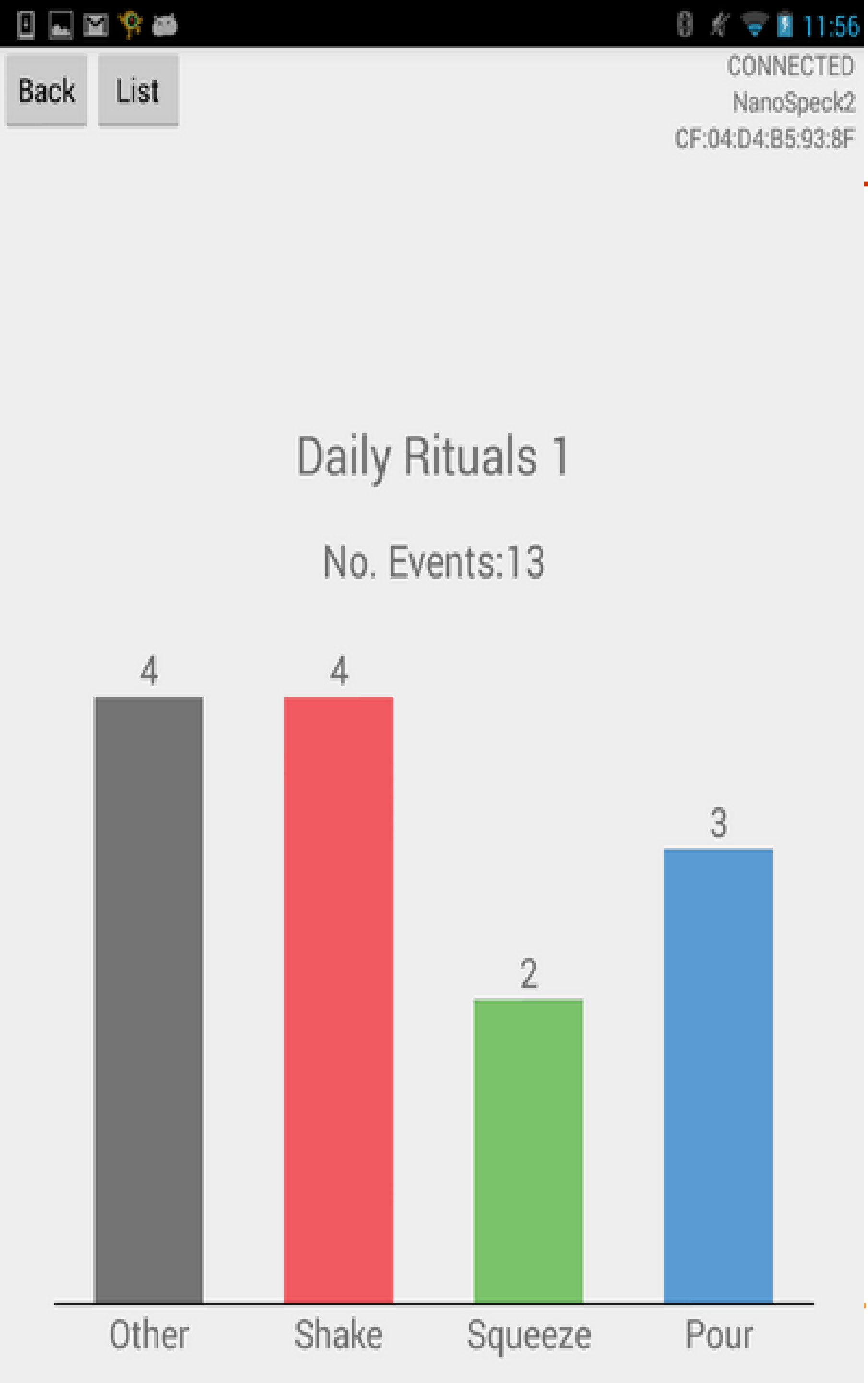
No change in consumer behaviour

- Customer oblivious to data collection
- Data transmitted automatically to server

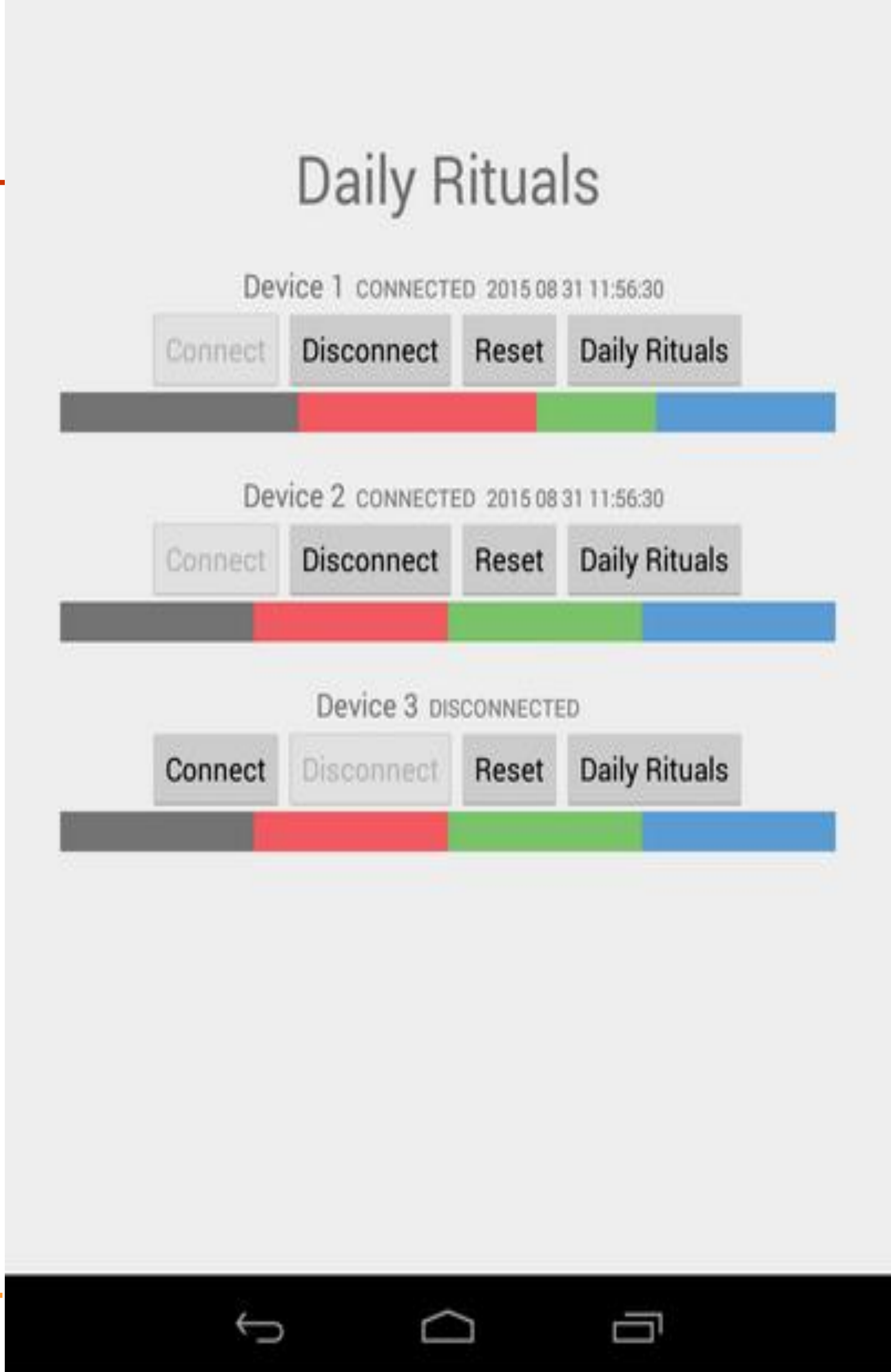
Data Analytics extracts actionable information

- Times and Frequency of usage
- Usage patterns (diurnal, monthly, annual)

Make informed Business and Design decisions



Back
List
CONNECTED
NanoSpeck2
CF:04:D4:B5:93:8F
Daily Rituals 1
No. Events:13
4
4
2
3
Other
Shake
Squeeze
Pour



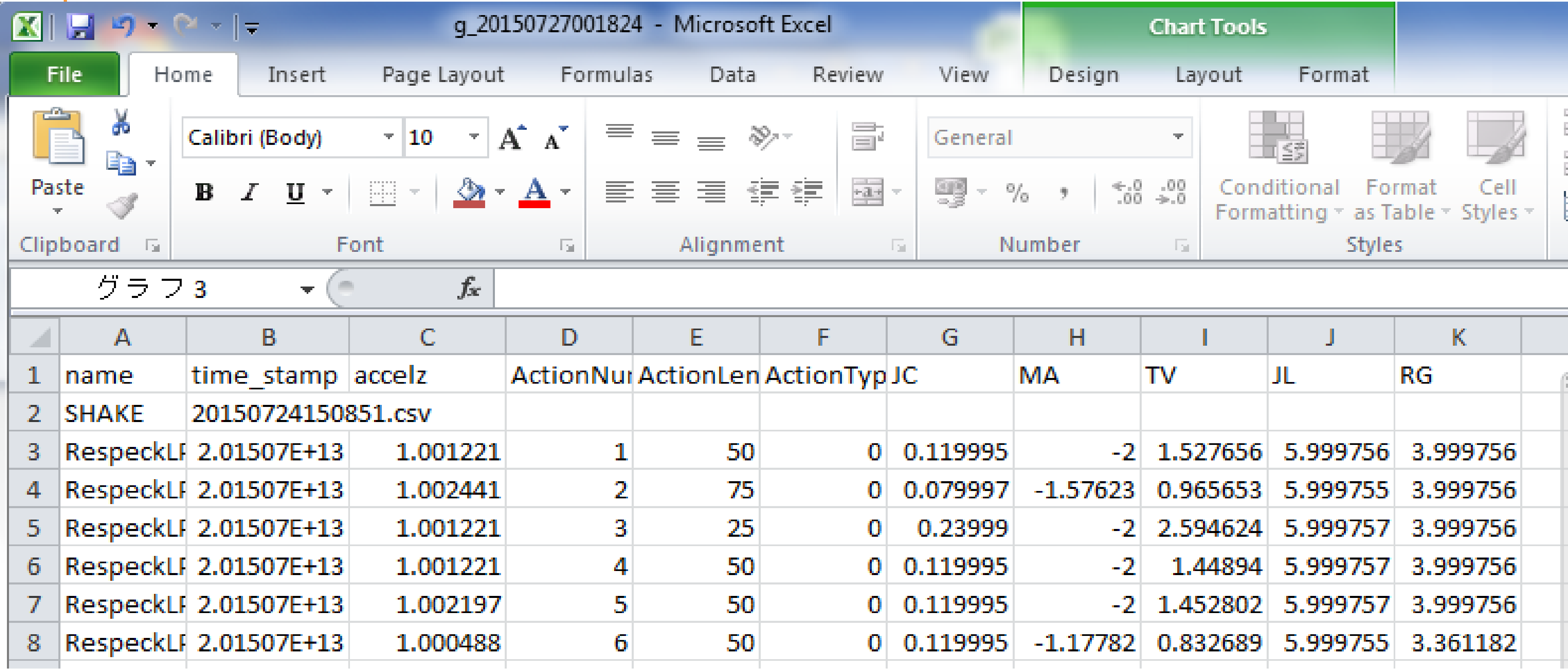
Daily Rituals
Device 1 CONNECTED 2015 08 31 11:56:30
Connect
Disconnect
Reset
Daily Rituals
Device 2 CONNECTED 2015 08 31 11:56:30
Connect
Disconnect
Reset
Daily Rituals
Device 3 DISCONNECTED
Connect
Disconnect
Reset
Daily Rituals

