Interaction Design Case Study - 2

Tweeting Bottles and other stories

Outcomes of Case Study - 1

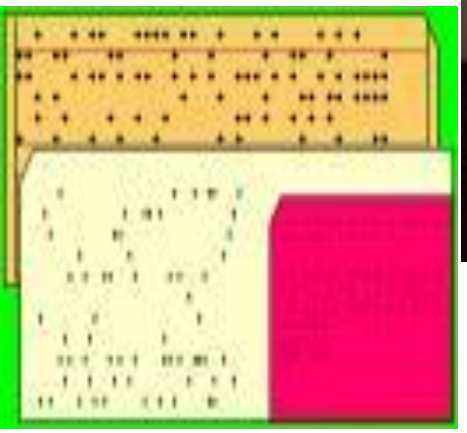
Literal and Stylised Representations

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

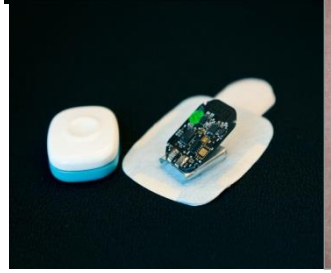
Outcomes of Case Study - 2

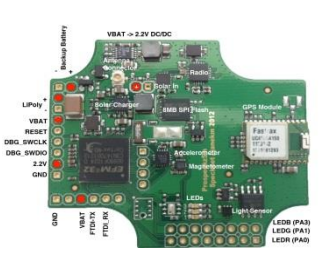
- Primary site of interaction: Virtual or Physical world
- Nature of Interaction: explicit or oblivious to the user
- Personal v/s Social v/s Public

I/O devices

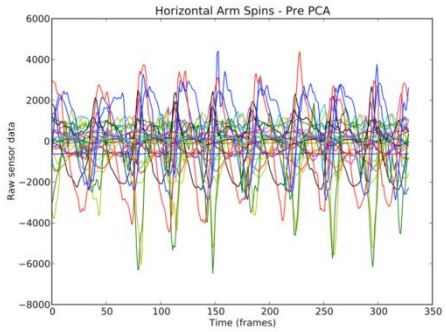




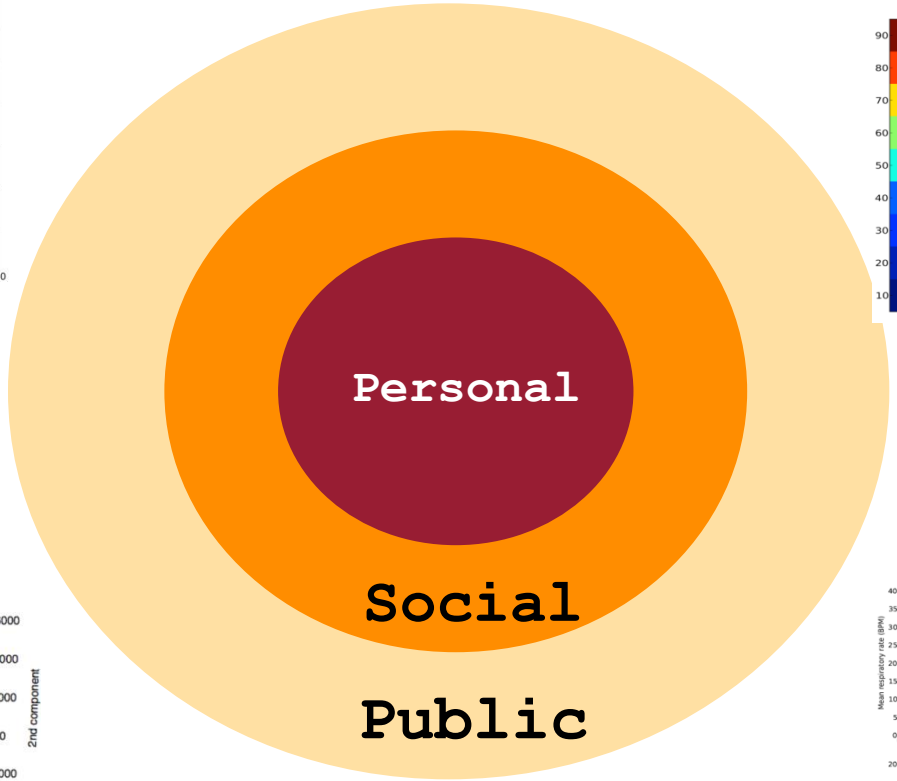


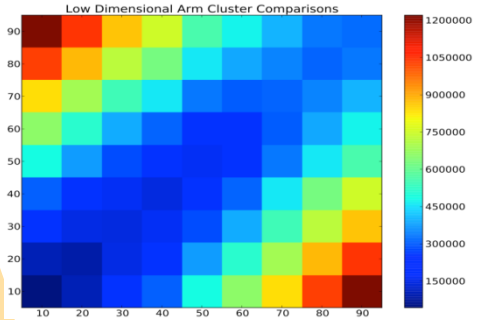


Integration of Computation, Communication and Control to provide time-bounded decisions and actions



