

Comparison of Orientation Filter Implementations

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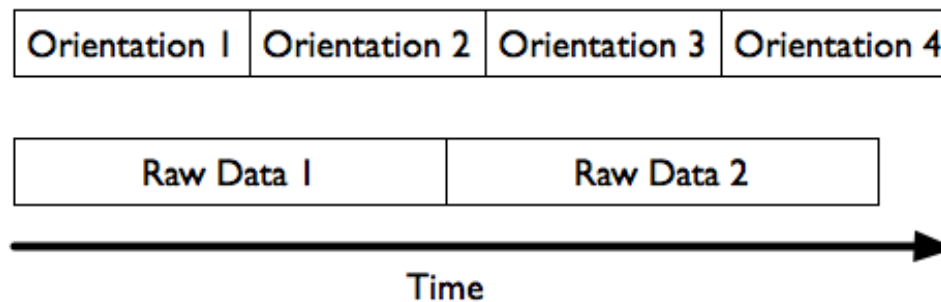
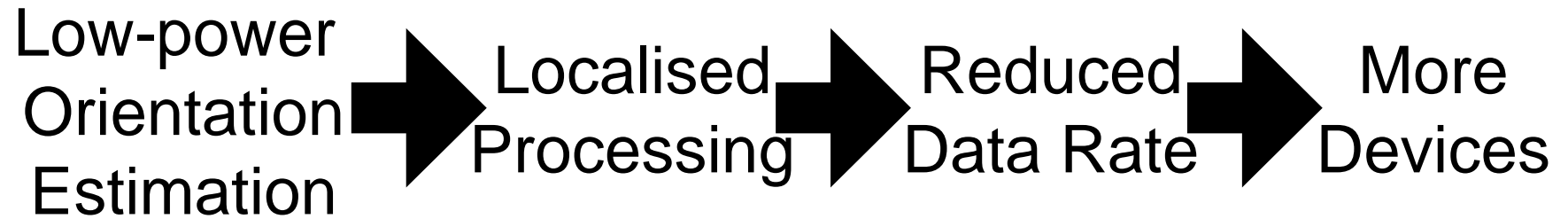


What is special about Orient?

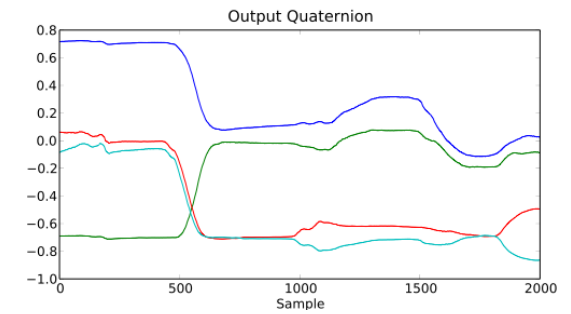
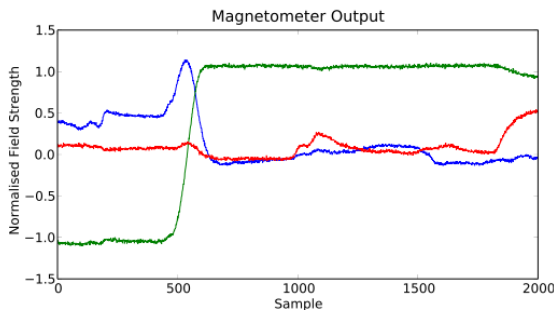
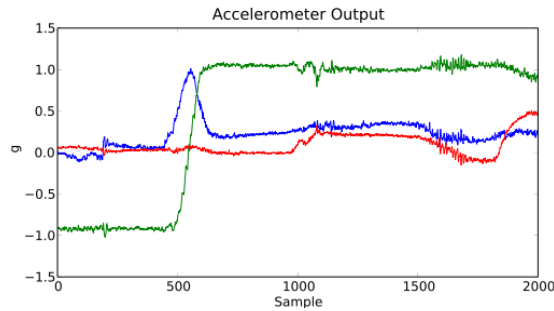
Only full body real time
wireless motion tracking
system



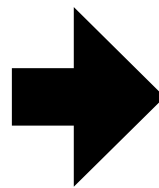
How is this possible?