Events

- Pouring
- Squeezing
- Shaking

Phone App

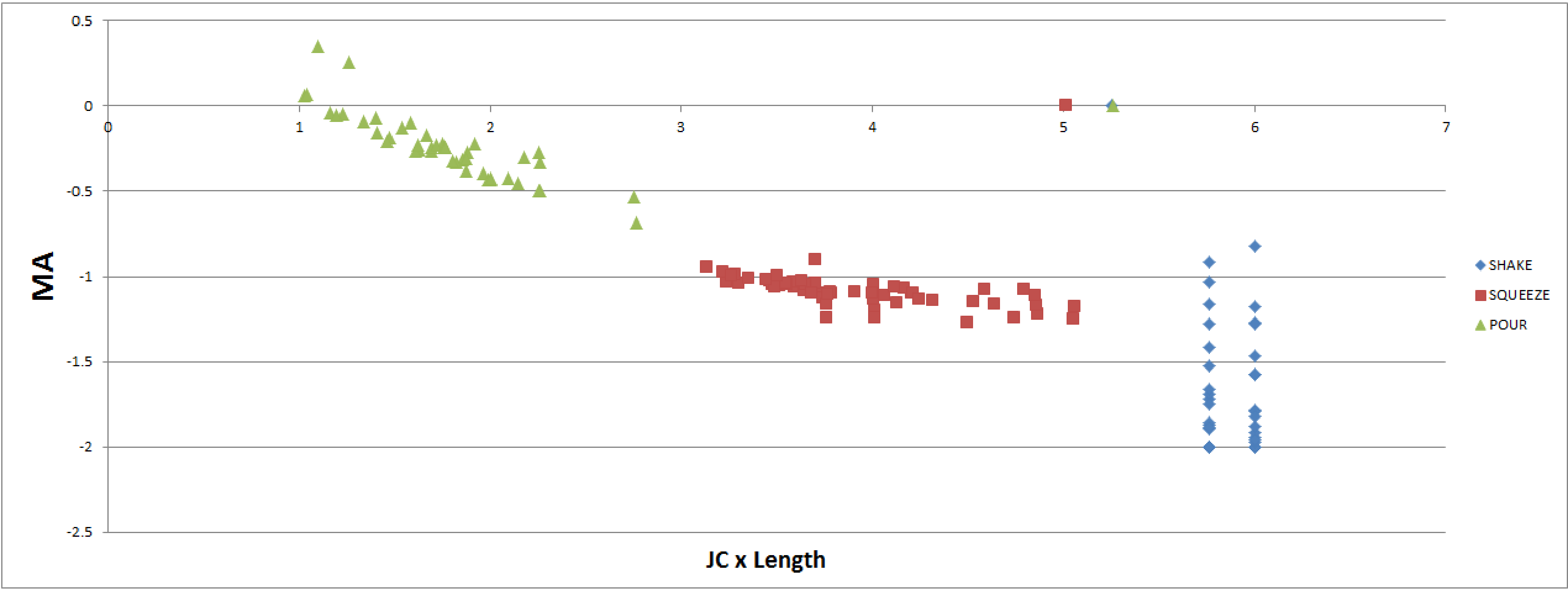
- Recognises events
- Timestamp
- Transmits to server



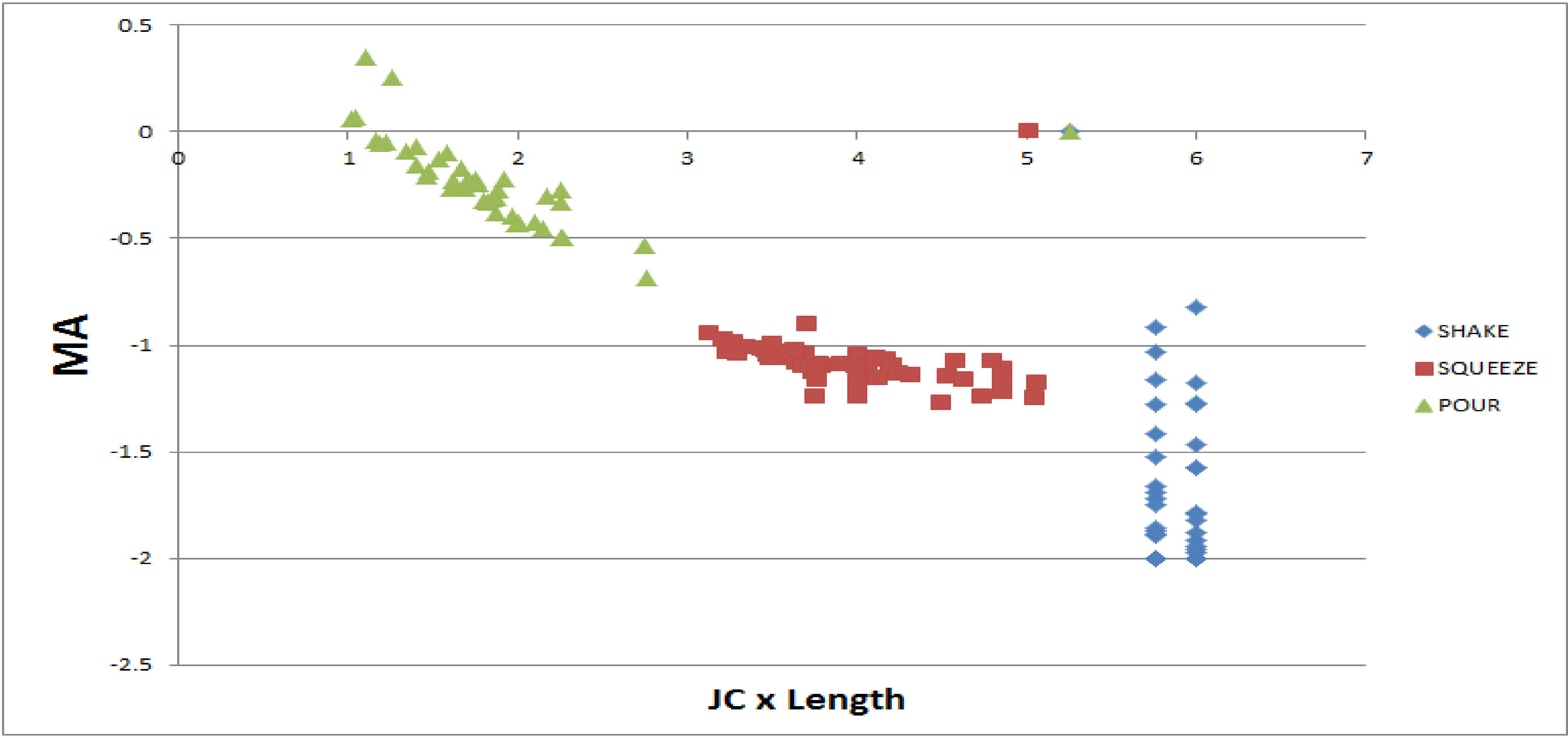
	A	B	C	D	E	F	G	H	I	J	K
1	name	time_stamp	accelz	ActionNu	ActionLen	ActionTyp	JC	MA	TV	JL	RG
2	SHAKE	20150724150851.csv									
3	RespeckLF	2.01507E+13	1.001221	1	50	0	0.119995	-2	1.527656	5.999756	3.999756
4	RespeckLF	2.01507E+13	1.002441	2	75	0	0.079997	-1.57623	0.965653	5.999755	3.999756
5	RespeckLF	2.01507E+13	1.001221	3	25	0	0.23999	-2	2.594624	5.999757	3.999756
6	RespeckLF	2.01507E+13	1.001221	4	50	0	0.119995	-2	1.44894	5.999757	3.999756
7	RespeckLF	2.01507E+13	1.002197	5	50	0	0.119995	-2	1.452802	5.999757	3.999756
8	RespeckLF	2.01507E+13	1.000488	6	50	0	0.119995	-1.17782	0.832689	5.999755	3.361182

- MA = min. avg. (avg. of 10 min. z-axis acclerometer values)
- JC = jerk count
- Length = number of z-axis accelerometer values in the window