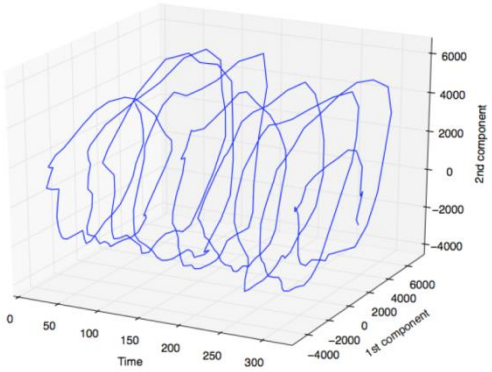
Sense – Learn -- Act

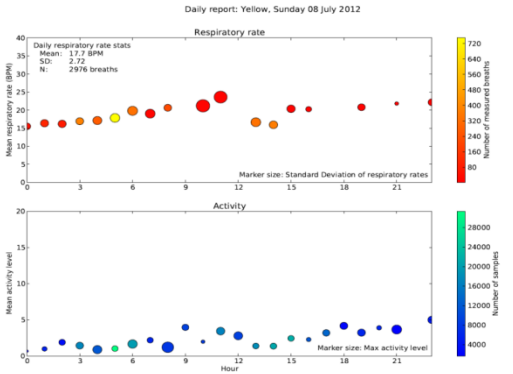




Computation

"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

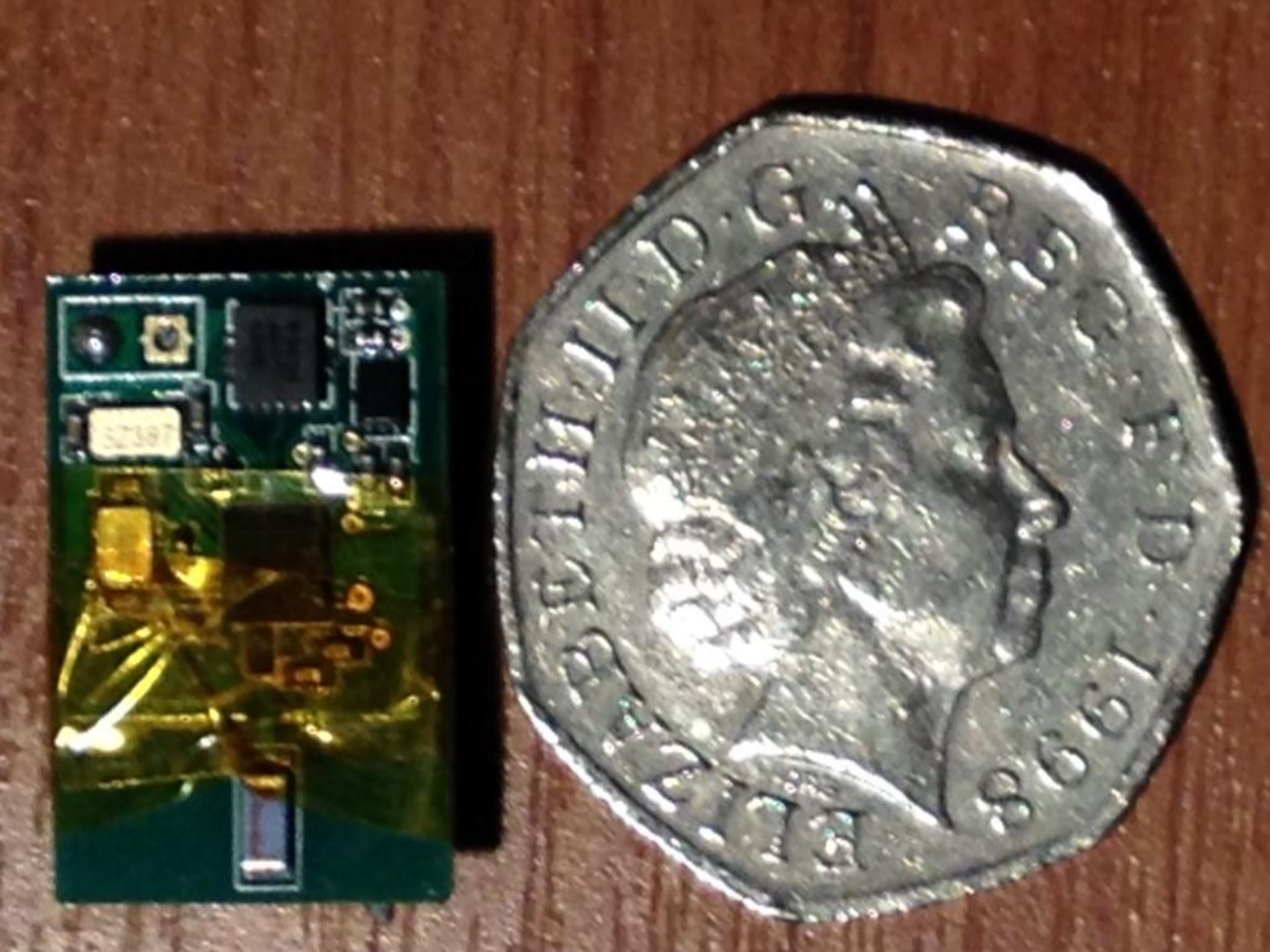
- Interviews
- Diaries
- Questionnaires

Advantages

- Low-tech

Disadvantages

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


ELIZABETH II D·G·REG·F·D·
1998

Tweeting bottles

Sensors recognise usage of FMCG products

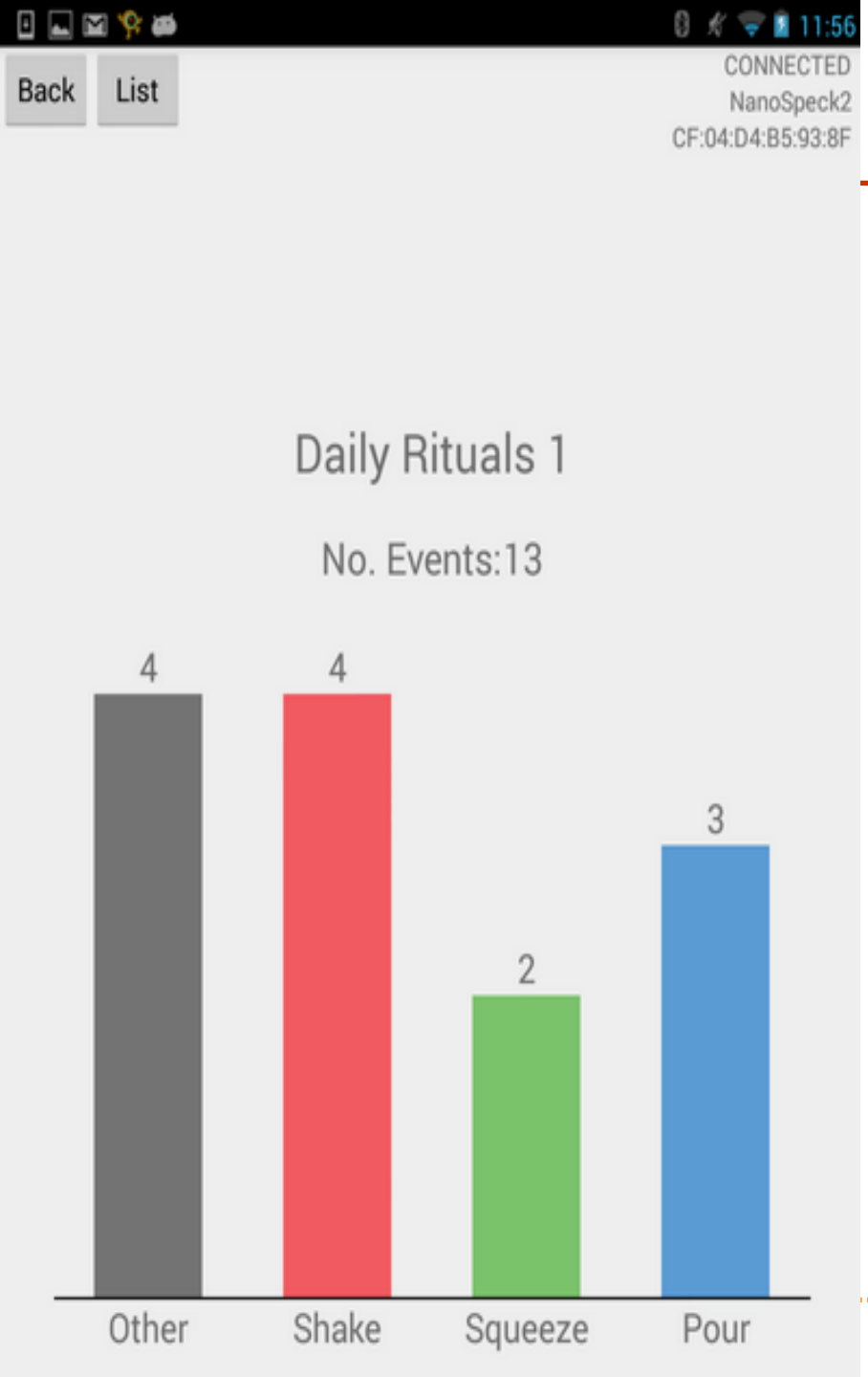
No change in consumer behaviour

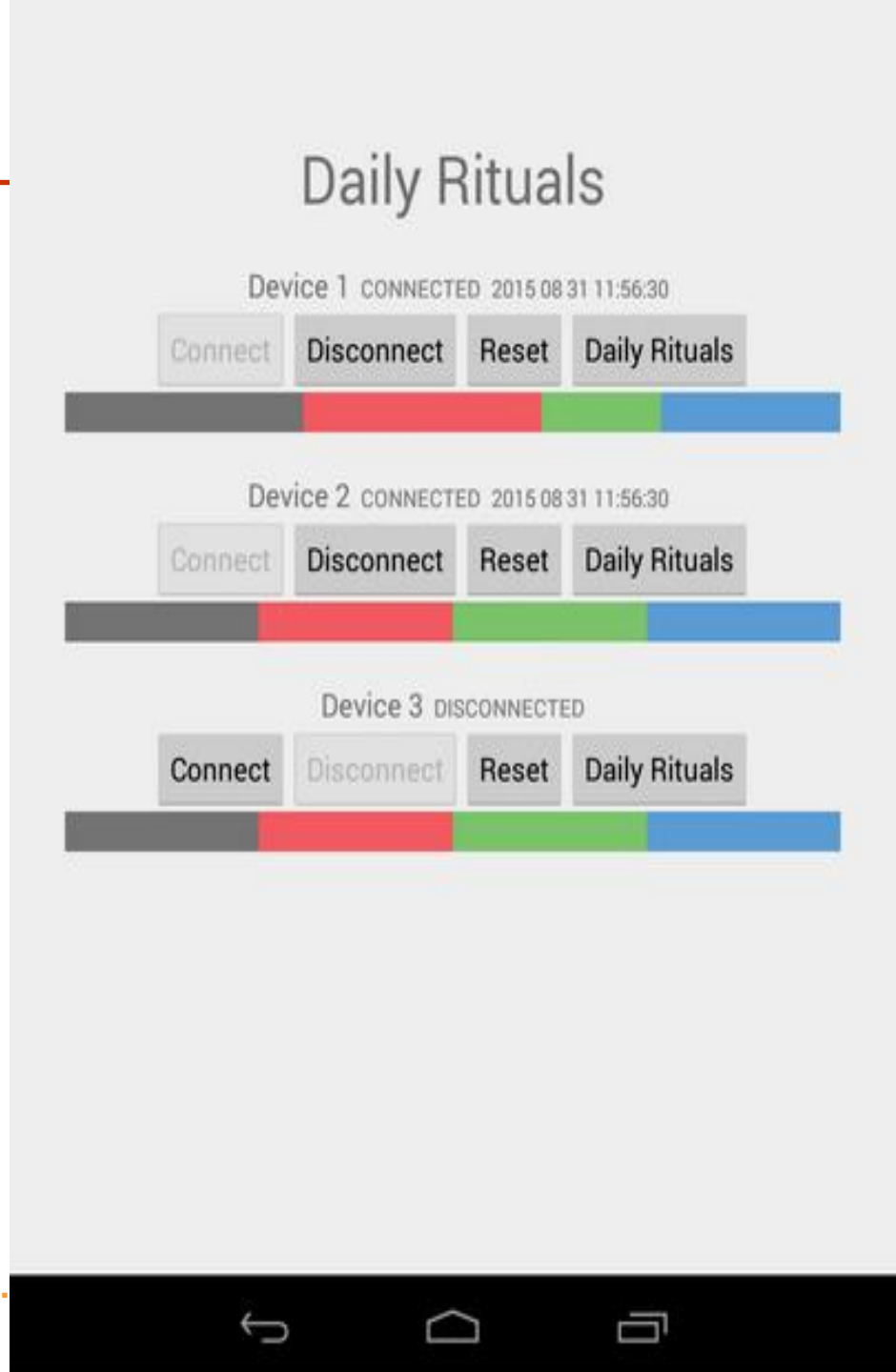
- Customer oblivious to data collection
- Data transmitted automatically to server

Data Analytics extracts actionable information

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

Make informed Business and Design decisions


11:56
Back
List
CONNECTED
NanoSpeck2
CF:04:D4:B5:93:8F
Daily Rituals 1
No. Events:13
4
4
2
3
Other
Shake
Squeeze
Pour

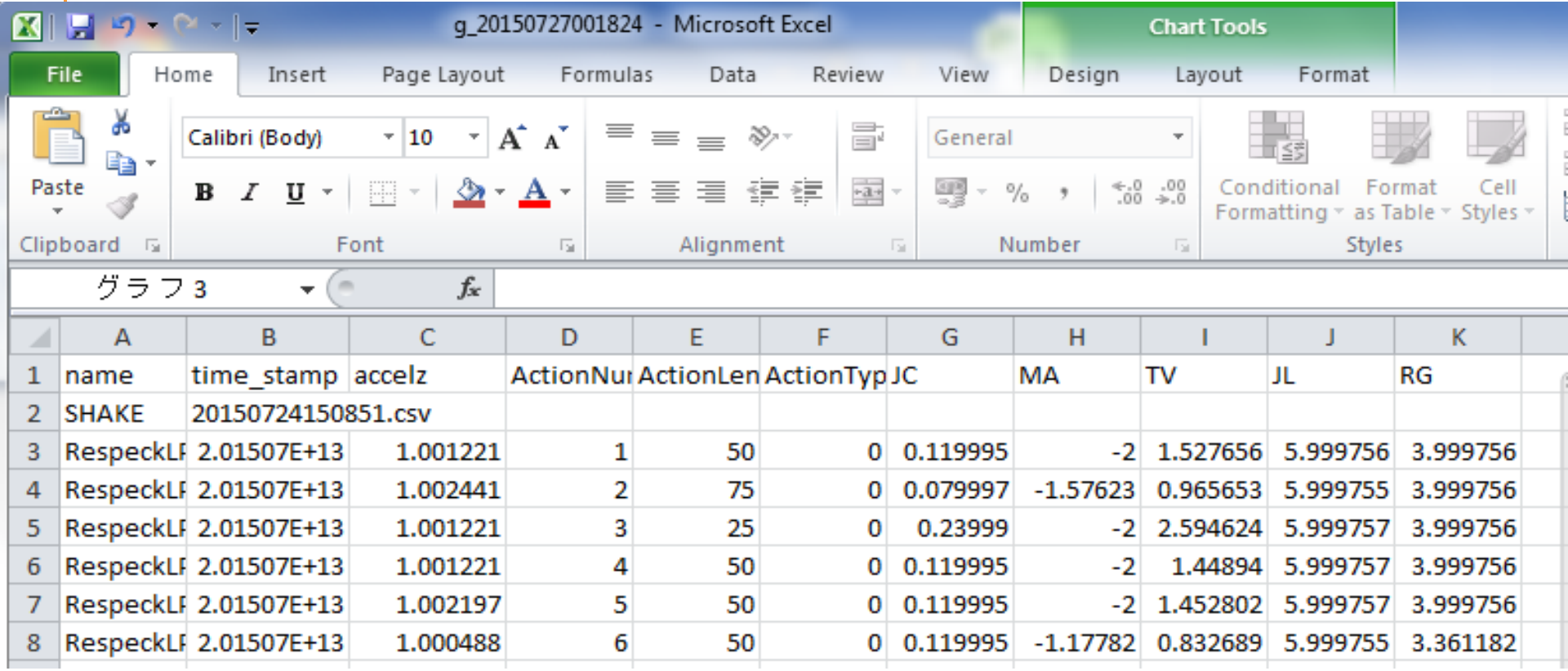

Daily Rituals
Device 1 CONNECTED 2015 08 31 11:56:30
Connect
Disconnect
Reset
Daily Rituals
Device 2 CONNECTED 2015 08 31 11:56:30
Connect
Disconnect
Reset
Daily Rituals
Device 3 DISCONNECTED
Connect
Disconnect
Reset
Daily Rituals