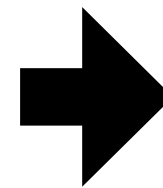
Estimation Problem



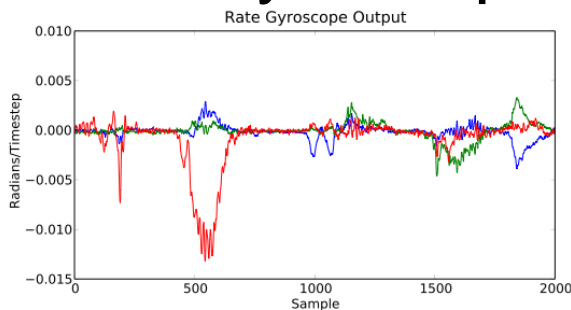
Accelerometers
Magnetometers
Rate Gyroscopes



Estimation
Filter



Estimated
Quaternion



Estimation Techniques

Gyroscope Integration

- Clean output
- Fast response
- Relative estimate
 - Cumulative drift error

Vector Observation

- Noisy output
- Inaccurate during movement
- Absolute estimate

Implementations

- Optimal
 - QUEST
- Non-optimal
 - Orient, TRIAD, FQA



Filter Structures

Complementary Filter

- Direct integration of rotational rate
- Correction from vector observation estimate
 - Heuristic gating to ignore movement induced error
- Constant correction co-efficient

Kalman Filter

- Predicts future state
 - Requires process model
- Correction from state related measurements
- Varying correction gain
 - Based on estimated confidence

Extended Kalman Filter design by Yun *et al.* 2006



Filter Comparison Setup

Qualisys optical motion capture system

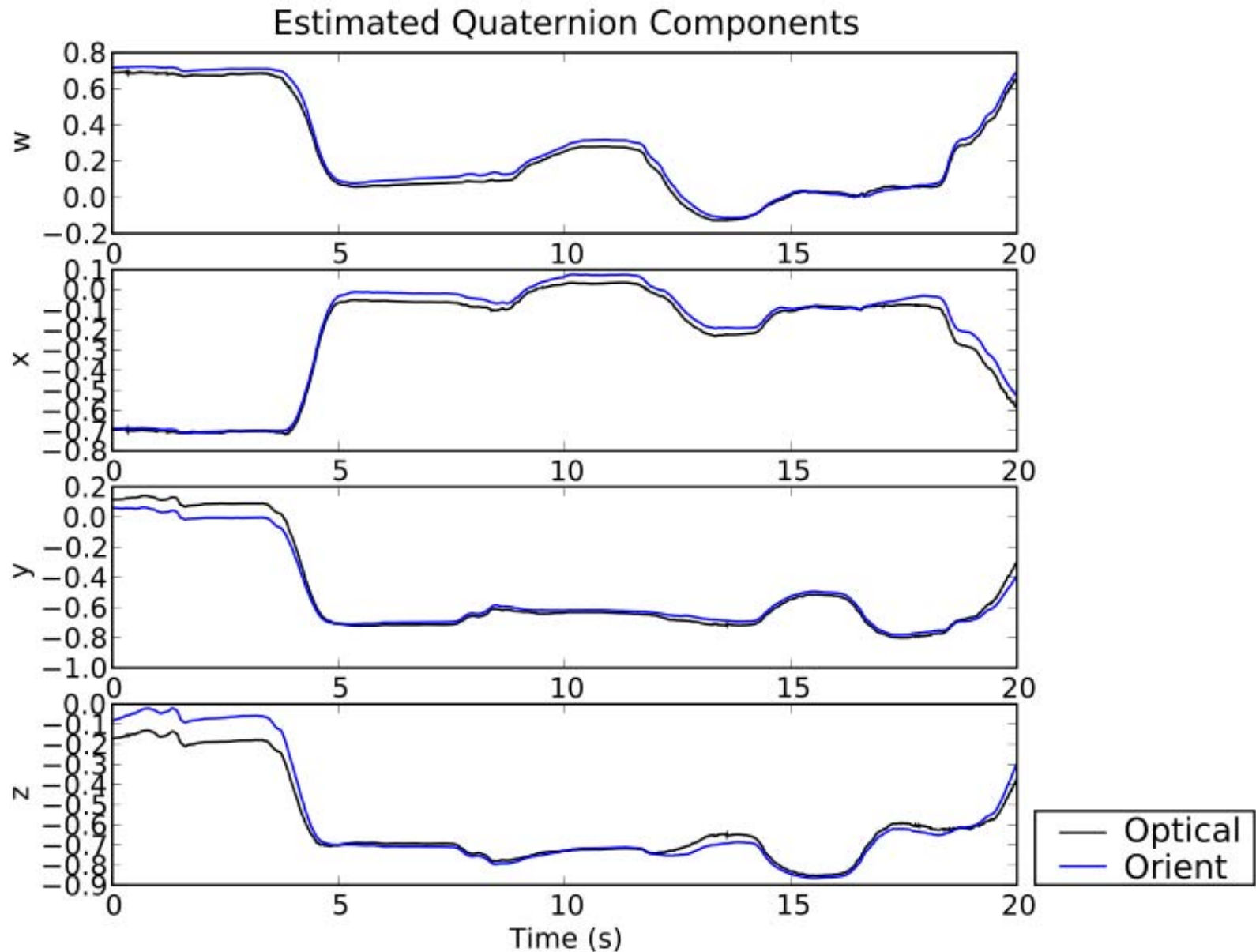
- Truth reference
- Frame synchronisation with Orient basestation
- Calibrated raw sensor data
- Offline python filter implementations