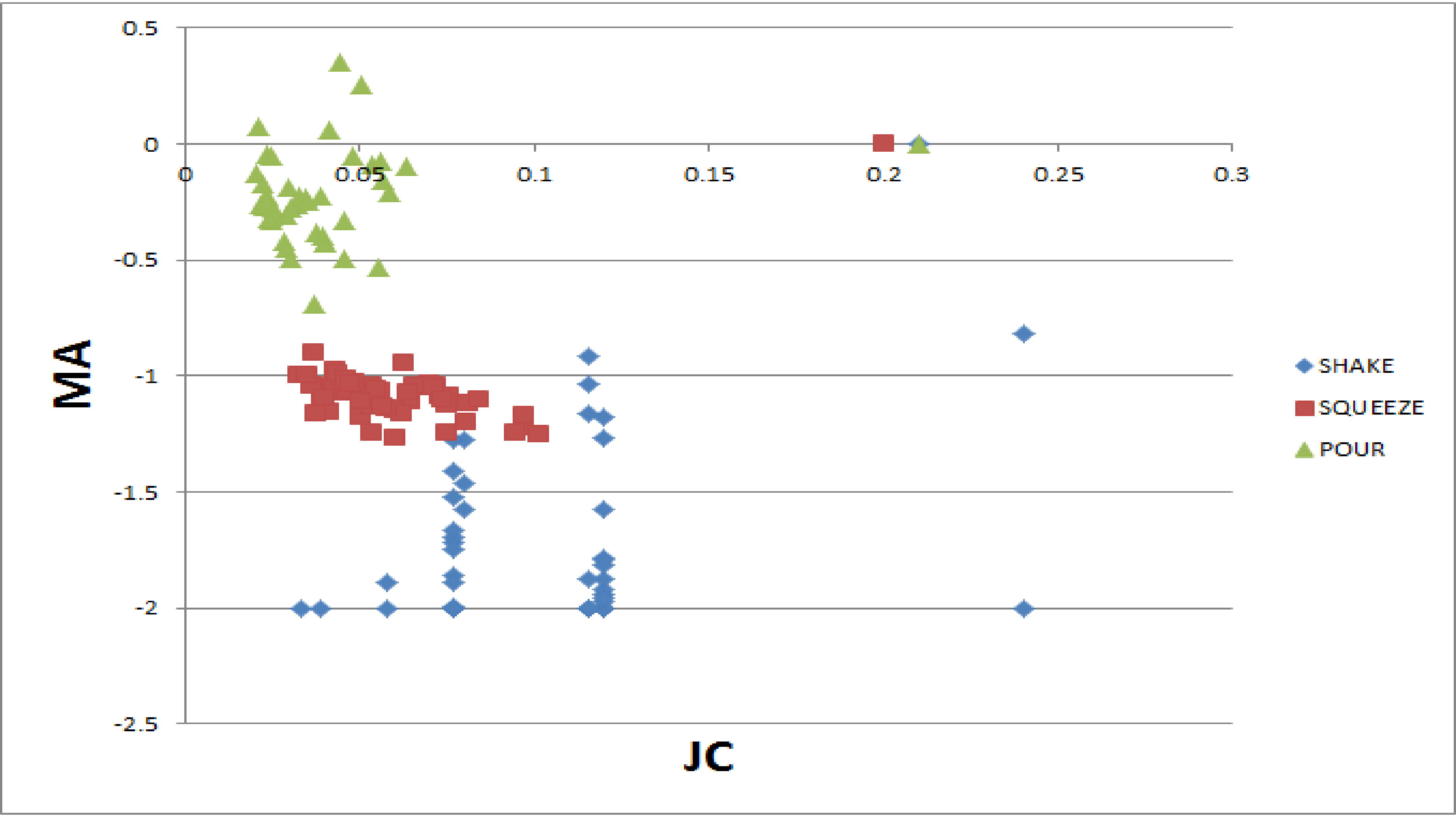
Clustering three actions - 1



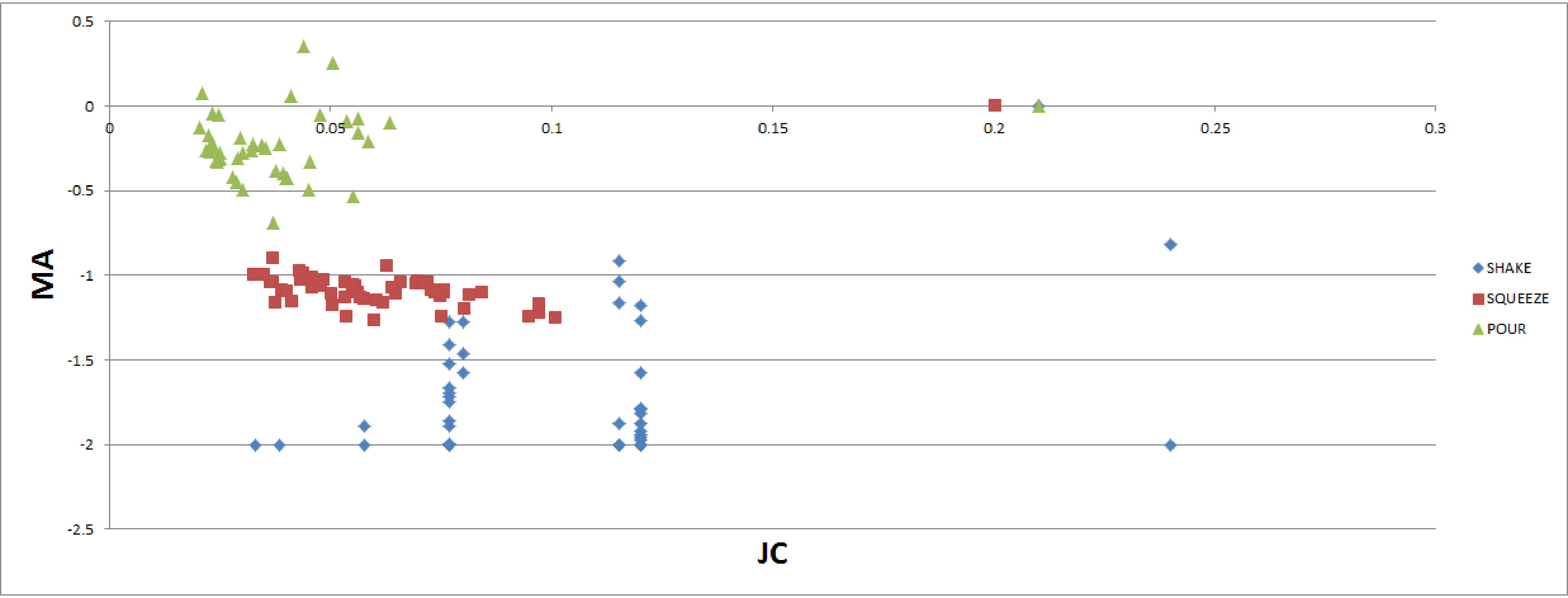
Clustering three actions - 2

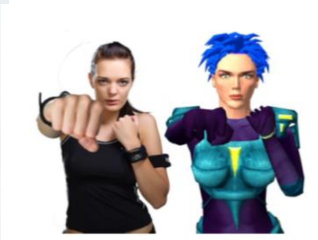


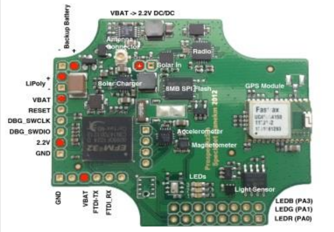
Clustering three actions - 3



Clustering three actions - 4

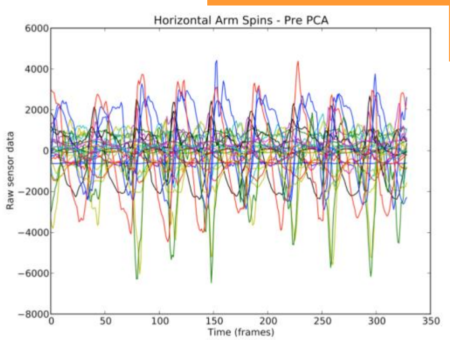


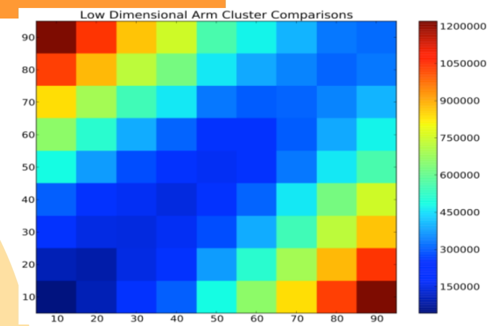



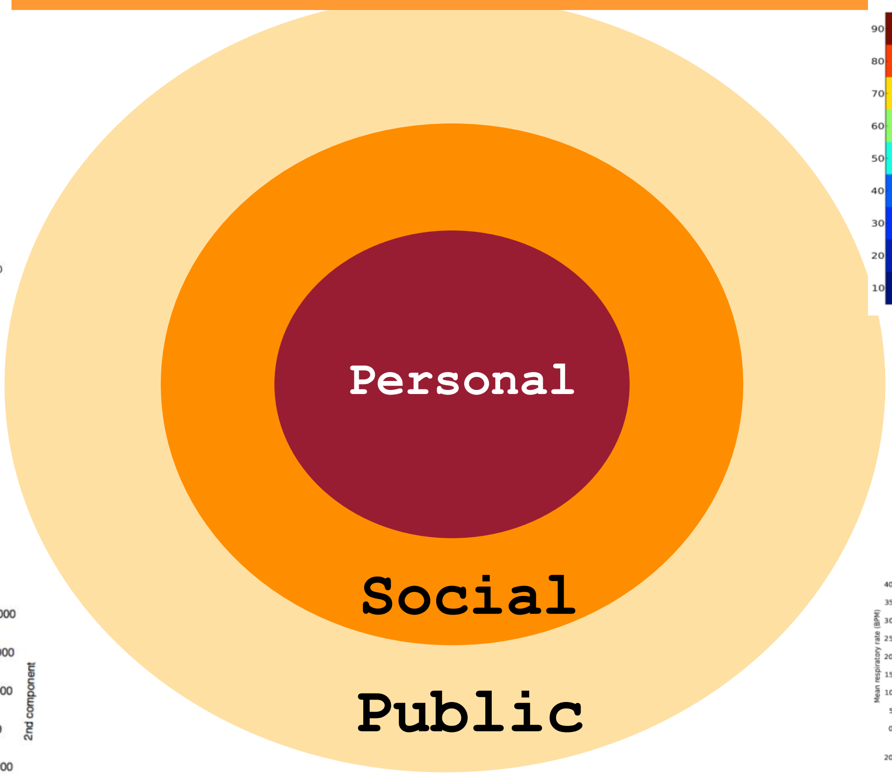




Integration of Computation, Communication and Control to provide time-bounded decisions and actions