Events

- Pouring
- Squeezing
- Shaking

Phone App

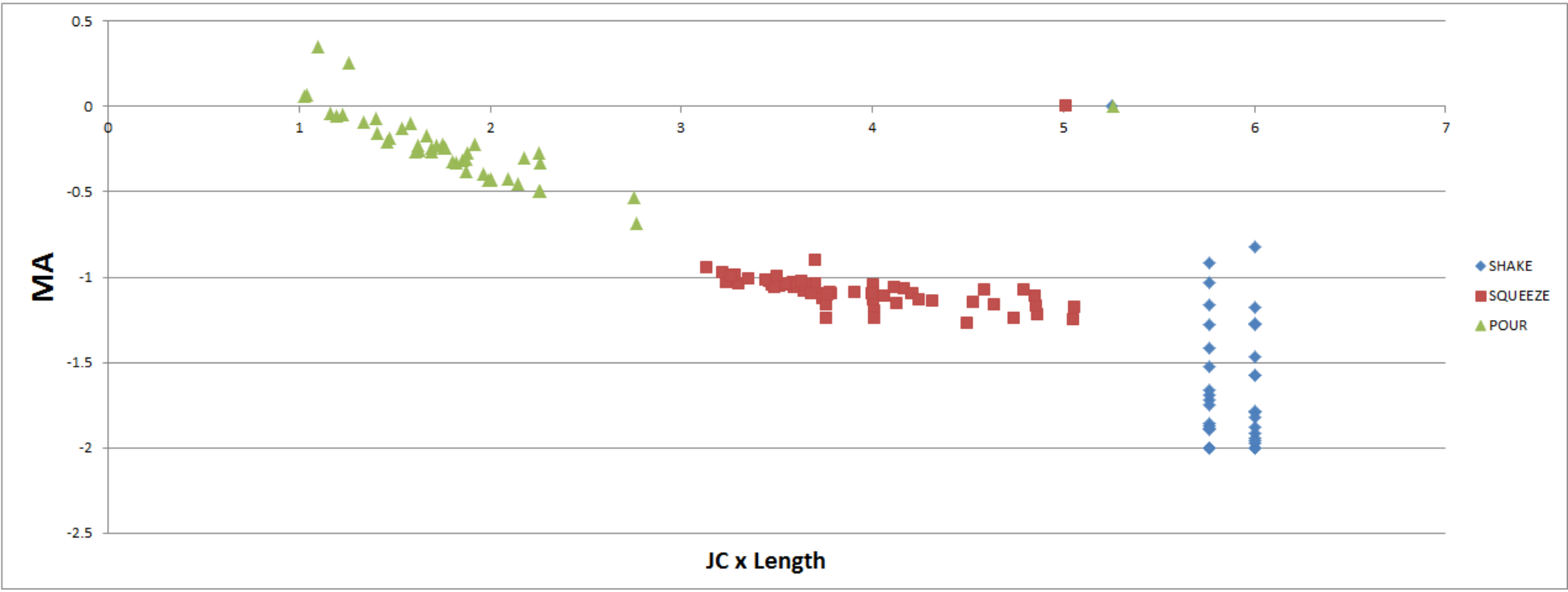
- Recognises events
- Timestamp
- Transmits to server



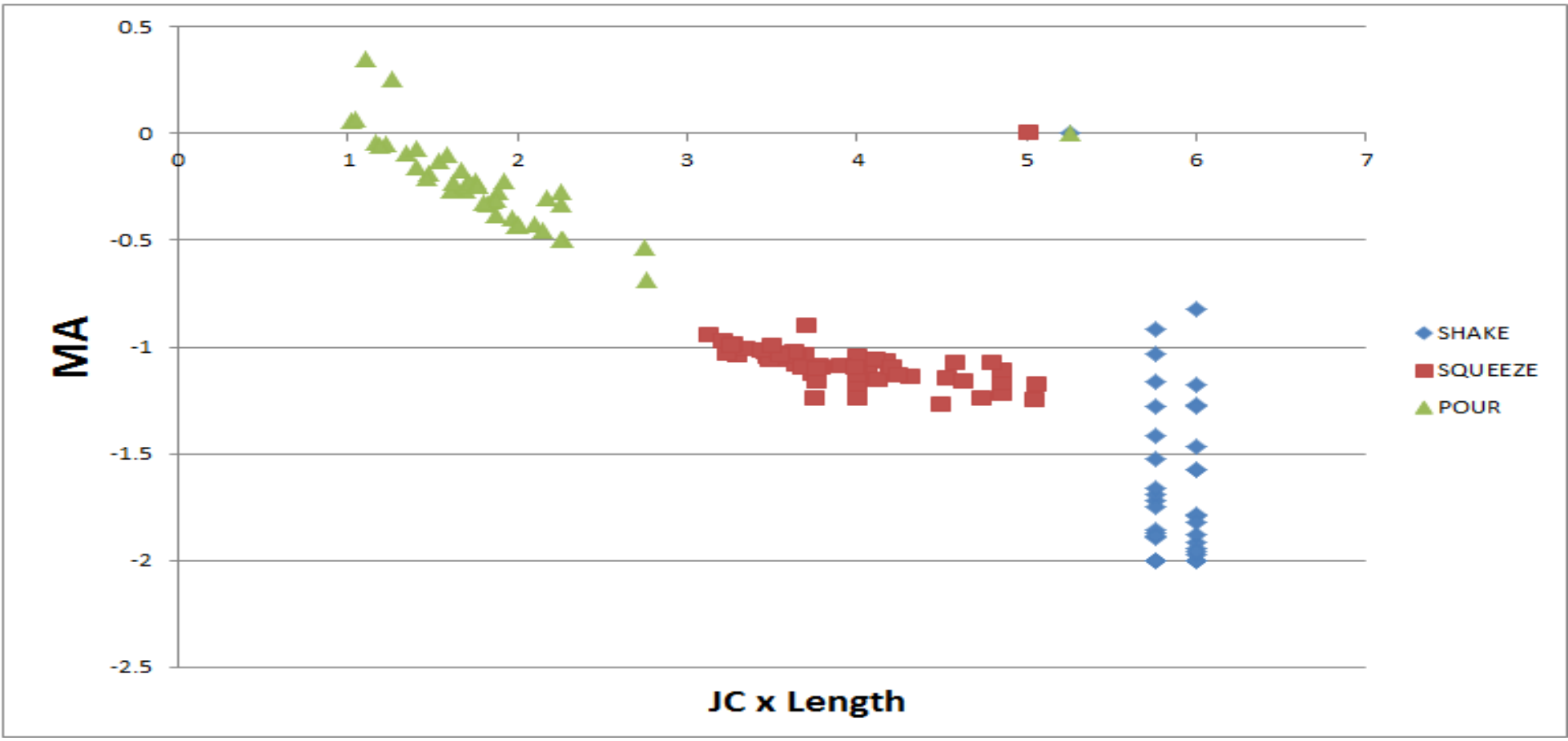
	A	B	C	D	E	F	G	H	I	J	K
1	name	time_stamp	accelz	ActionNu	ActionLen	ActionTyp	JC	MA	TV	JL	RG
2	SHAKE	20150724150851.csv									
3	RespeckLF	2.01507E+13	1.001221	1	50	0	0.119995	-2	1.527656	5.999756	3.999756
4	RespeckLF	2.01507E+13	1.002441	2	75	0	0.079997	-1.57623	0.965653	5.999755	3.999756
5	RespeckLF	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

