Sensor fusion for complex articulated body tracking applied in rowing

Emanuele Ruffaldi
Lorenzo Peppoloni
Alessandro Filippeschi

2014 IEEE International Conference on Robotics and Automation (ICRA) Hong Kong Convention and Exhibition Center
Hong Kong, China.

Research Context

Motion analysis, expertise modeling and synthesis for…

Sport training in Real and Virtual Environments with focus on rowing

Motion and force tracking for ecological ergonomic assessment

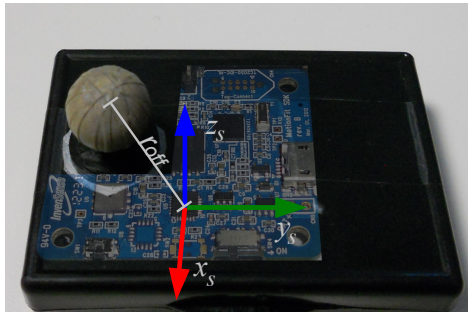
Objective

- Provide body tracking based on inertial measures in outdoor environment
- Taking advantage of existing instrumentation
  - Oar and Seat sensing
- Sensor fusion between sensing systems

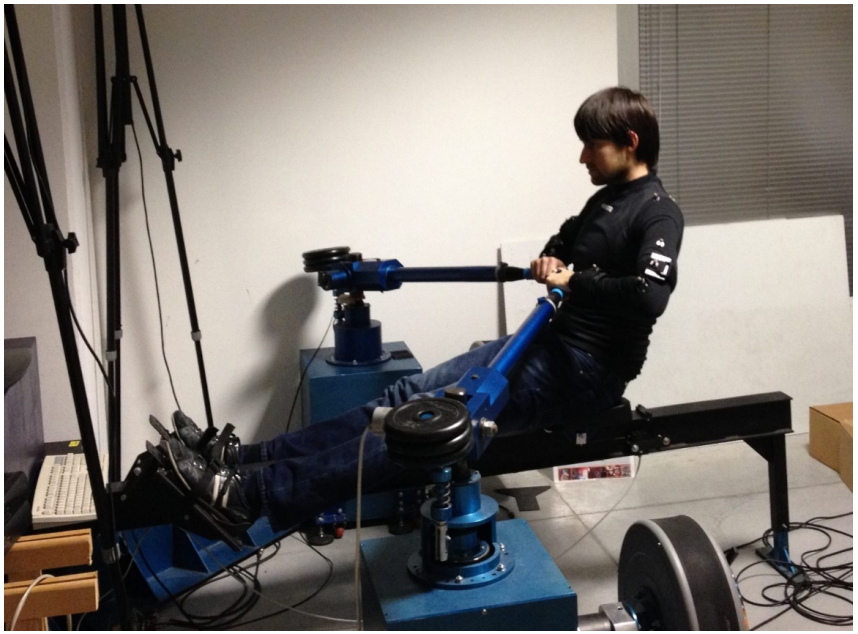
[Filippeschi 2013 SMC]

Approach

- Indoor testing using the validated SPRINT platform and inertial wearable units (5 9-axis)
- Two kinematic chains with **imposed closure** considering that the seat position corresponds to the rower's pelvis position and the tip of the oar handles positions and orientations match the rower's wrist poses