Sense – Learn -- Act

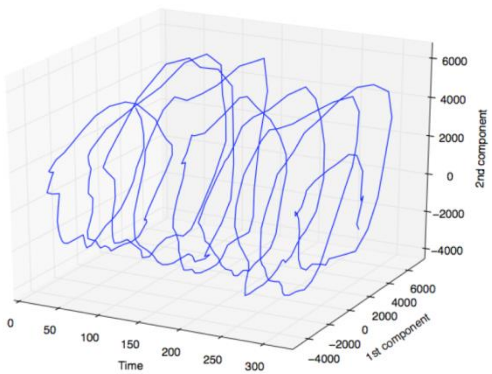


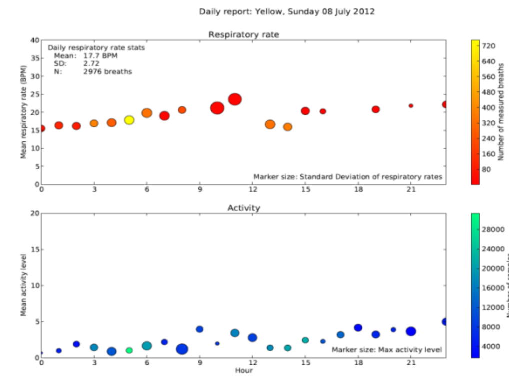




Computation

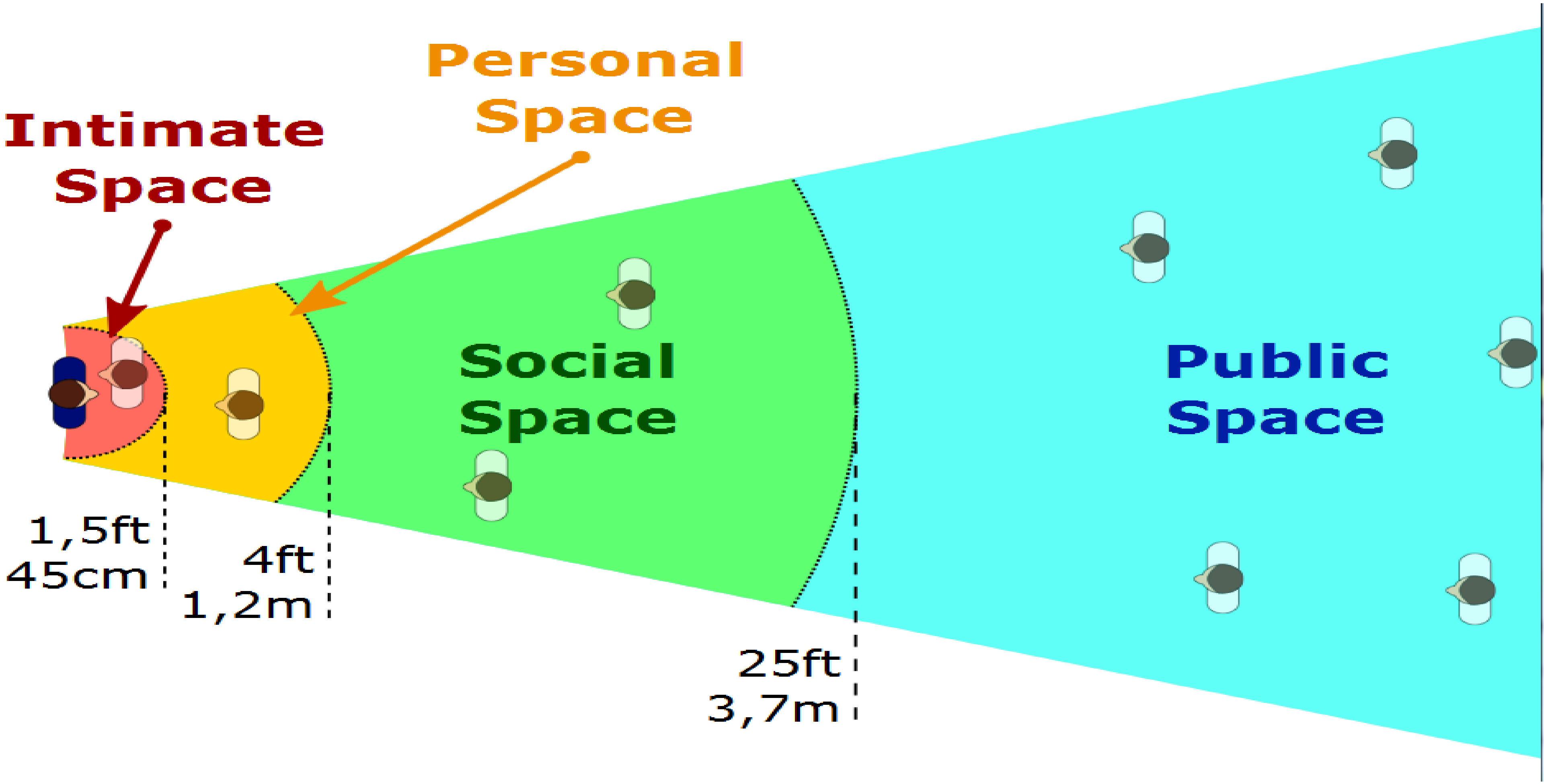
"Intelligence"





Communication

Centre for Speckled Computing


Personal Space
Intimate Space
Social Space
Public Space
1,5ft
45cm
4ft
1,2m
25ft
3,7m

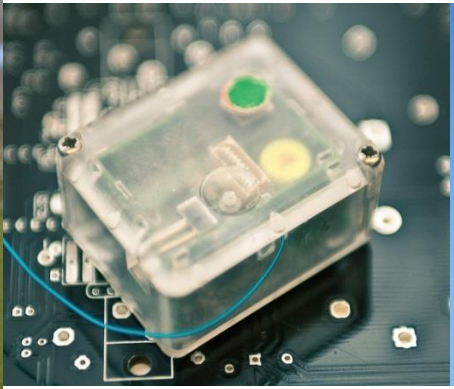
Golf Swing

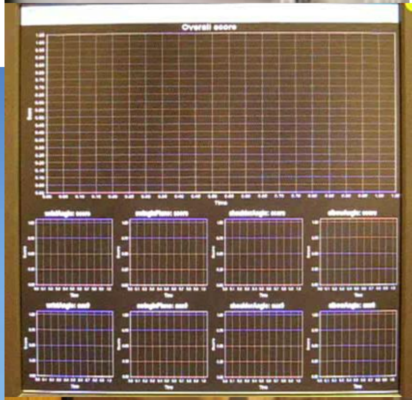
Arvind, D.K., Bates, C.A., 2008 ``The Speckled Golfer'', In 3rd Int. Conf. on Body Area Networks, March 13 - 17, 2008, Tempe AZ, USA, IEEE Press.

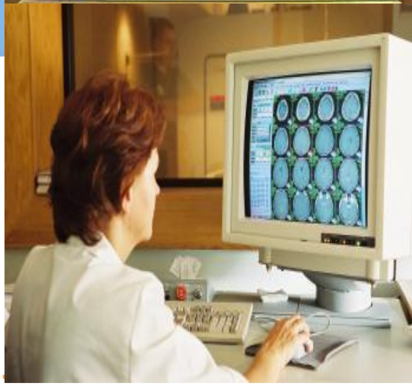
Analysis of golf swing ….

- …. on the golf course, and not in the studio
- Accurate, infrastructure-less, portable, strap-on
- Real-time feedback either sonic or visual (on a PDA)
- Fully wireless, and full body (if required)
- Score the "goodness" of a swing based on existing body of research on the biomechanics of golf swing
- Estimate the "distance" of a swing from the personal best

Golf Swing Statistics from any place ....







Analysis of Motor Control Skills

- Swing of the club
- Impact of the clubhead with the ball
- Flight of the ball towards the target

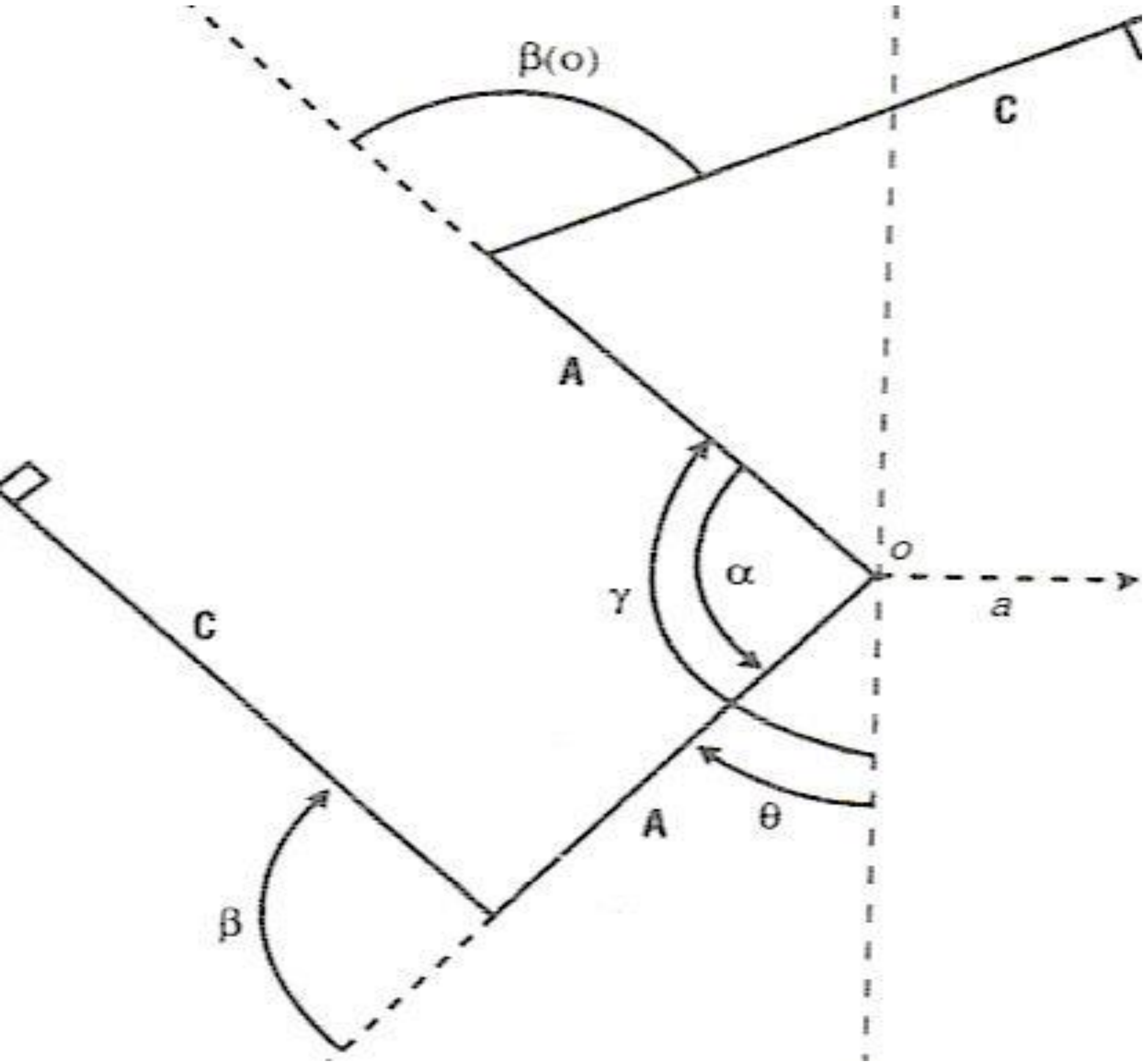
Swing of the Club

- Modelled as a double pendulum
  - Arms of the golfer act as one pendulum connected to the club
  - Club acts as another pendulum
- Equation of motion for a double pendulum using Newton's Laws