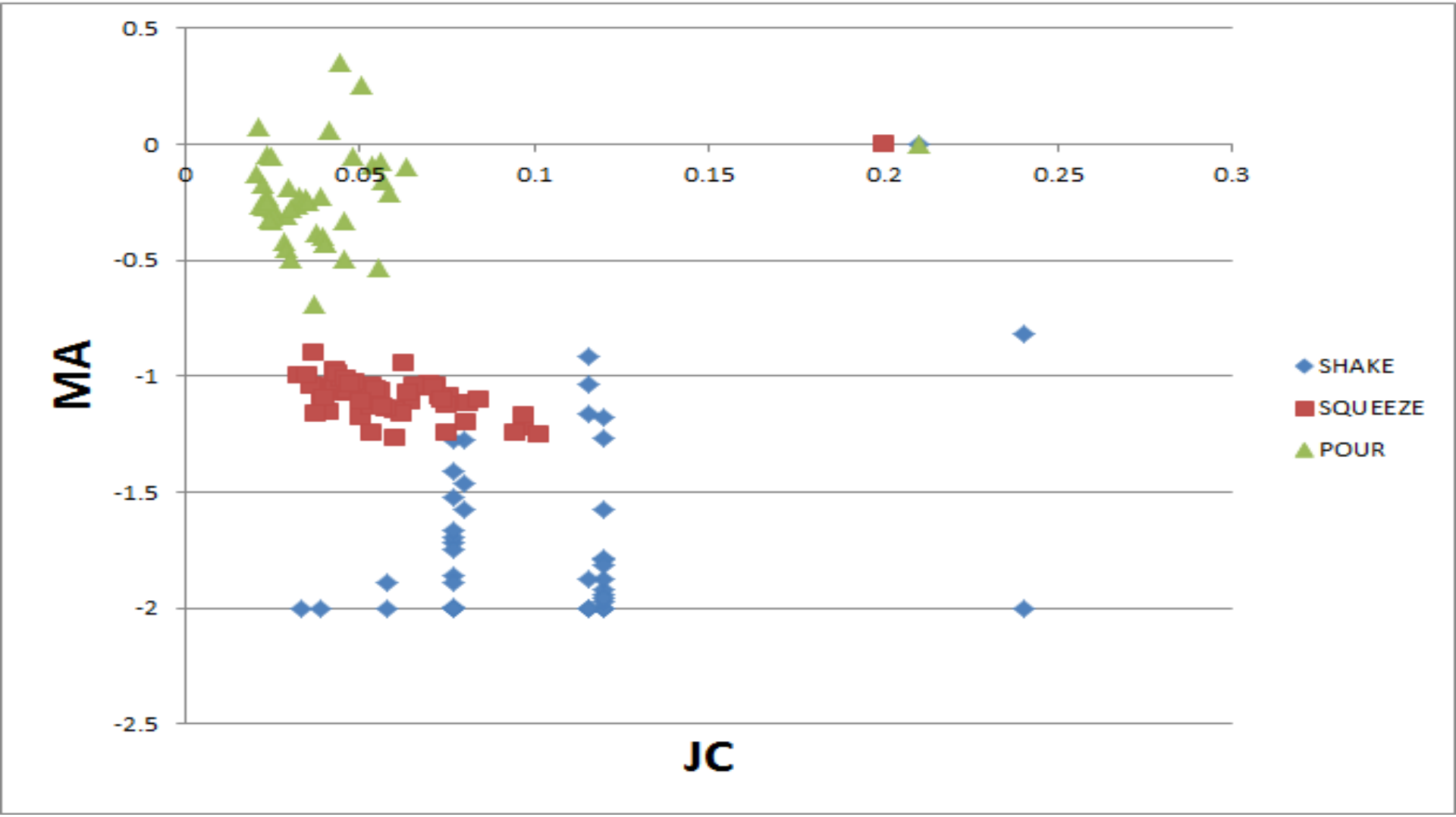
Clustering three actions - 1



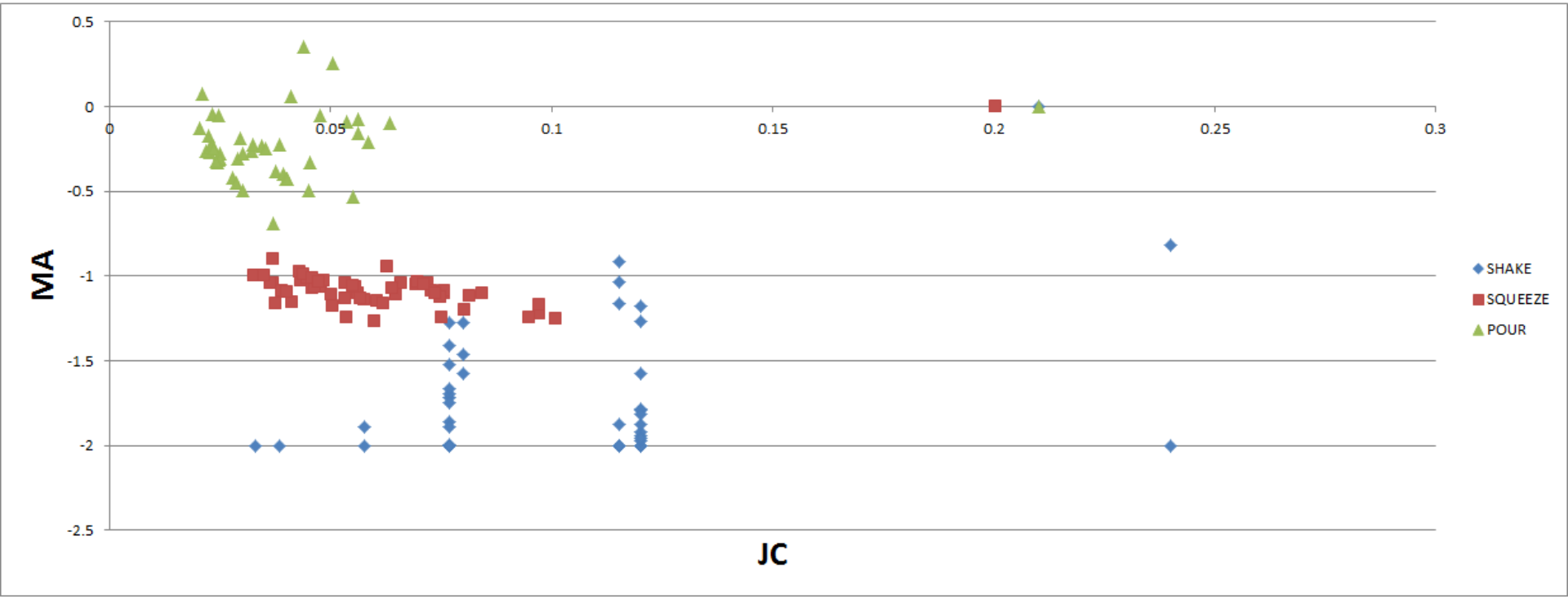
Clustering three actions - 2



Clustering three actions - 3



Clustering three actions - 4



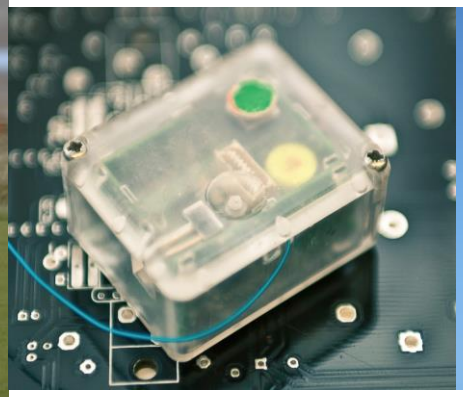
Golf Swing

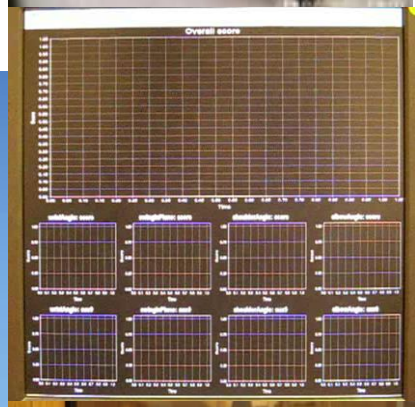
Arvind, D.K., Bates, C.A., 2008 ``The Speckled Golfer'', In 3rd Int. Conf. on Body Area Networks, March 13 - 17, 2008, Tempe AZ, USA, IEEE Press.

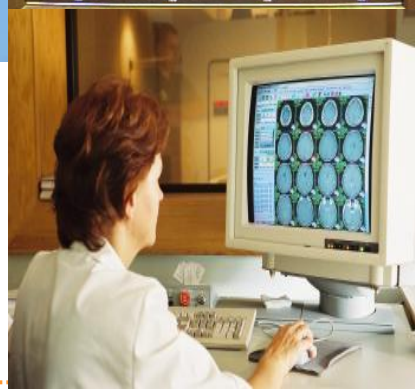
Analysis of golf swing ....