Two scenarios

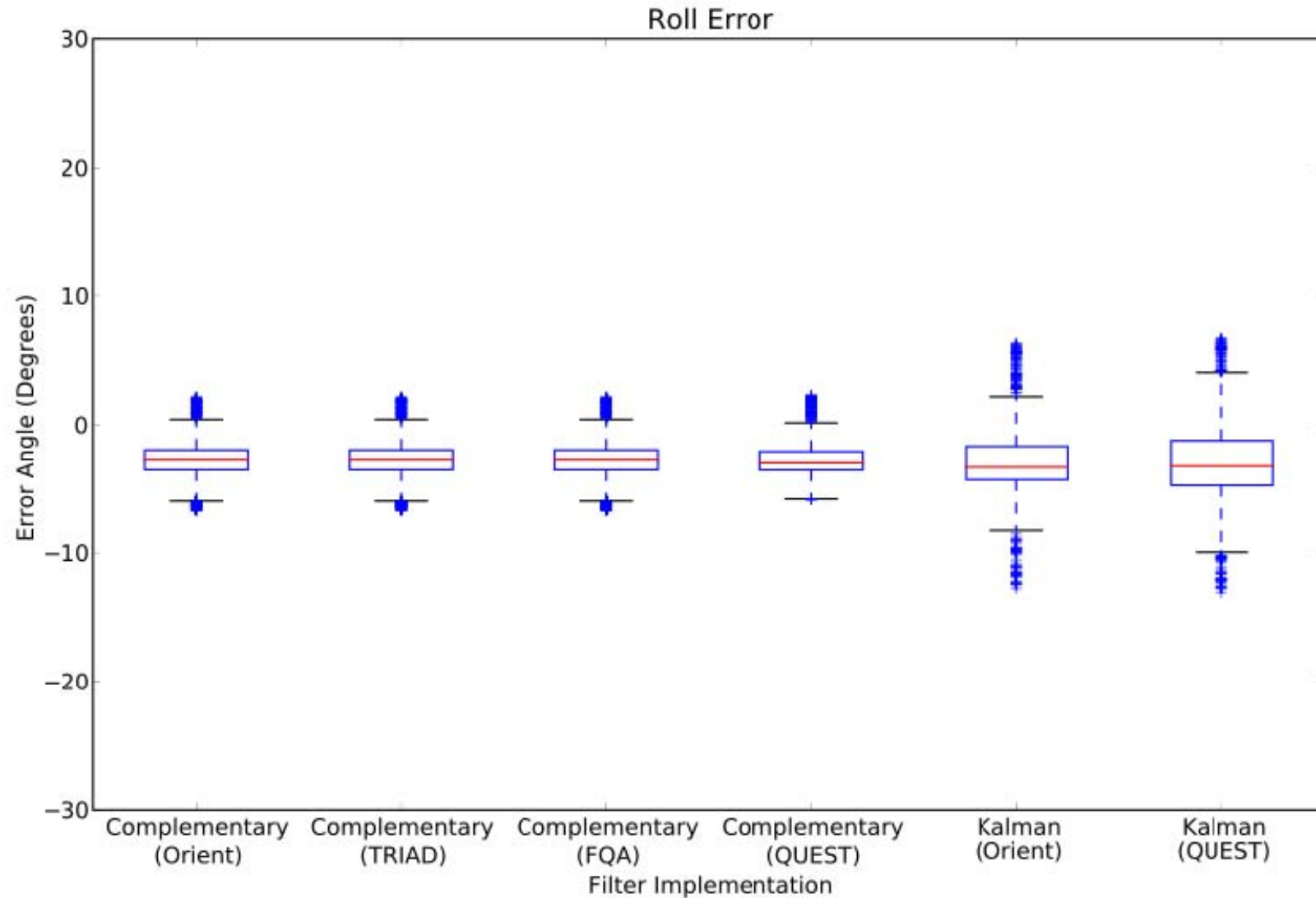
- Simple rotation
- Walking



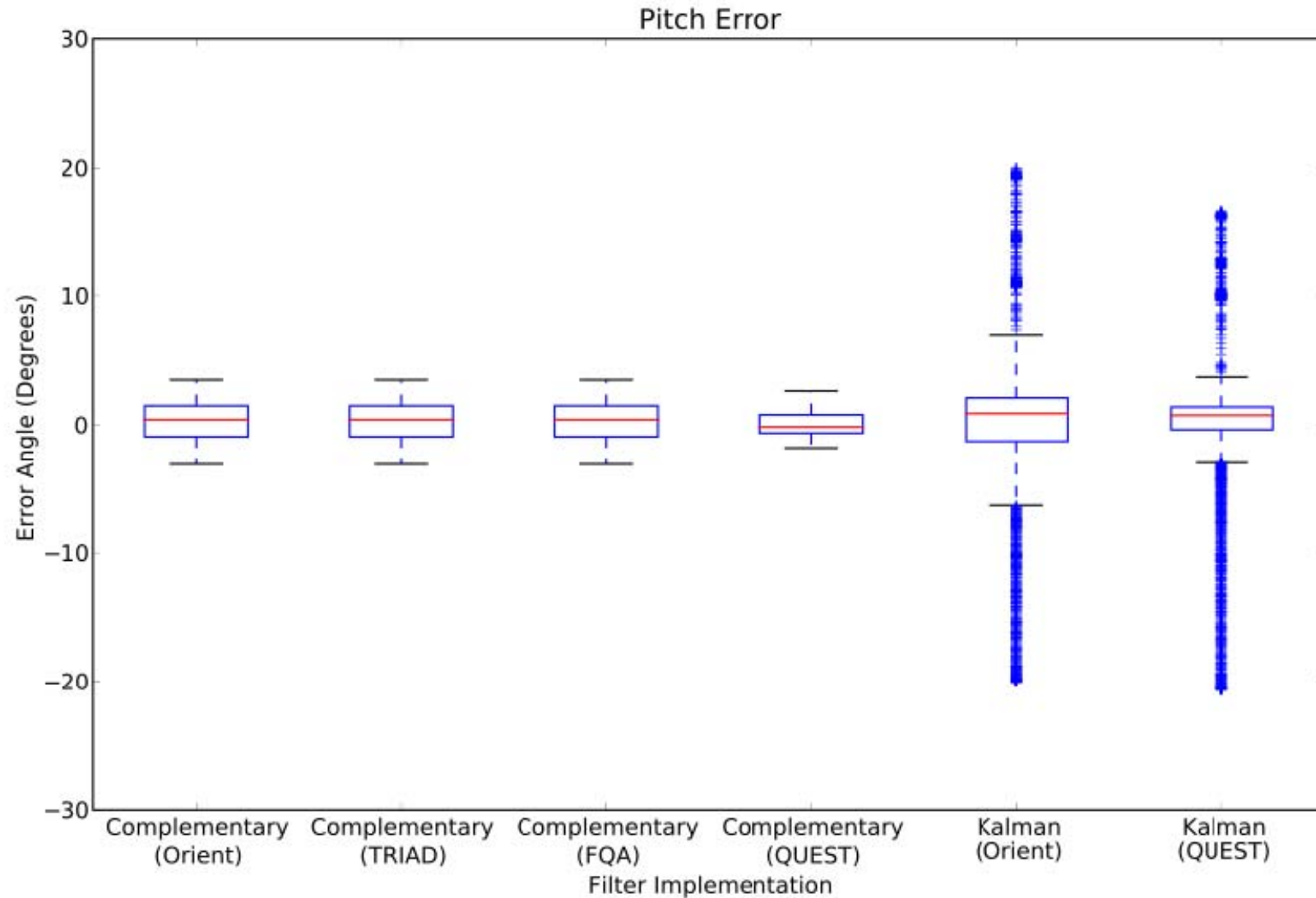
Simple Rotation Accuracy