Model of the Swing

- Arms of the golfer swing about an axis that moves during the downswing
- Club swings about a moving axis near the wrists of the golfer
- Two rigid rods – Arm (A) and the Club (C)
- Rod A: point halfway b/w shoulder to wrist

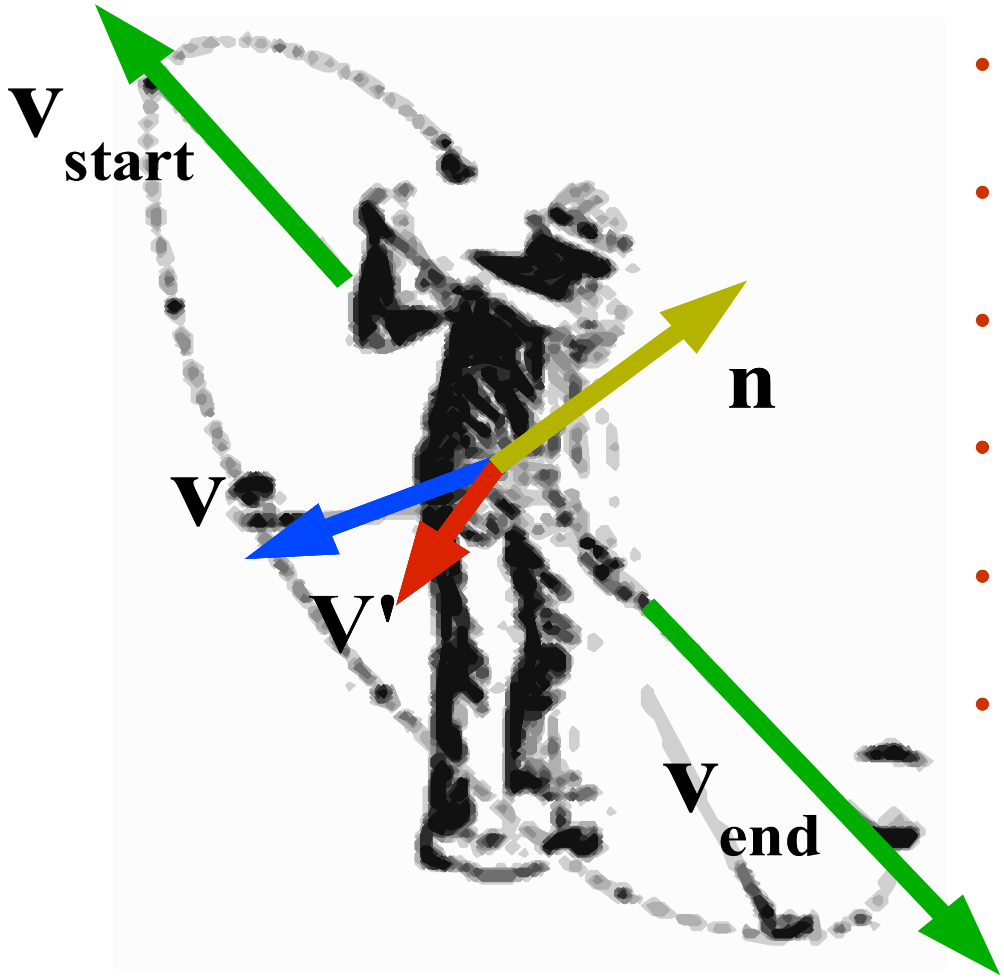
Biomechanics of the Swing



Physics of Golf by T.P. Jorgensen, Springer, p9

- *a*: hor. accl. at O
- *Gamma*: angle of rod A with the downward dir. at the start of the downswing
- *Beta*: wrist-cock angle
- *Theta*: downward angle of rod A
- *Alpha*: downward swing angle
- *Alpha dot*: angular vel. of rod A
- *Alpha double dot*: angular accl. of rod A

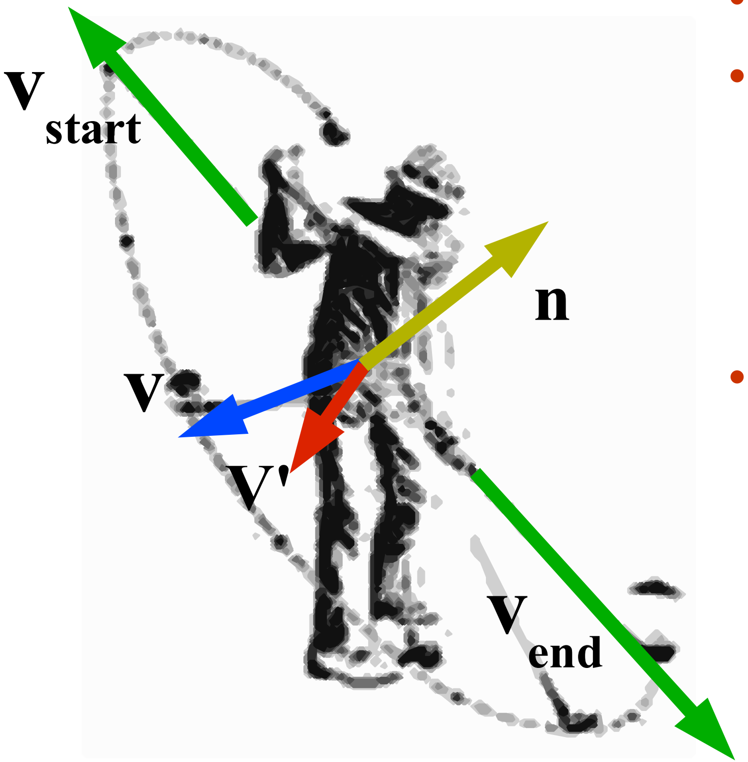
“Swinging in the Plane” Rule



- **vstart** – vector pointing down the shaft at the start of swing
- **vend** – shaft vector at the end of the swing
- **n** = **vstart x vend** and is normal to the swing plane
- **v’** – general shaft vector during the swing which does not lie in the plane
- **v** – correct shaft vector which does lie in the plane defined by **n**
- α - angle between **v’** and **n,** where

cos(α) = v’.n / |v’||n|

"Swinging in the Plane" Rule

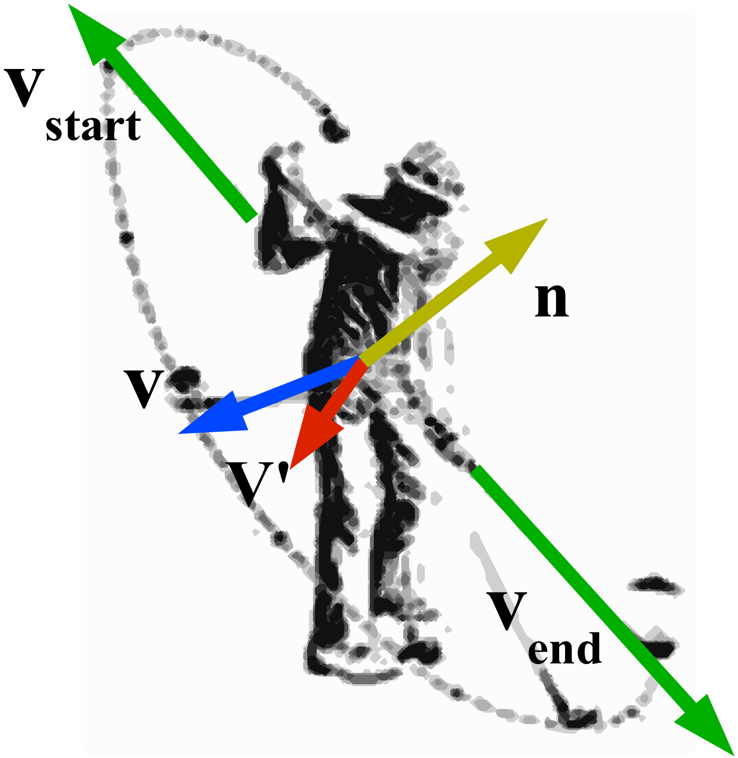


- **cos(α) = v'.n / |v'||n|**, *α* - angle between **v'** and **n**
- **v'** is obtained by taking the local down-shaft vector in the club sensor's co-ordinate system and rotating it by the current orientation of the device, to give a vector that points down the shaft in the world co-ordinate system
- **vworld** = **q*** x **vlocal** x **q**

q – quaternion specifying orientation of the device; **q*** is the conjugate; "**vworld,** vector pointing down the shaft in the world co-ordinate system, and **vlocal**, in the local co-ordinate frame; **x** is the quaternion product

The rule returns 1 – cos(α) as a score, which is 1 for a swing perfectly within the plane, and 0 when perpendicular to the swing plane