- …. 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

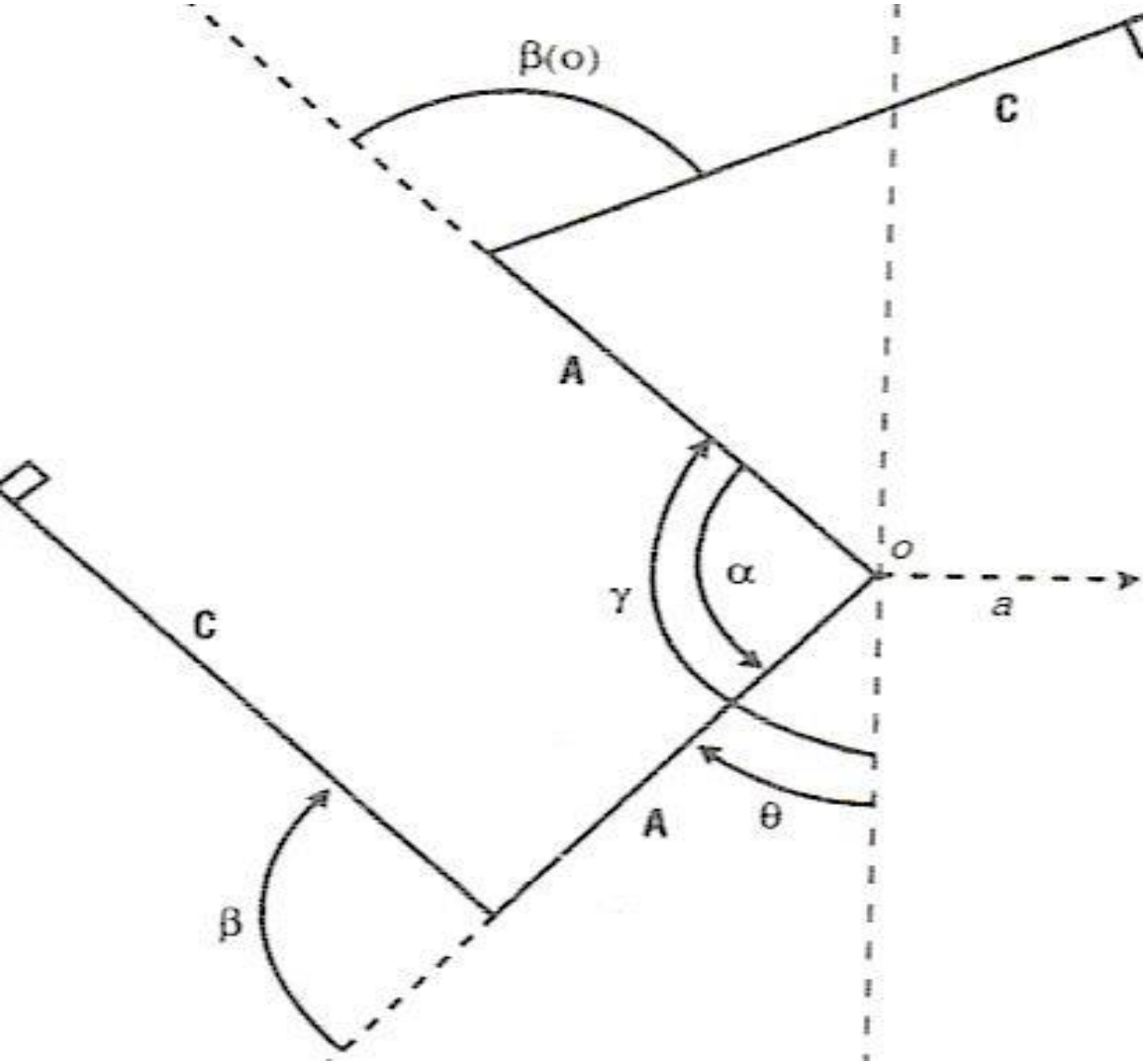
Swing of the Club

- 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

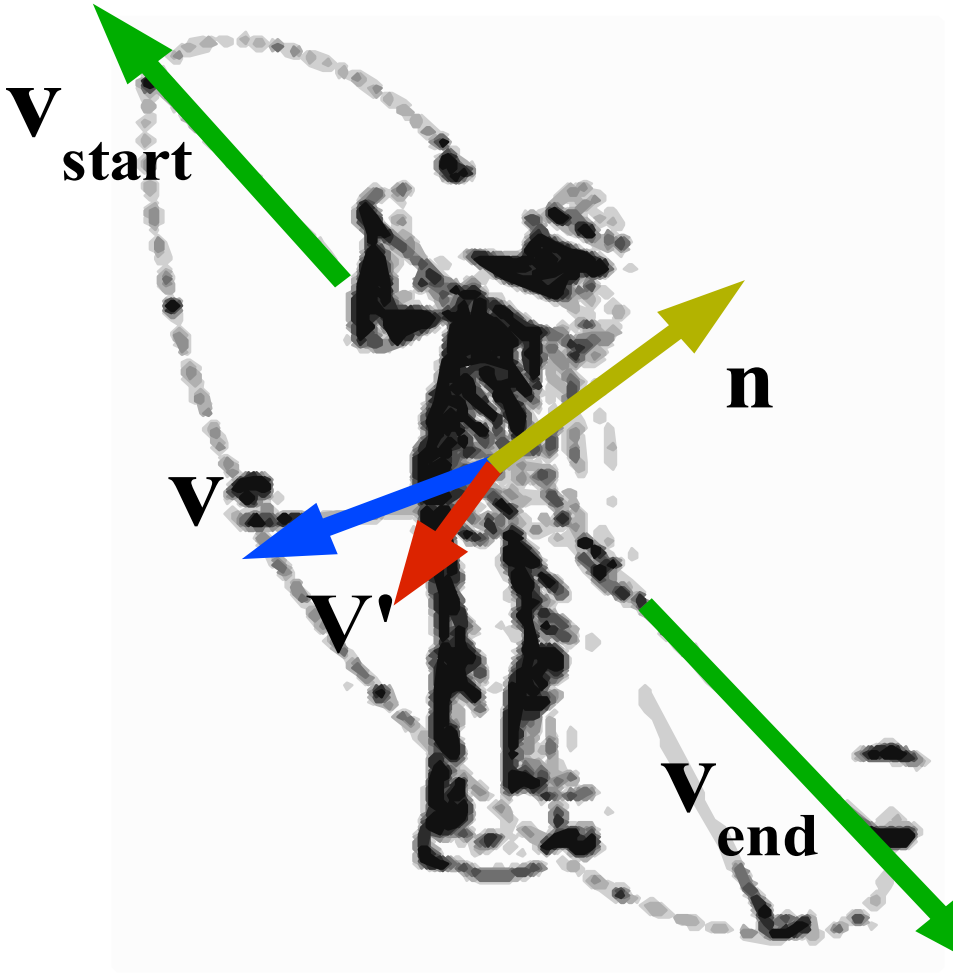
Biomechanics of the Swing



- *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

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

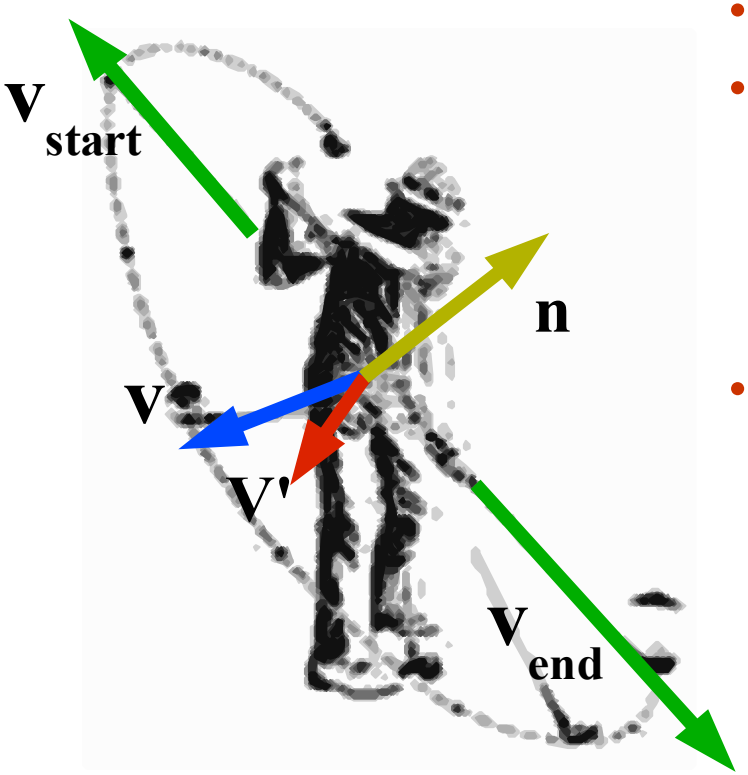
“Swinging in the Plane” Rule



- **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

$$\cos(\alpha) = \mathbf{v'}.\mathbf{n} \,/\, |\mathbf{v'}||\mathbf{n}|$$

"Swinging in the Plane" Rule

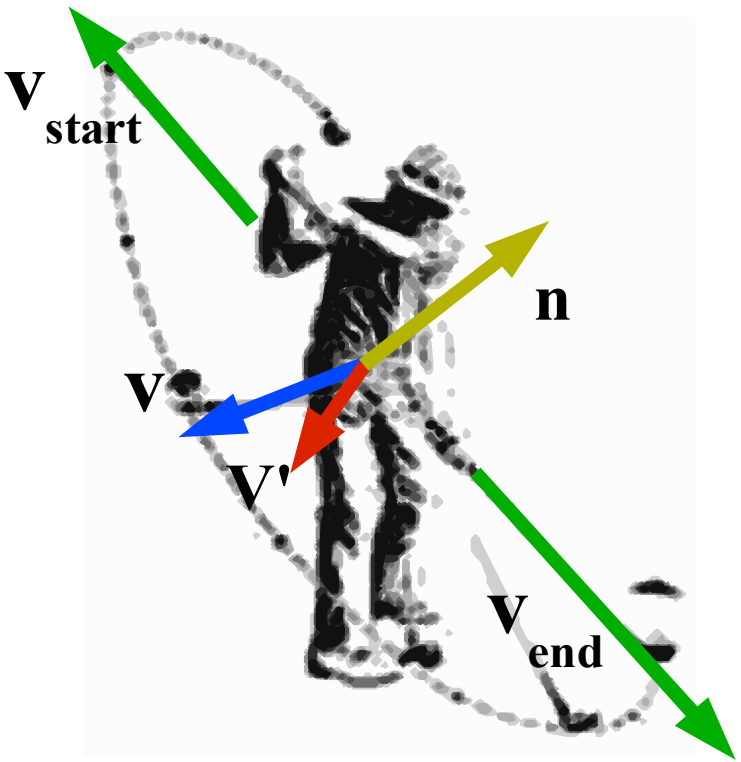


- **cos(α) = v'.n / |v'||n|,** α - angle between **v'** and **n**
- **v'** is obtained by taking the local down-shaft vector in the club sensor's co-ordinate system and rotating it by the current orientation of the device, to give a vector that points down the shaft in the world co-ordinate system
-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