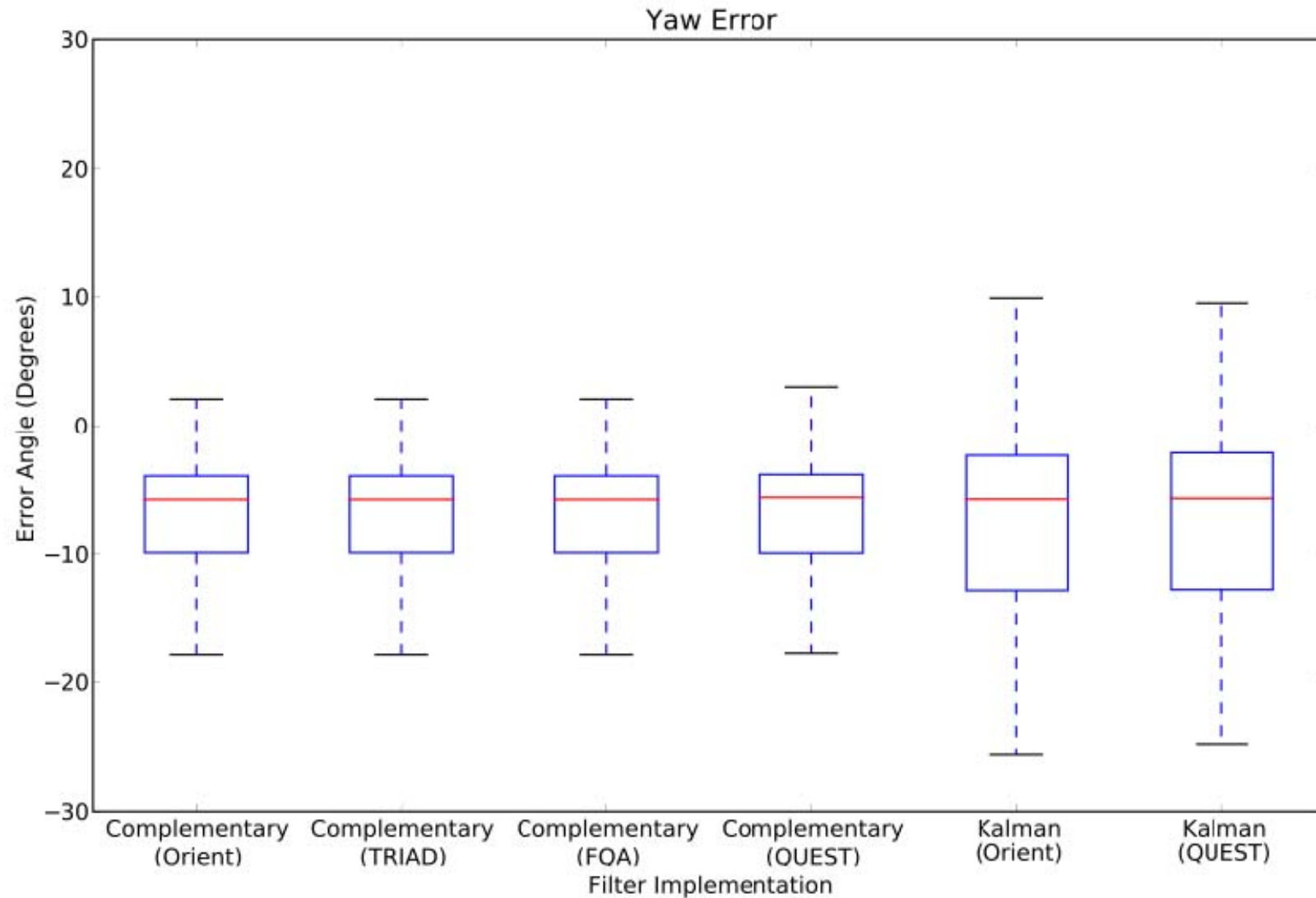
Simple Rotation Accuracy



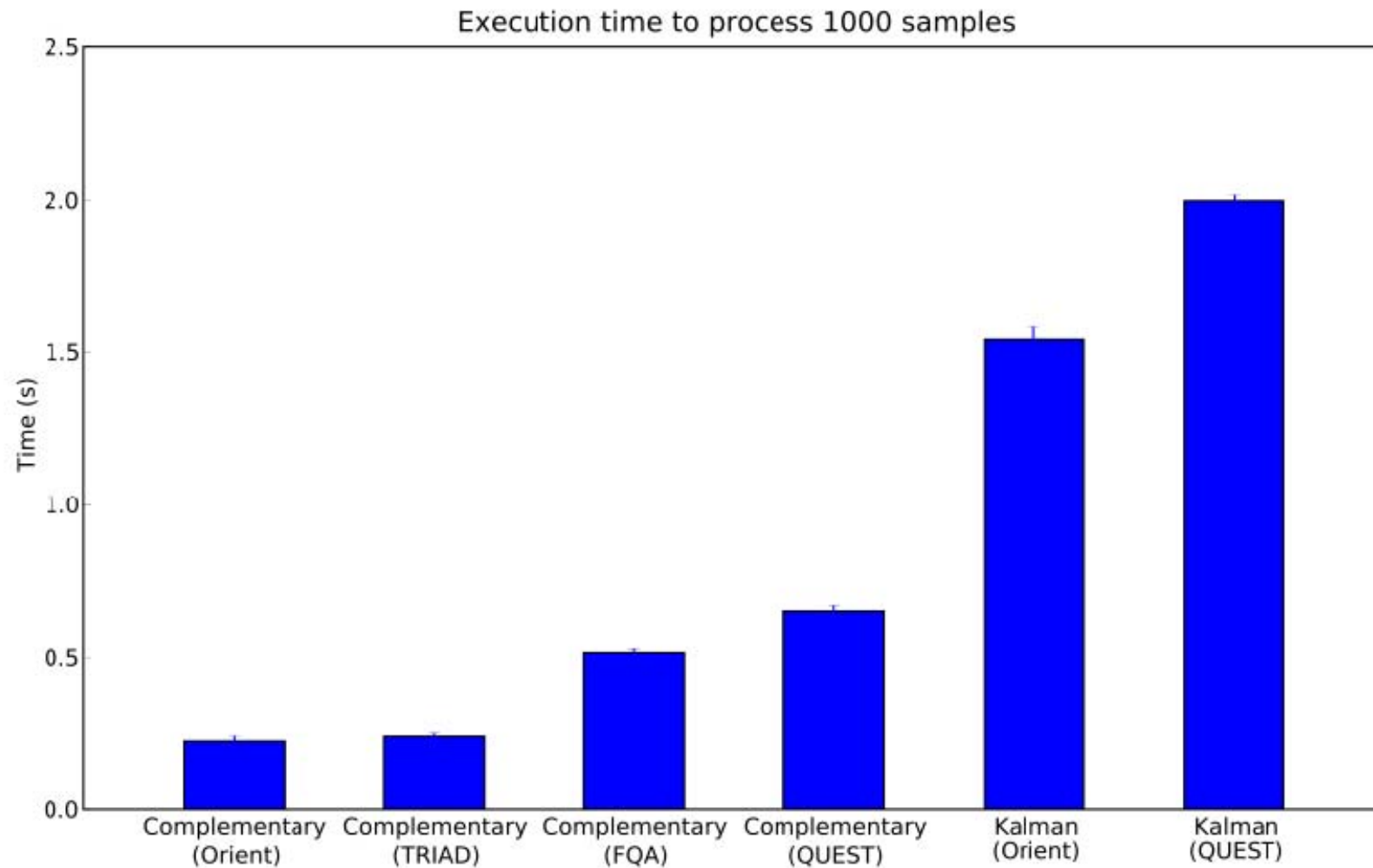
Simple Rotation Accuracy