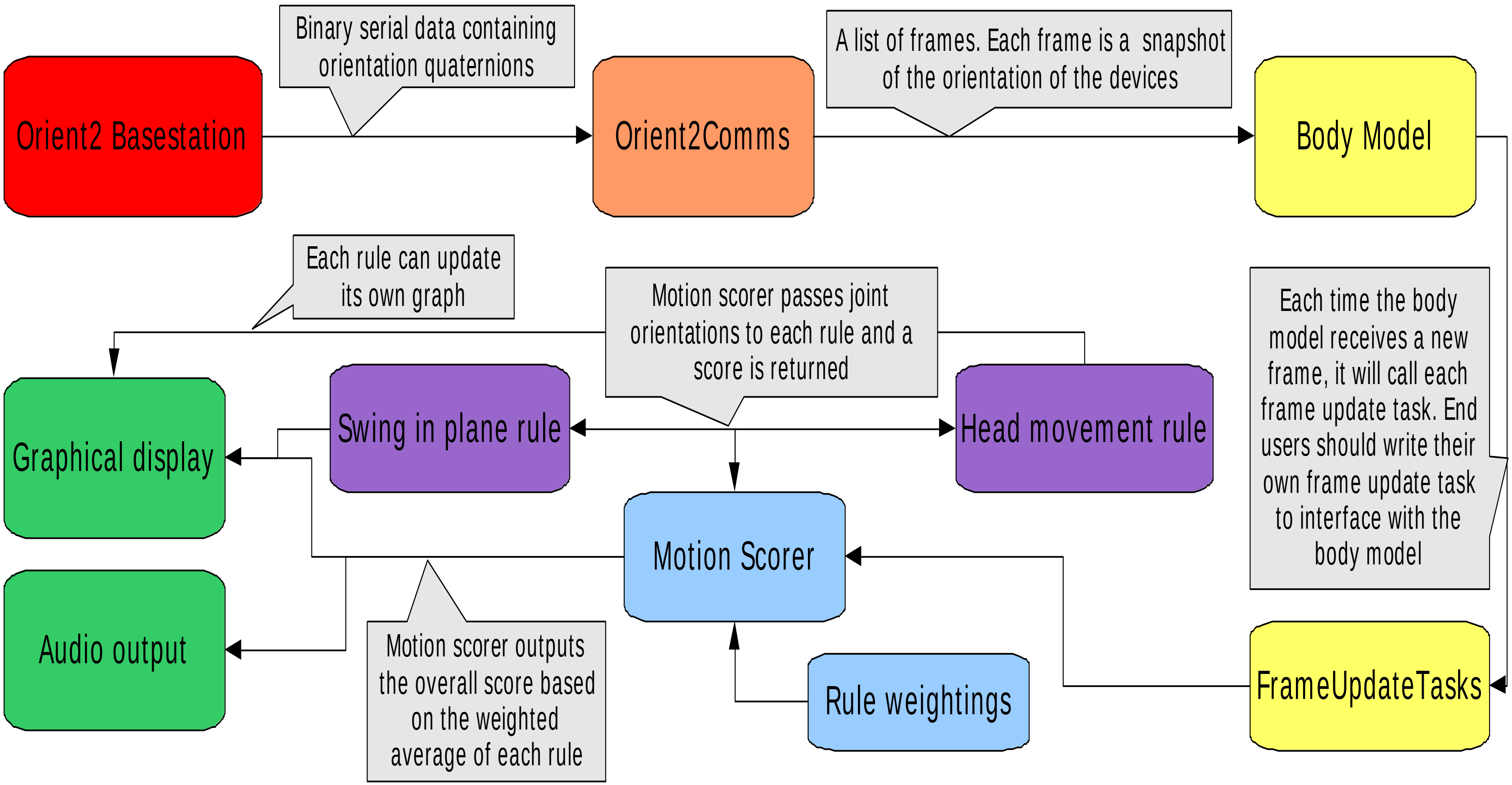
"Head Movement" Rule

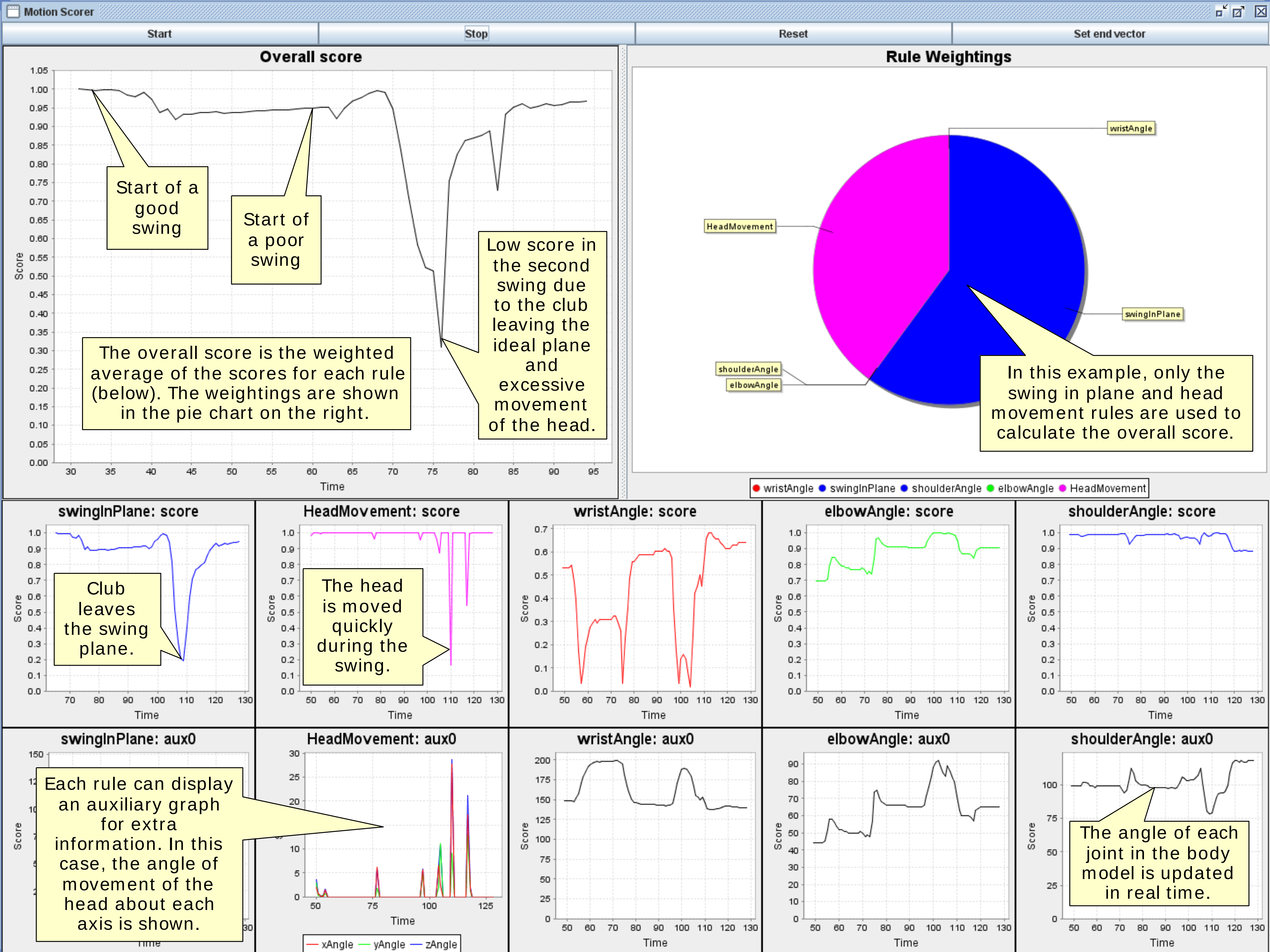


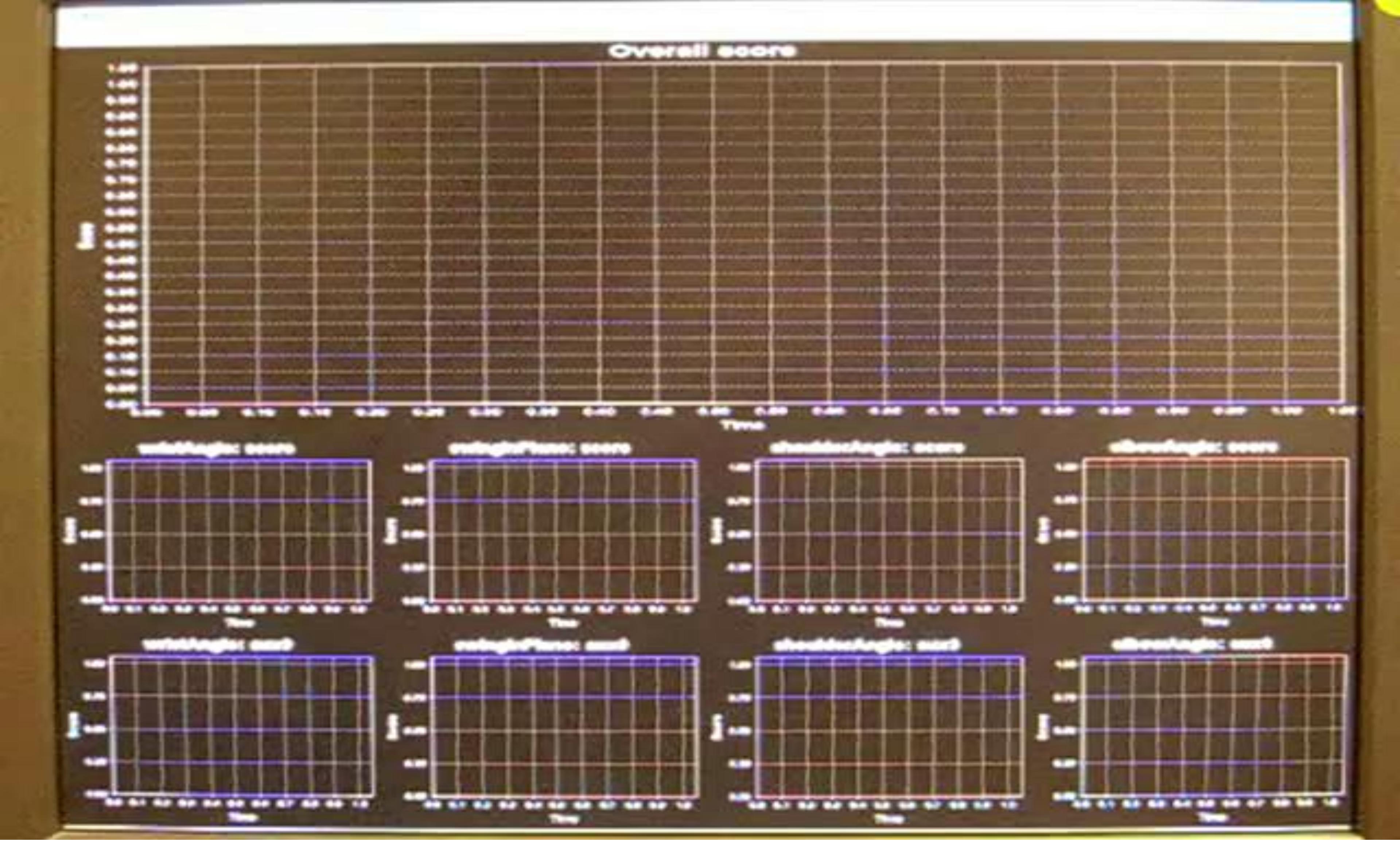
- Change in the orientation of the head about each axis between consecutive snapshots of the golf swing
- **Orient** speck attached to the cap – the root for the body model, and any head movement is recorded relative to the motion of the body
- For each snapshot calculate the world direction vector that points along each axis of the head-mounted device, and compare it to the previous value

score = (Abs(cos(δx)) + Abs(cos(δy)) + Abs(cos(δz))) /3,
δx, δy, δz are changes in alignment along the x, y and z axis