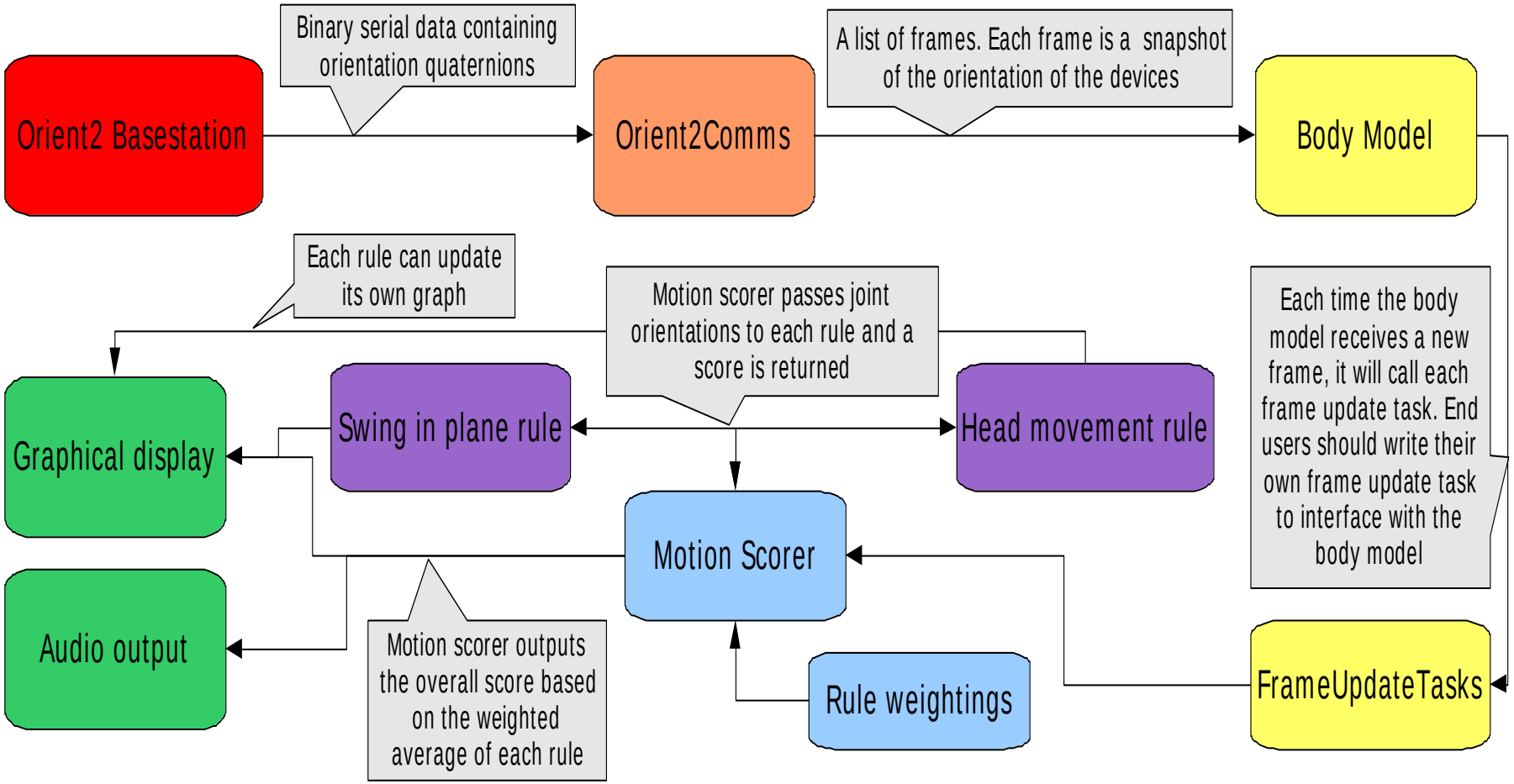
“Head Movement” Rule



- 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

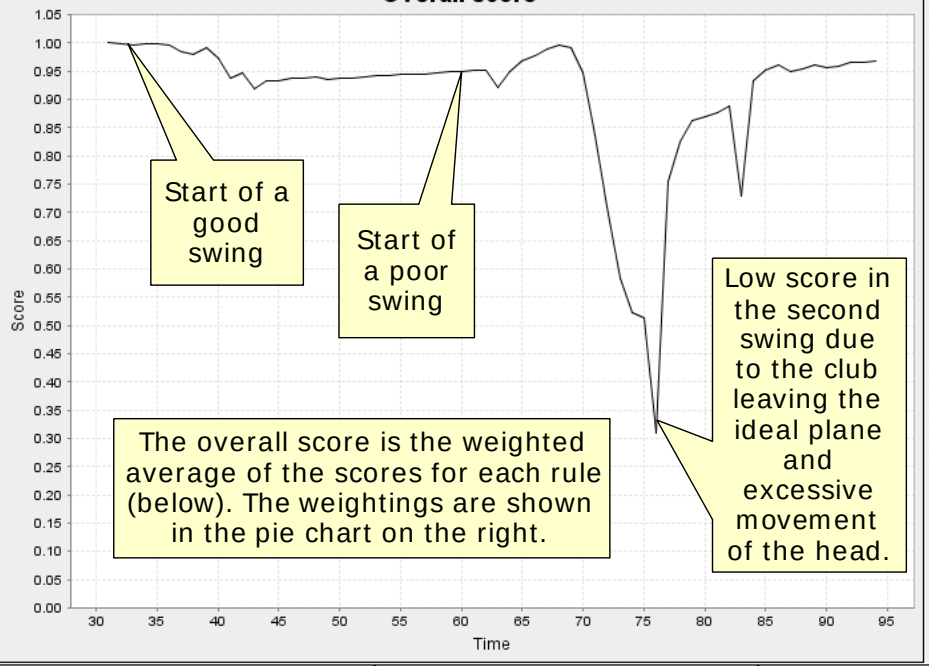
Body model on the Mobile



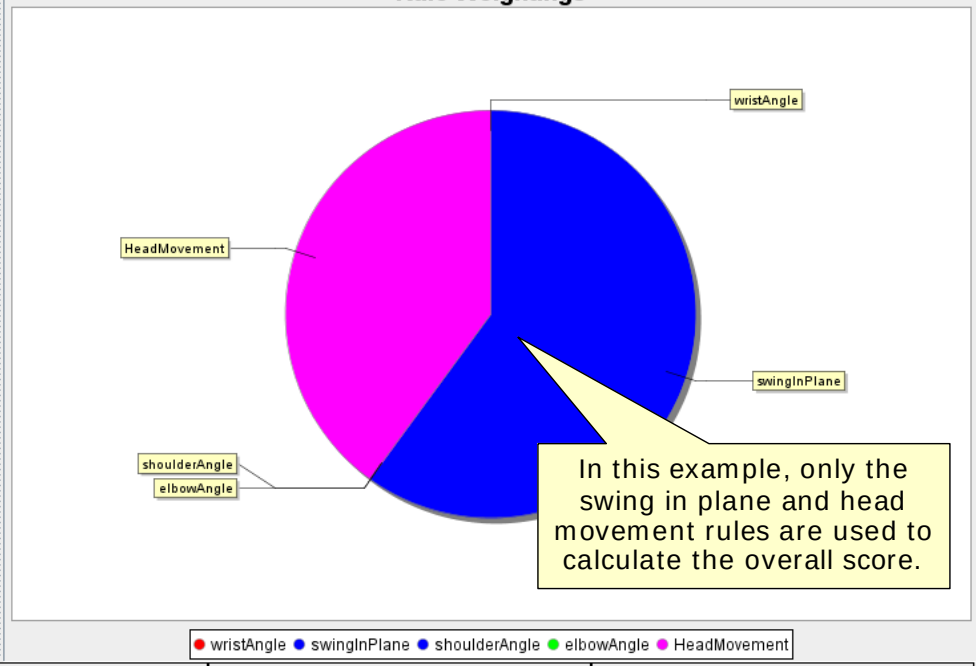
Motion Scorer

Start | Stop | Reset | Set end vector

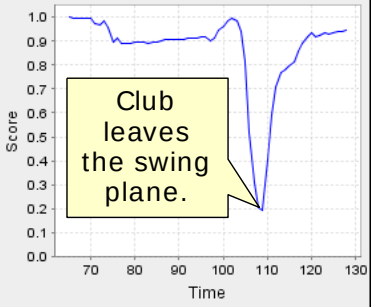
Overall score



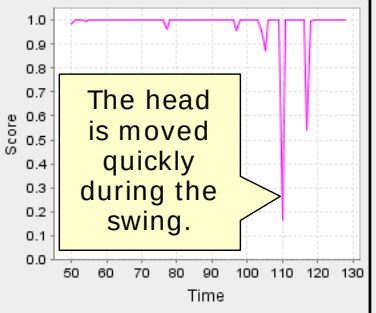
Rule Weightings



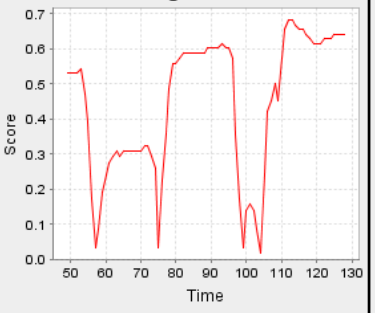
swingInPlane: score



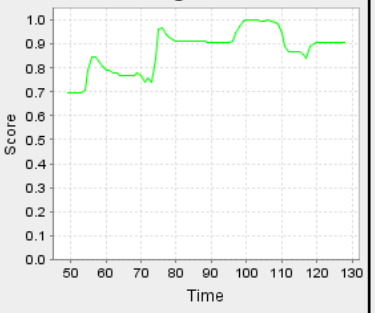
HeadMovement: score



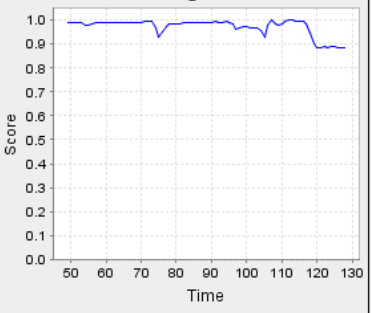
wristAngle: score



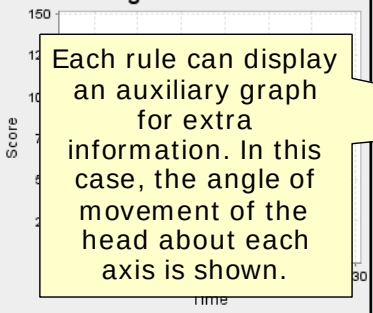