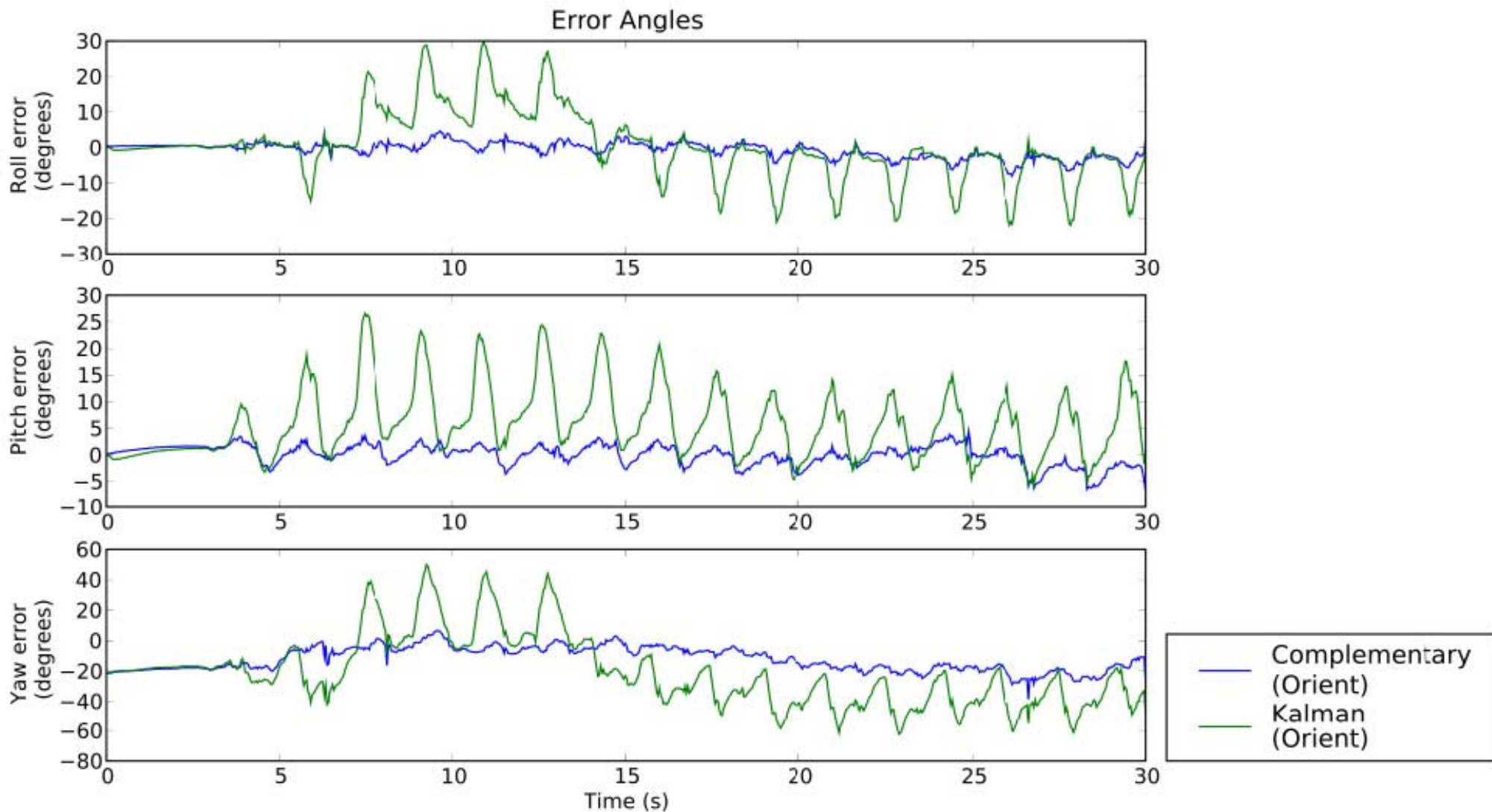
Simple Rotation Accuracy



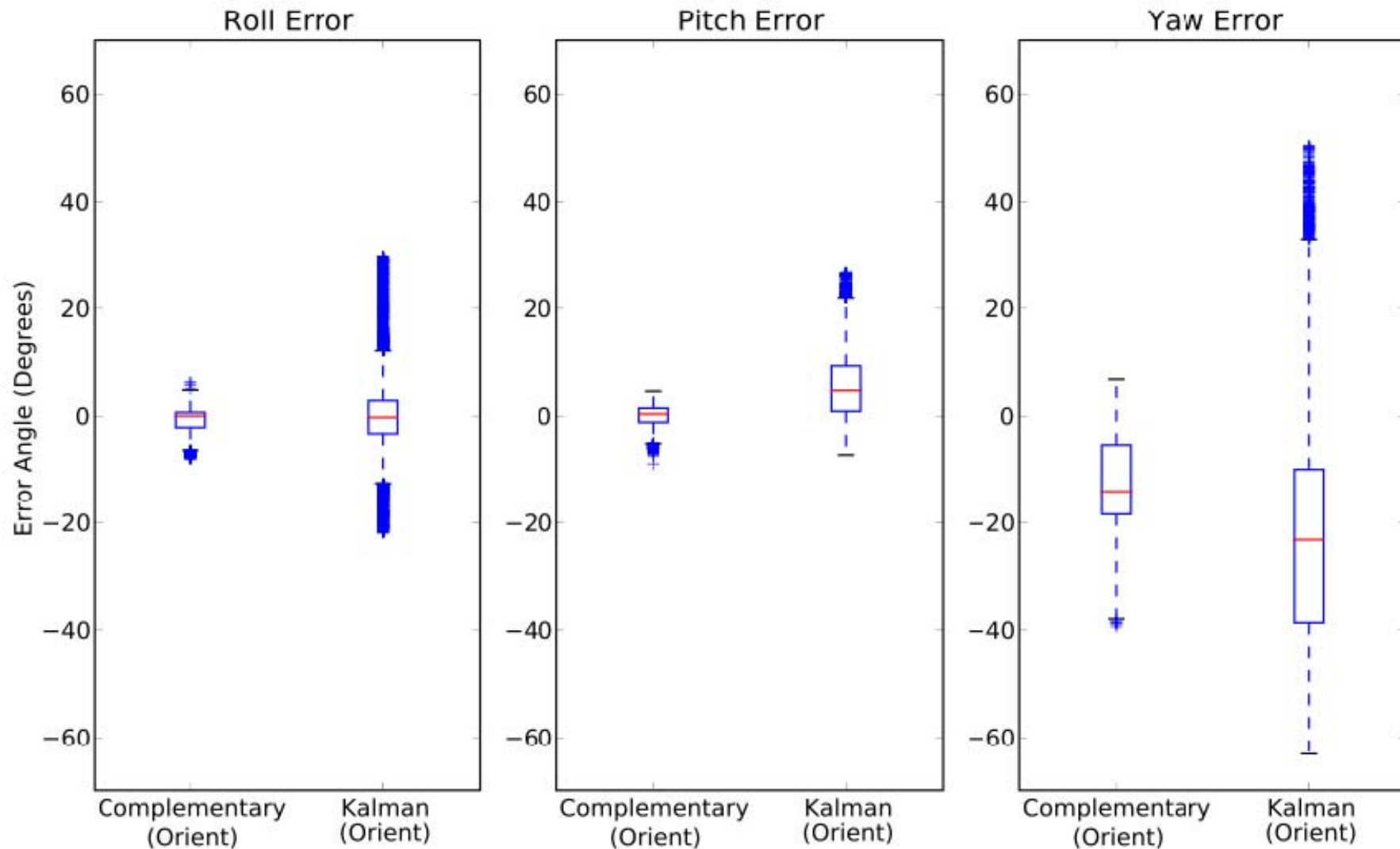
Execution Time



Walking Accuracy



Walking Accuracy



Conclusions

Complementary filter is the clear winner

- Much faster than Kalman filter
- At least as accurate for simple motions
- Poor Kalman process model leads to large errors during repetitive motion

Is it all bad news for Kalman filters? - Not really

- Better process model may help for repetitive motion such as human gait
- Could be used in conjunction with existing complementary filter