Body model on the Mobile



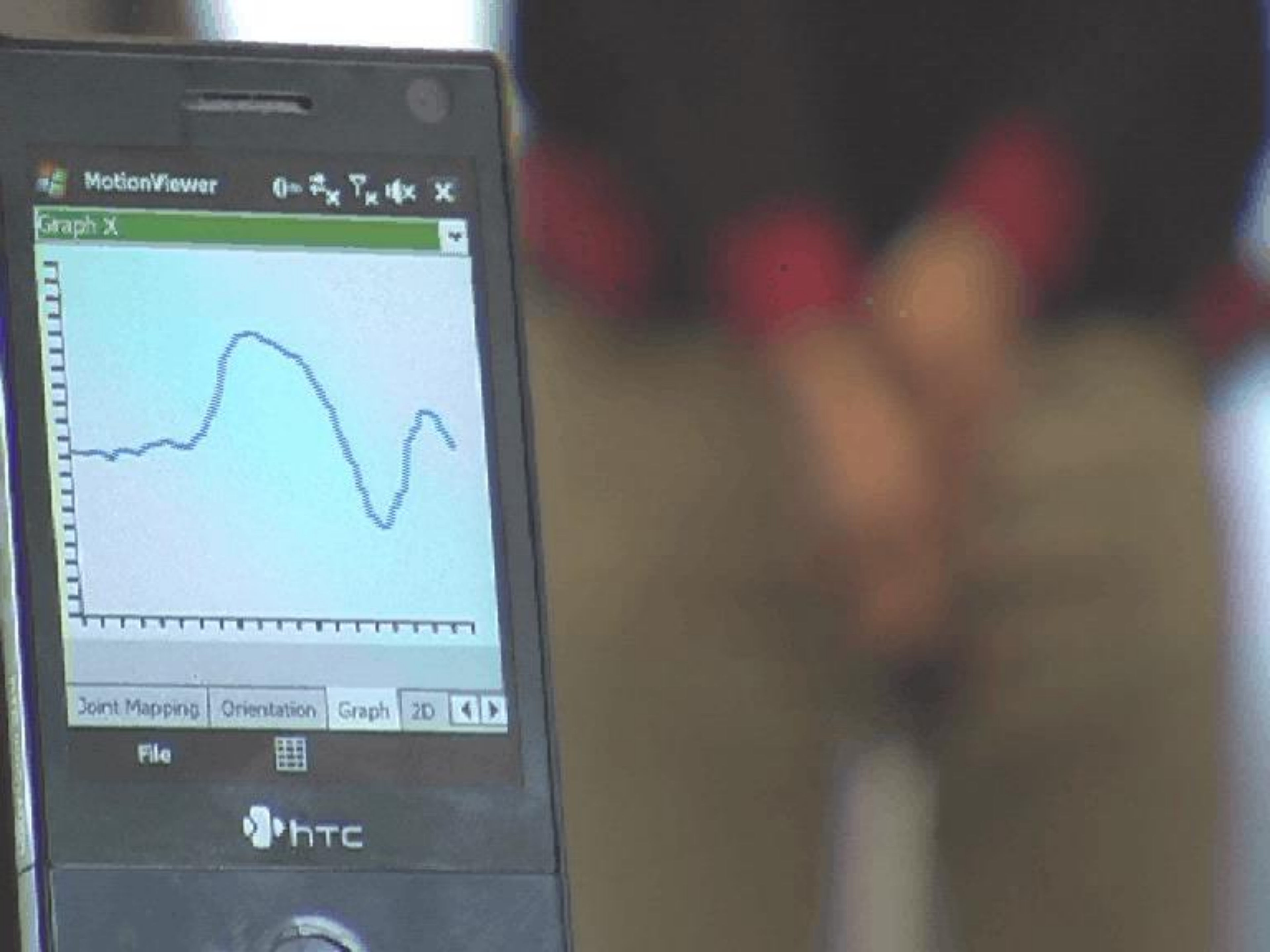

Motion Scorer
Start
Stop
Reset
Set end vector
Overall score
Score
Time
Start of a good swing
Start of a poor swing
Low score in the second swing due to the club leaving the ideal plane and excessive movement of the head.
The overall score is the weighted average of the scores for each rule (below). The weightings are shown in the pie chart on the right.
Rule Weightings
wristAngle
HeadMovement
swingInPlane
shoulderAngle
elbowAngle
In this example, only the swing in plane and head movement rules are used to calculate the overall score.
wristAngle swingInPlane shoulderAngle elbowAngle HeadMovement
swingInPlane: score
Club leaves the swing plane.
HeadMovement: score
The head is moved quickly during the swing.
wristAngle: score
elbowAngle: score
shoulderAngle: score
swingInPlane: aux0
Each rule can display an auxiliary graph for extra information. In this case, the angle of movement of the head about each axis is shown.
HeadMovement: aux0
xAngle yAngle zAngle
wristAngle: aux0
elbowAngle: aux0
shoulderAngle: aux0
The angle of each joint in the body model is updated in real time.



Top Row: Distance of swing from ideal plane

Middle Row: Sine of the angle at the wrist, elbow and shoulder

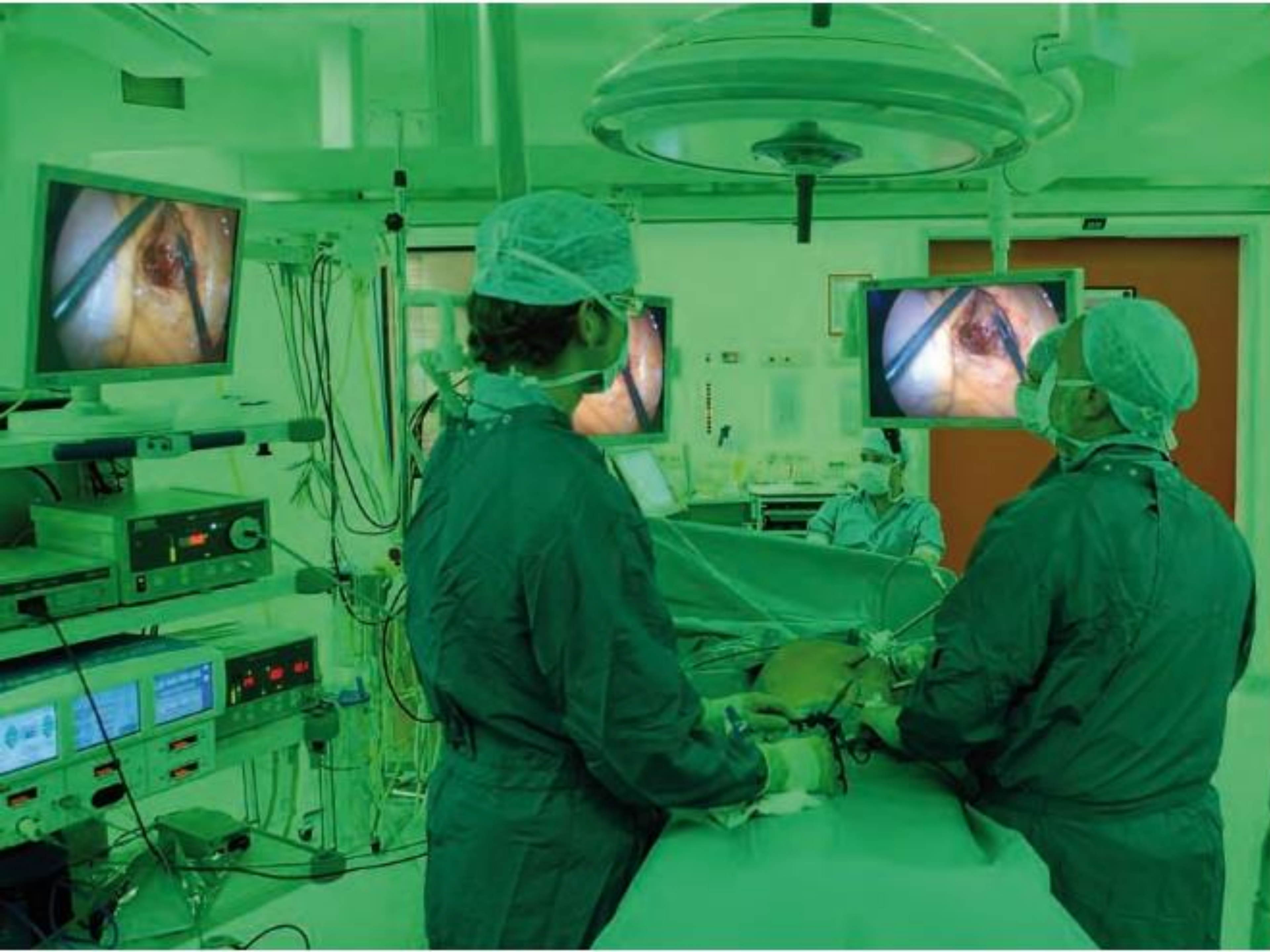
Bottom Row: Angle away from the plane and the 3 joint angles