elbowAngle: score



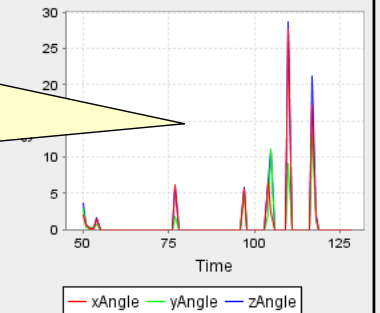
shoulderAngle: score



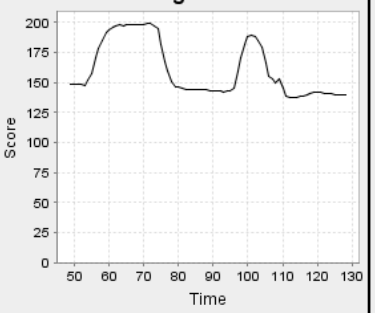
swingInPlane: aux0



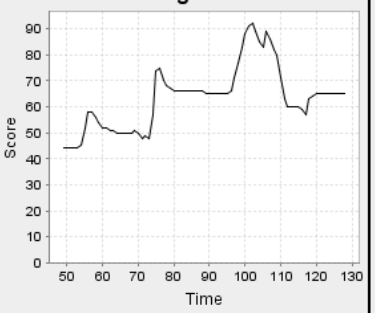
HeadMovement: aux0



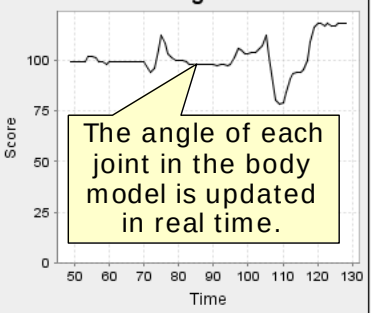
wristAngle: aux0

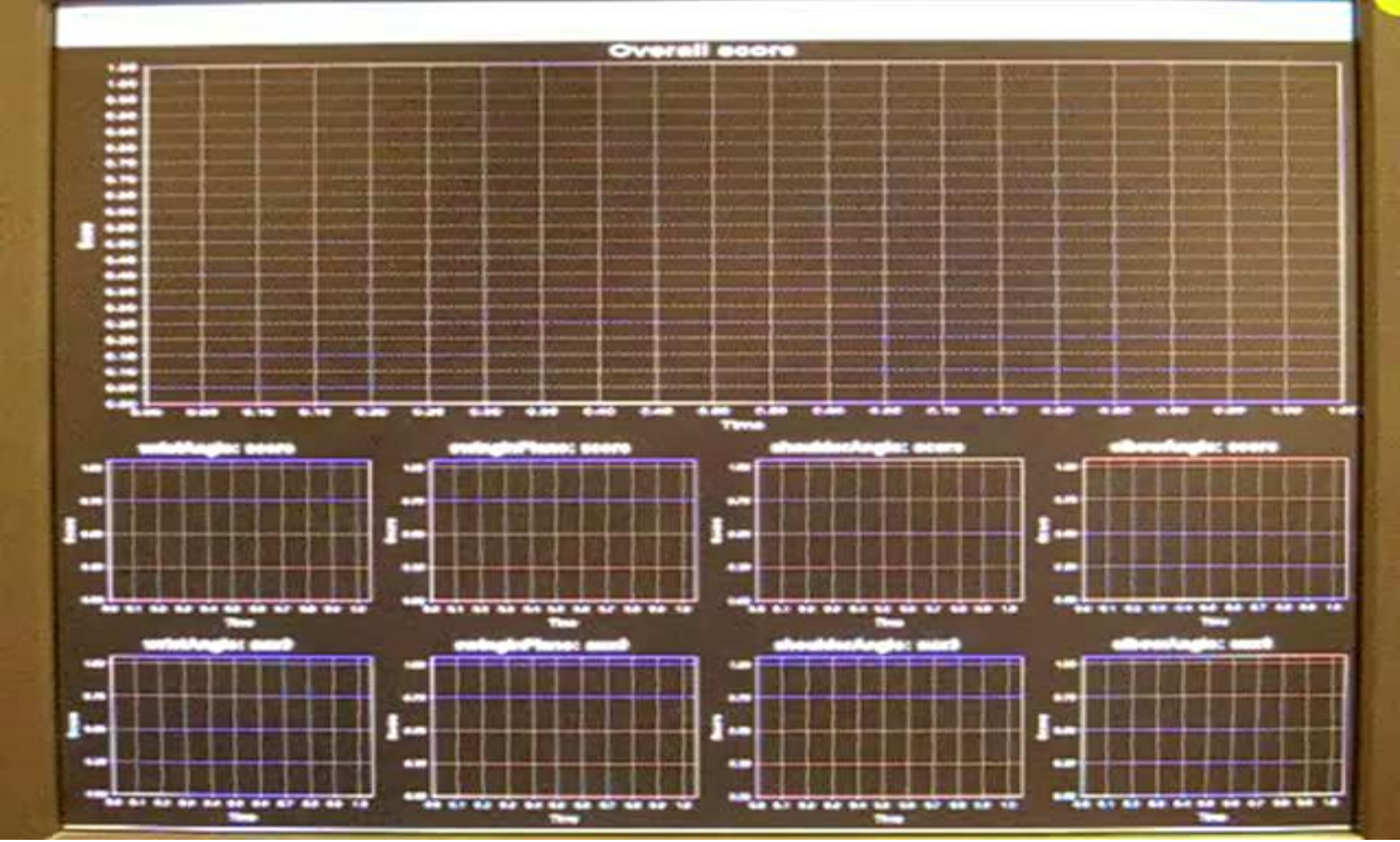


elbowAngle: aux0

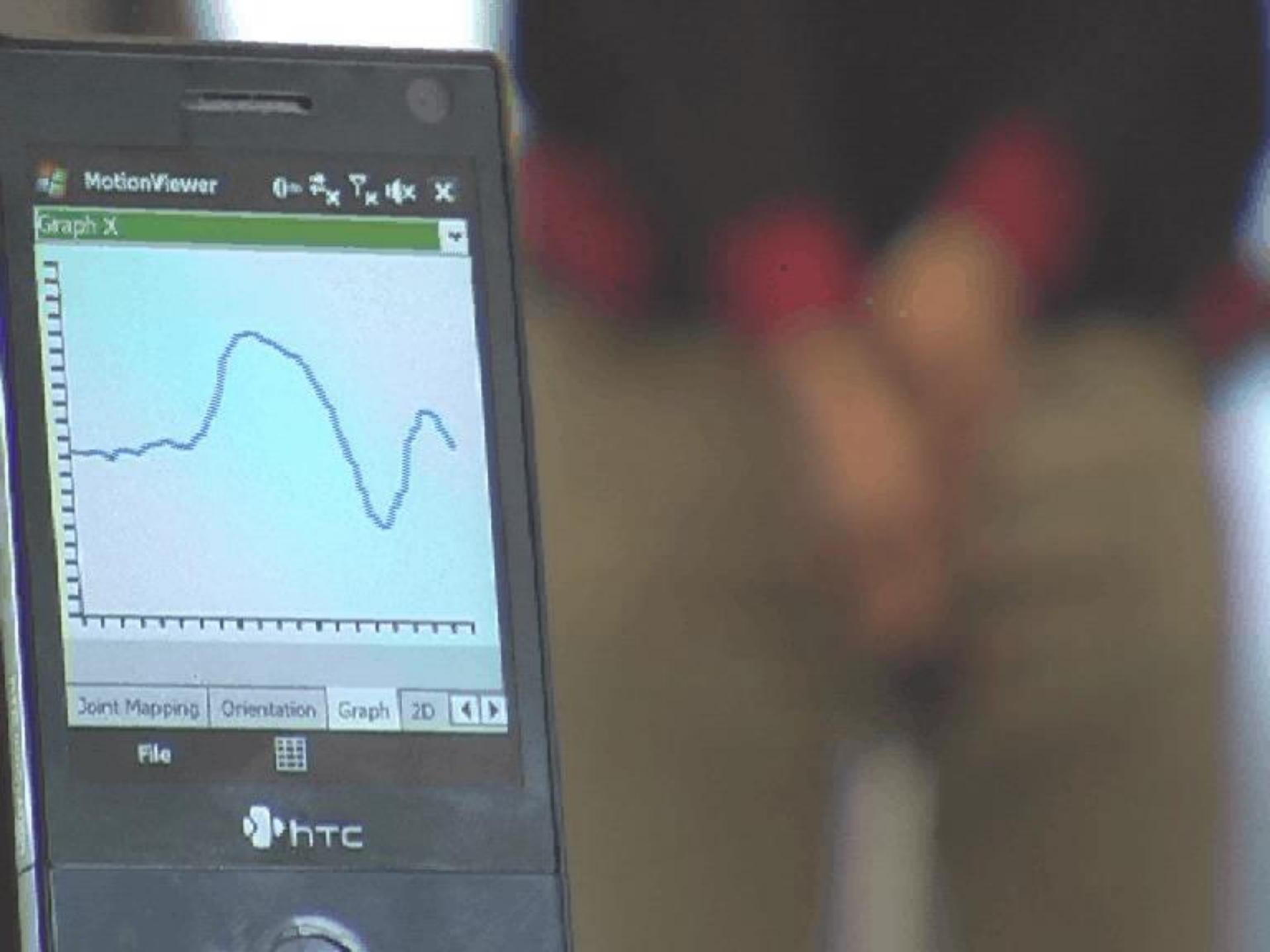


shoulderAngle: aux0





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

Centre for Speckled Computing

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

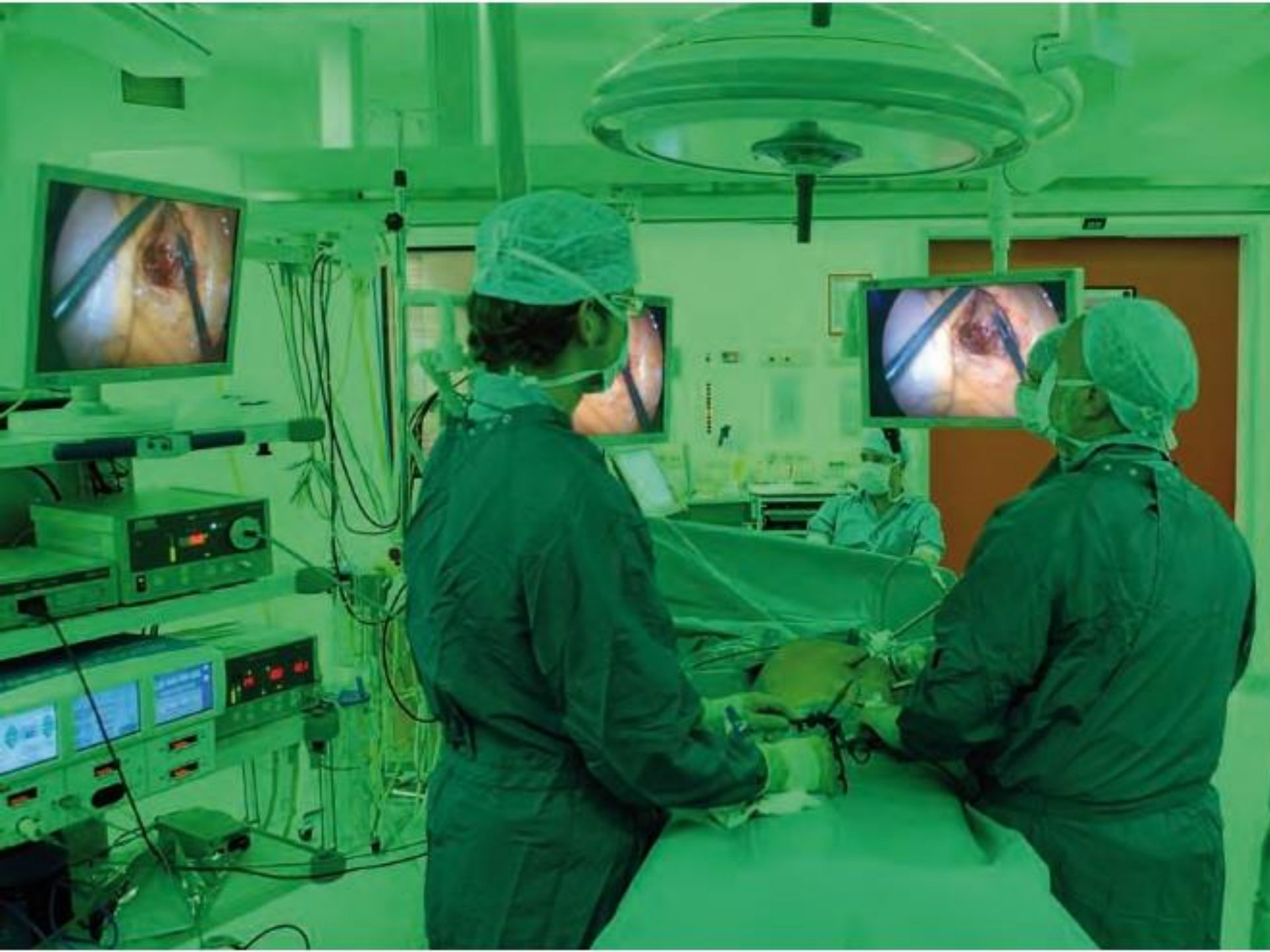
R L Evans[1], R W Partridge[2] and D K Arvind[1]