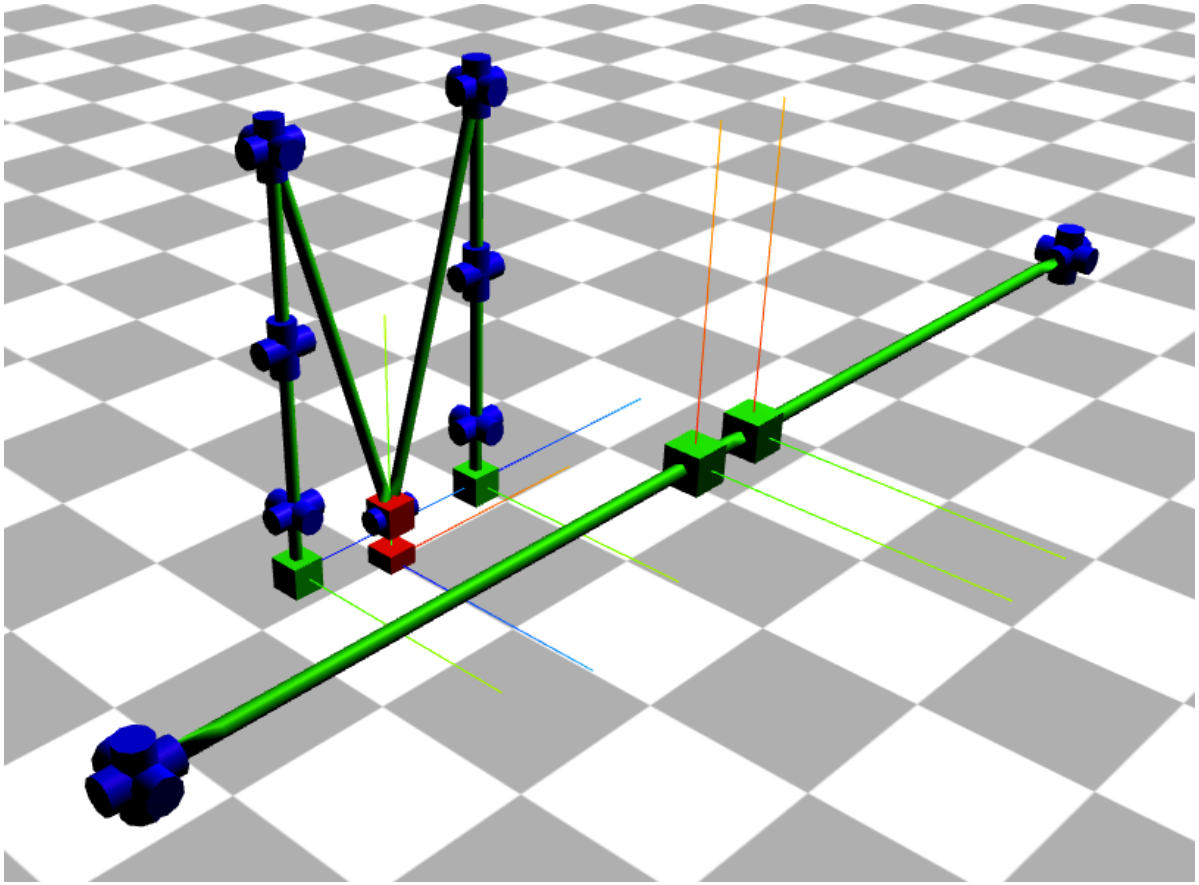


5 9-axis IMUs



Seat and Oar Tracking

Kinematic Model and Estimation



2 + 7 per Arm + 2 per Oar = 18 DOF
Overall 25 frames in Denavit-Hartenberg notation

UKF model with 37 state dimensions and 58 measurements dimensions

Results

Comparison with VICON Motion Capture

Joints	RMS	Joints	RMS
q_1 $[m]$	0.107	q_7 $[deg]$	0.203
q_2 $[deg]$	0.326	q_8 $[deg]$	0.134
q_3 $[deg]$	0.118	q_9 $[deg]$	0.193
q_4 $[deg]$	0.220	q_{10} $[deg]$	0.306
q_5 $[deg]$	0.382	q_{11} $[deg]$	0.282
q_6 $[deg]$	0.329	q_{12} $[deg]$	0.172

Position	E_p	Positions	E_p
p_{ShR} $[m]$	0.078	p_{ElL} $[m]$	0.153
p_{ShL} $[m]$	0.081	p_{WrR} $[m]$	0.034
p_{ElR} $[m]$	0.158	p_{WrL} $[m]$	0.054

Conclusions and Future

- More constraints can be applied
- Computational complexity has to be addressed (UKF with large domain space)
- Transfer to outdoor boat capture
  - Issues of inertial component of boat motion

See Also @ICRA2014

A novel approach to motion tracking with wearable sensors based on Probabilistic Graphical Models (Ruffaldi et al., Session S226 Monday Morning)

See you at the poster!

email:
e.ruffaldi@sssup.it

ISTITUTO DI TECNOLOGIE DELLA COMUNICAZIONE, DELL'INFORMAZIONE E DELLA PERCEZIONE
Scuola Superiore Sant'Anna
PERCRO Perceptual Robotics Laboratory