MotionViewer
Graph X
Joint Mapping
Orientation
Graph
2D
File
htc

A comparative study of surgical skills assessment in a physical laparoscopy simulator using wireless inertial sensors

R L Evans[1], R W Partridge[2] and D K Arvind[1]
[1]School of Informatics, University of Edinburgh
[2] Royal Hospital for Sick Children, NHS Lothian
Edinburgh, Scotland

In Proc. Wireless Health 2014, Bethesda MA,USA, Nov. 2014,
ACM Press



Overview

- **Laparoscopy Surgery Training**
  - Medical expertise combined with manual dexterity in both hands and spatial awareness
  - Training on real patients under supervision is expensive and time-consuming
  - Surgical Simulators are a safe environment to practise key skills and provide automated measure of performance and feedback on improvements
- **An improved Use-case model**
  - Take-home surgical simulator (eosim.com)
  - Surgeons practise basic skills in their own time
  - Inertial sensors (Orient specks) attached to the instruments provide feedback on performance of standard set of key skills
  - Keep track of individual progress and comparison with cohort of trainees

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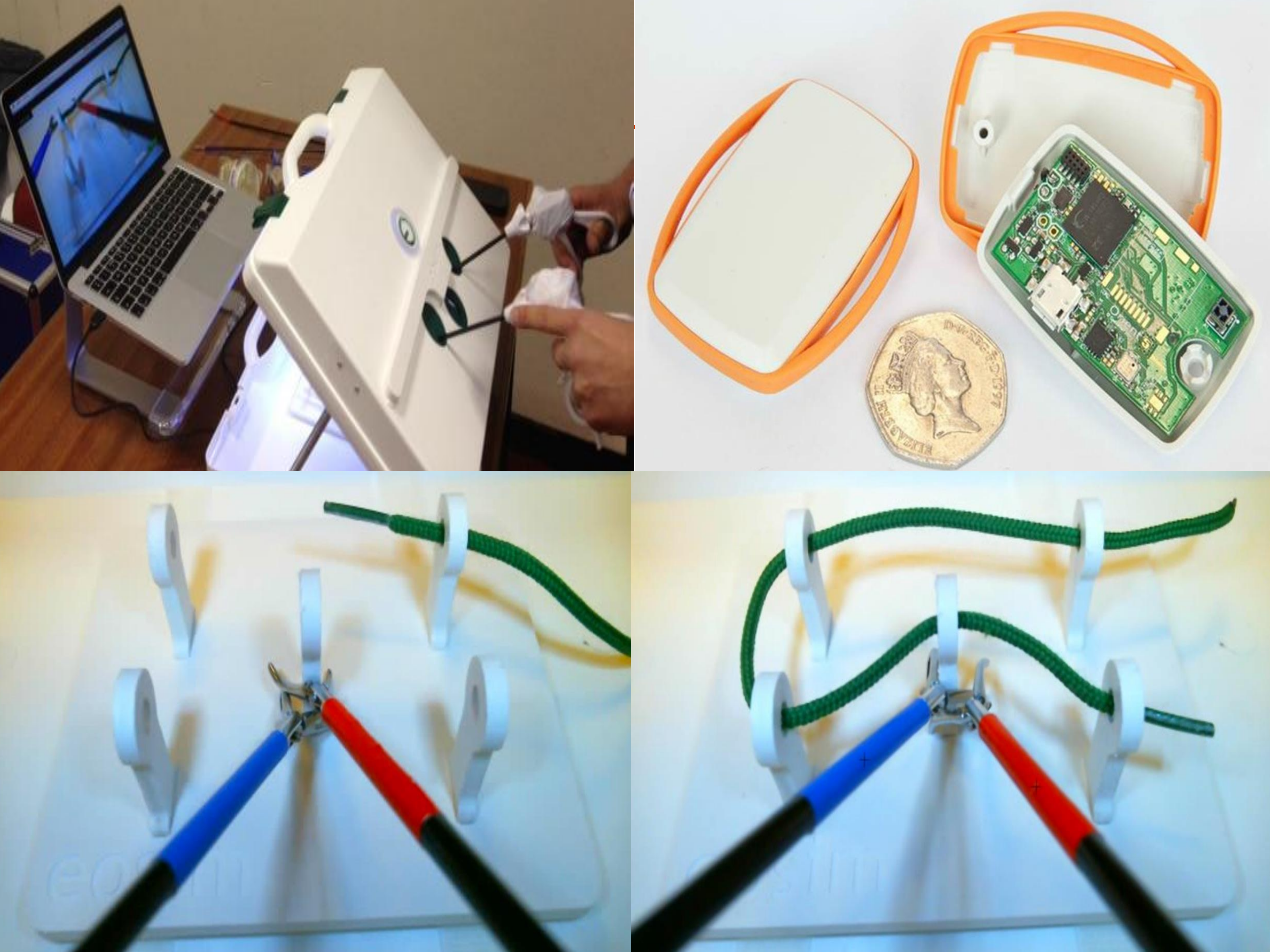
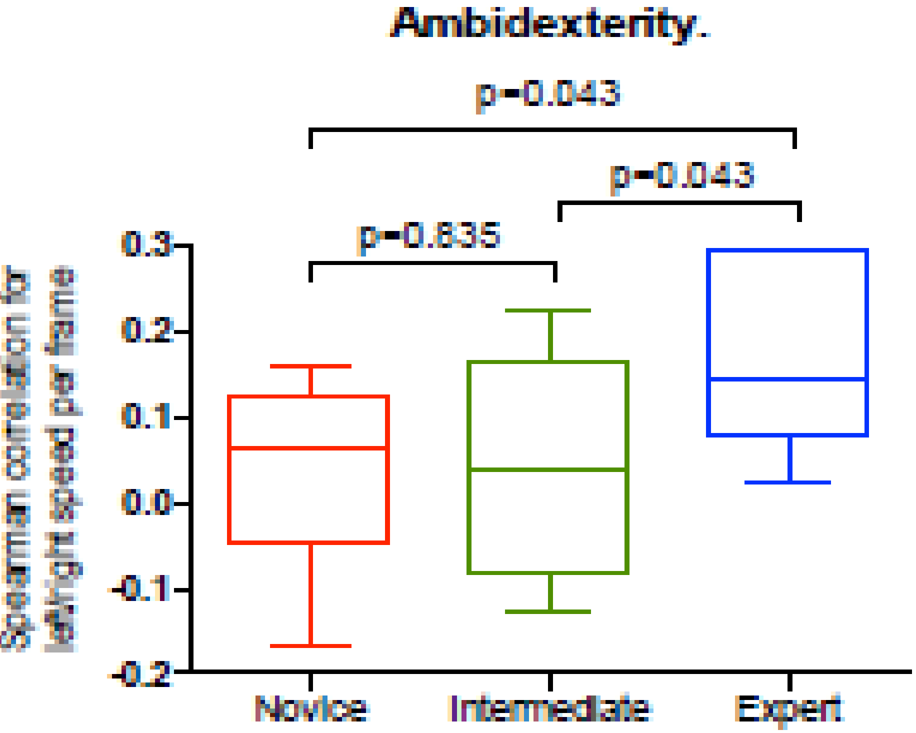
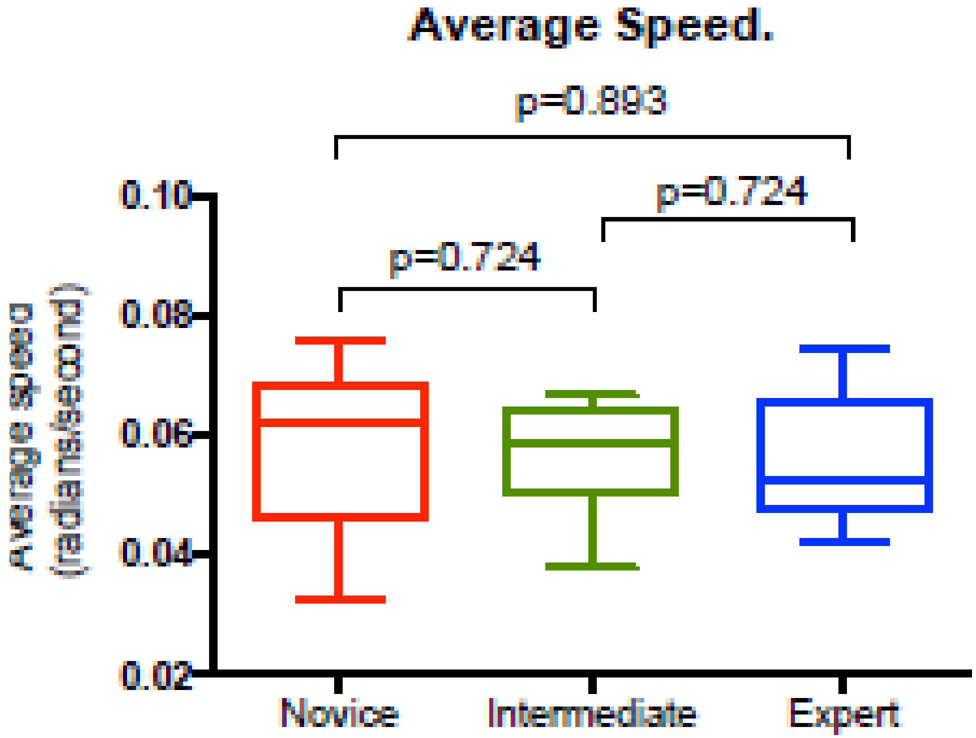



Ambidexterity.
p=0.043
p=0.043
p=0.835
Spearman correlation for left/right speed per frame
0.3
0.2
0.1
0.0
-0.1
-0.2
Novice
Intermediate
Expert


Average Speed.
p=0.893
p=0.724
p=0.724
Average speed (radians/second)
0.10
0.08
0.06
0.04
0.02
Novice
Intermediate
Expert

Combined outputs from a leave-one-out cross-validation of the linear regression model.

$$score = -2 + 1000\alpha - 0.02T + 5 \times 10^{-10} \cdot S - 0.4\theta - 1.6A$$

Average Acceleration (α), Total Duration (*T*), Motion Smoothness (*S*), Angular Distance (θ), Ambidexterity (*A*).