[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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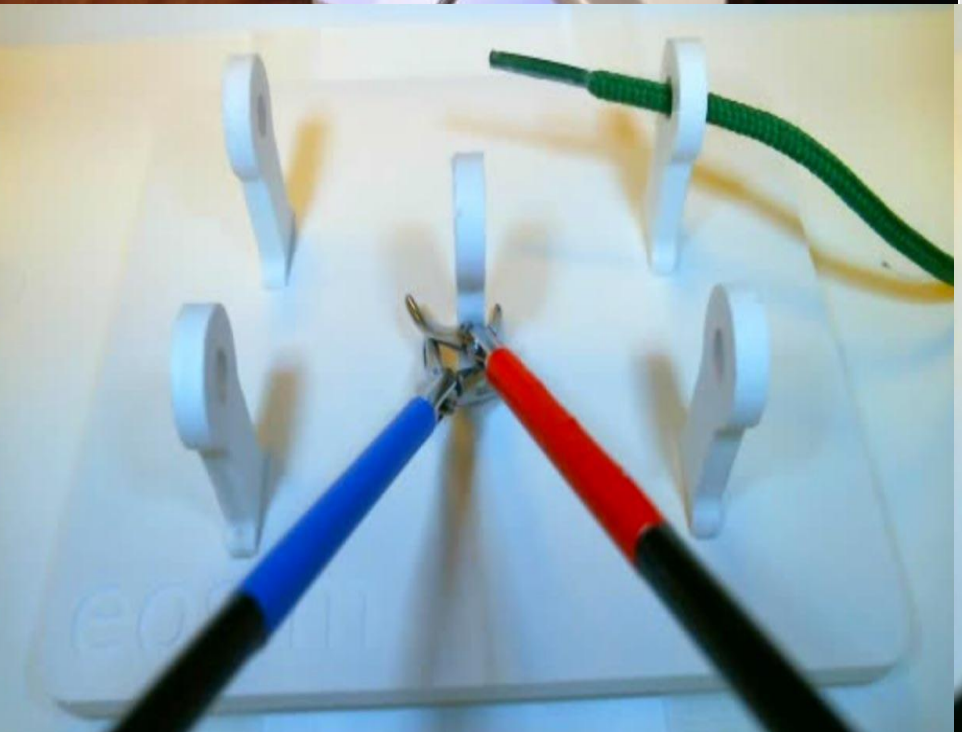
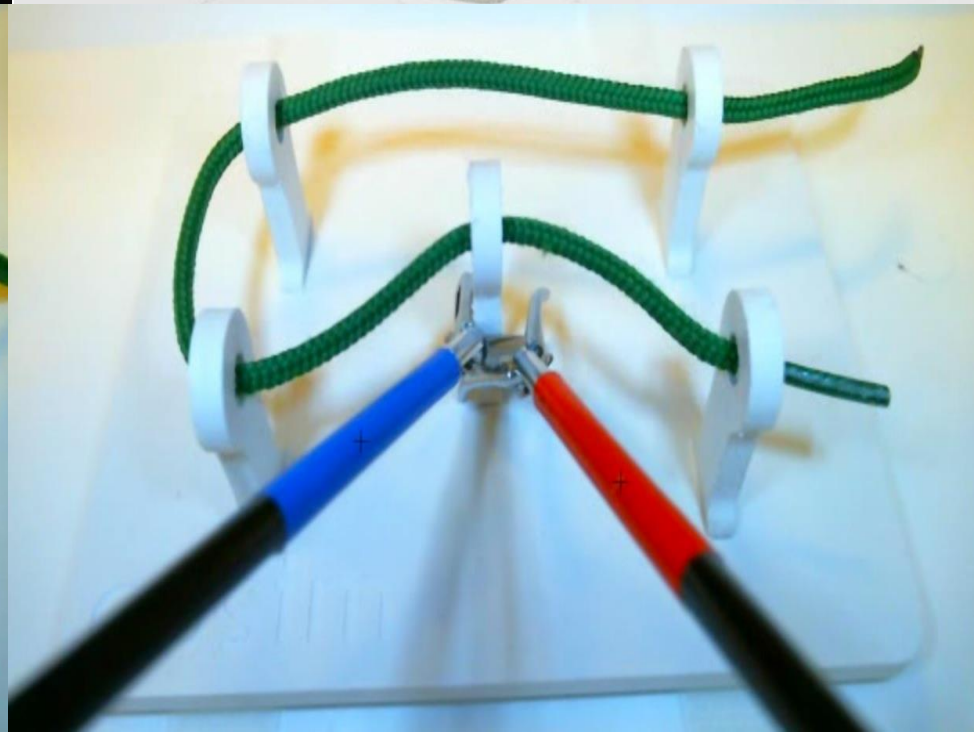
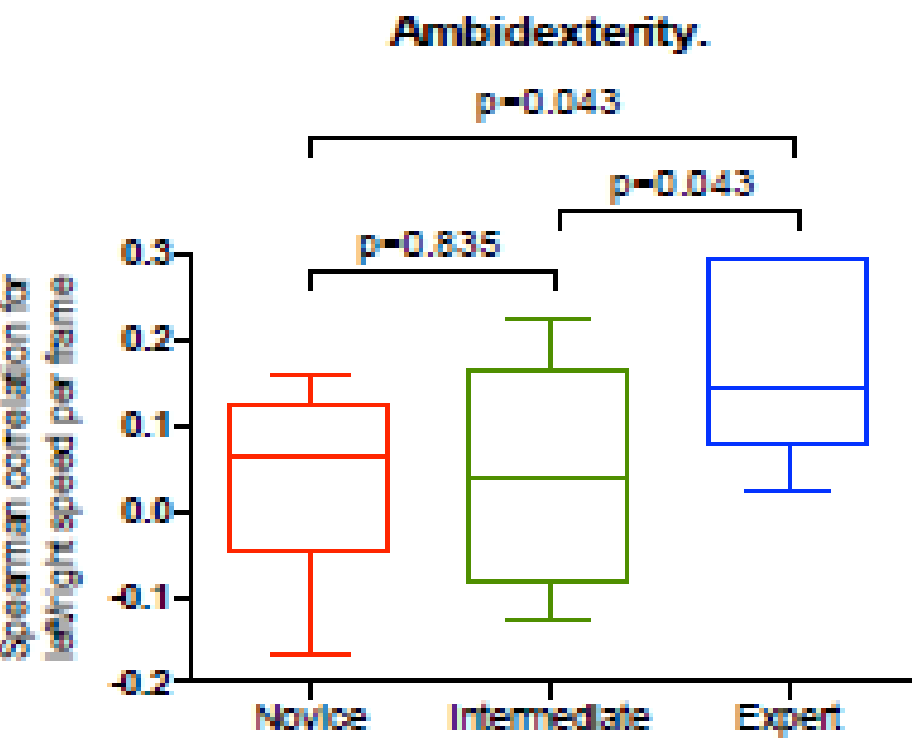
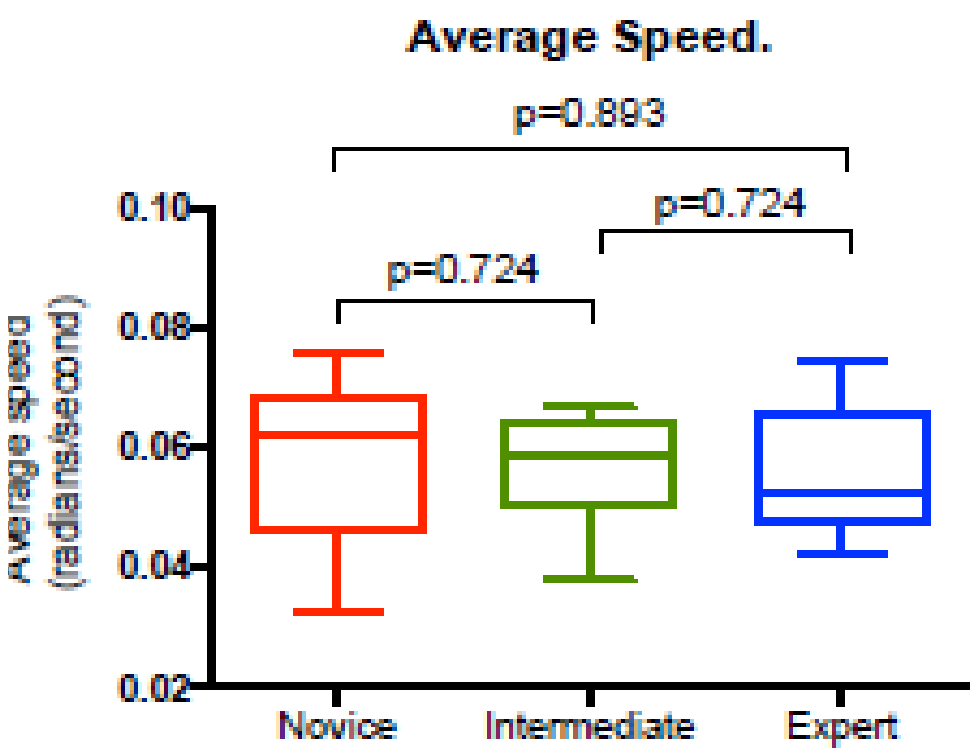





Ambidexterity.
p=0.043
p=0.043
p=0.835
Spearman correlation for left/right speed per frame
0.3
0.2
0.1
0.0
-0.1
-0.2
Novice
Intermediate
Expert


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.

$$\text{score} = -2 + 1000\alpha - 0.027T + 5 \times 10^{-10} \cdot S - 0.4\theta - 1.6A$$

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