PIETRO GAROFALO

TECHNICAL DIRECTOR

TURINGSENSE EU LAB S.R.L.
FORLI' (ITALY)

Easy-to-use calibration of inertial sensors-based smart clothing for consumers

Pietro Garofalo[1], Michele Raggi[1], Paola Di Florio[1], Carmelo Fiorentino[1], Lorenzo Marchesini[1] and Alessandro Montanari[1]

[1] Turingsense EU LAB, Forli, Italy

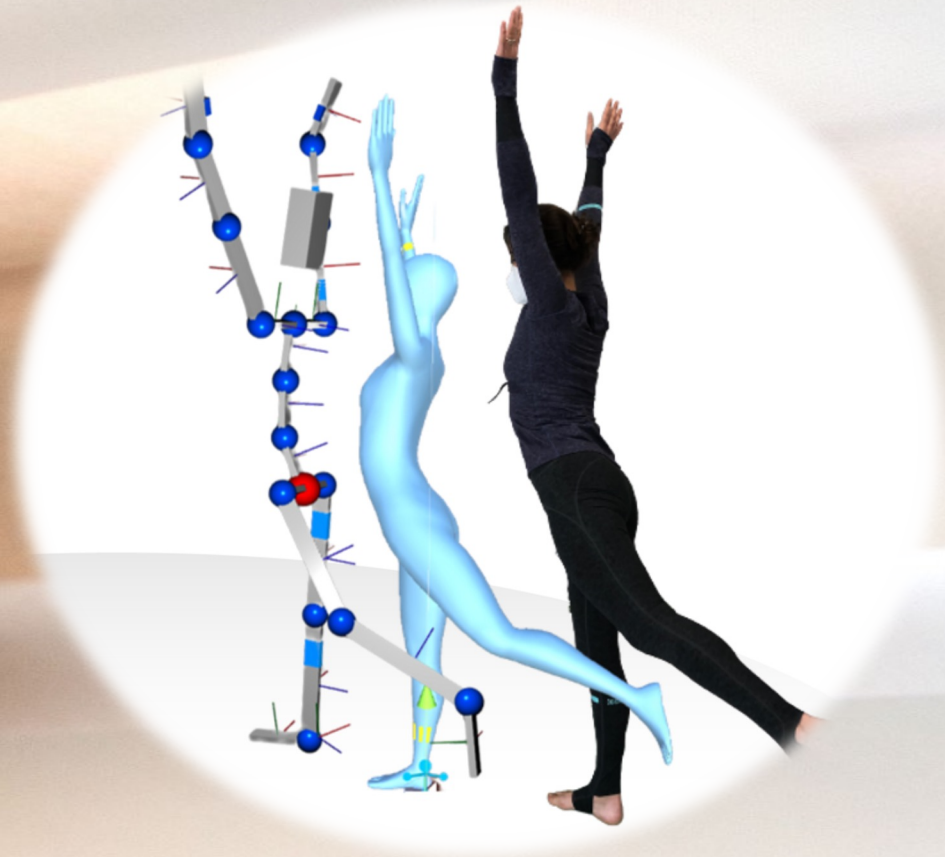
WHERE WE ARE


Cerca
Groenlandia
Islanda
Svezia
Finlandia
Norvegia
Russia
Mongolia
Danimarca
Irlanda
Bielorussia
Kazakistan
Cina
Germania
Polonia
Ucraina
Kirghizistan
Francia
Austria
Romania
Turkmenistan
Nepal
Spagna
Italia
Portogallo
Afghanistan
Pakistan
India
Grecia
Turchia
Siria
Iran
Iraq
Marocco
Tunisia
Sahara Occidentale
Algeria
Libia
Egitto
Arabia Saudita
Oman
Mauritania
Yemen
Mali
Niger
Sudan
Guinea
Burkina Faso
Ciad
Etiopia
Ghana
Nigeria
Sudan del Sud
Somalia
Kenya
Gabon
Repubblica Democratica
Tanzania

THE QUESTION TO SOLVE

- MOTION CAPTURE TECHNOLOGY USES AFFORDABLE AND CHEAP SENSING TECHNOLOGY…
- … BUT TO MEASURE HUMAN BODY IS NOT CHEAP AND EASY:

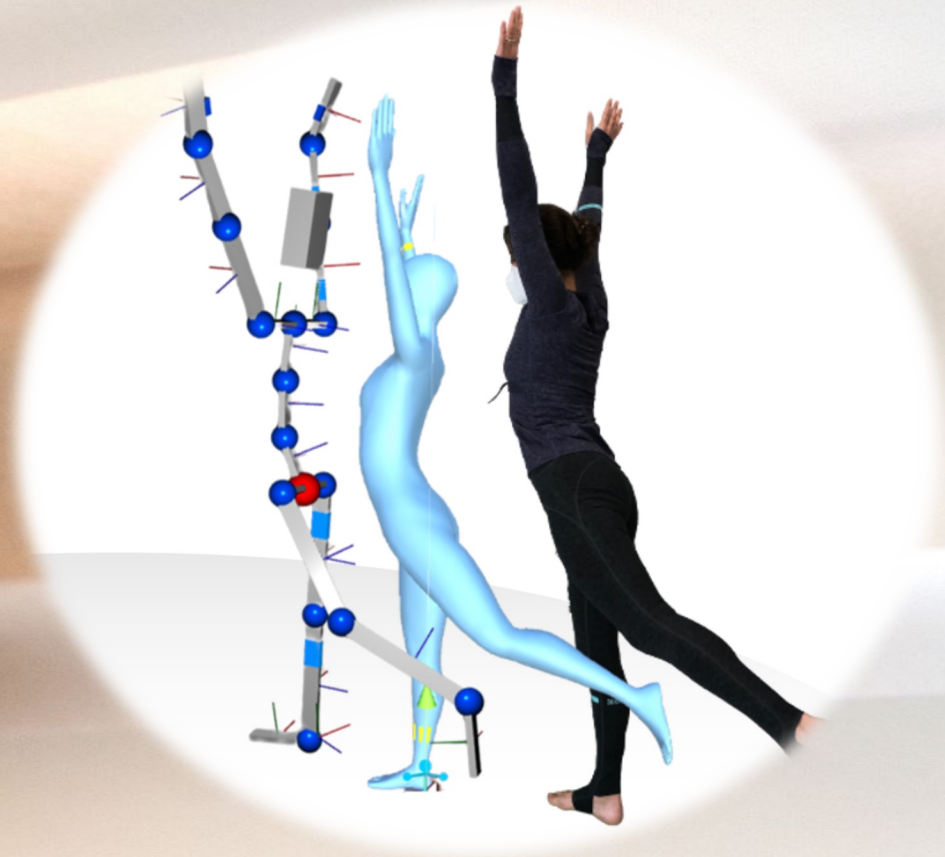
  - TECHNOLOGY IS USUALLY CUMBERSOME
  - NEED TECHNICAL EXPERTISE
  - NOT CONSUMER GRADE
  - MOTION CAPTURE IS USUALLY MAGNETOMETER DEPENDENT
  - INTERFACE WITH THE BODY IS STILL ARCHAIC
  - CALIBRATION OF THE SYSTEM TAKES TIME



OUR MISSION

- To transform the way in which movement analysis is carried out in sports and rehabilitation

- Wearable technologies that can be suitable in end-user scenarios



HOW

A new framework of R&D in human motion capture:

from the creation of easy to use hardware up

to a customized end-user application

MEMS
INERTIAL
SENSORS

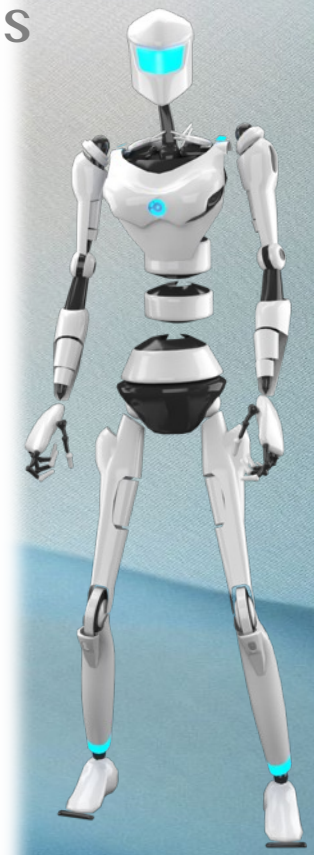
CLOUD
SERVICES

3D GRAPHICS

SENSOR FUSION

MOTION
DETECTION

BIOMECHANICAL
MODELS



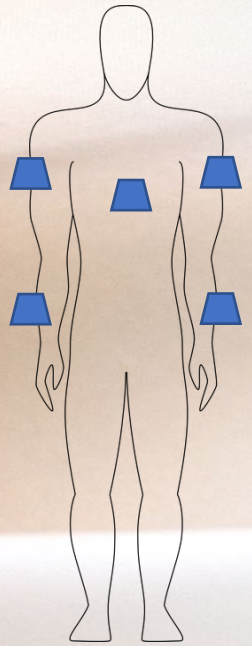
HOW IT USUALLY WORKS

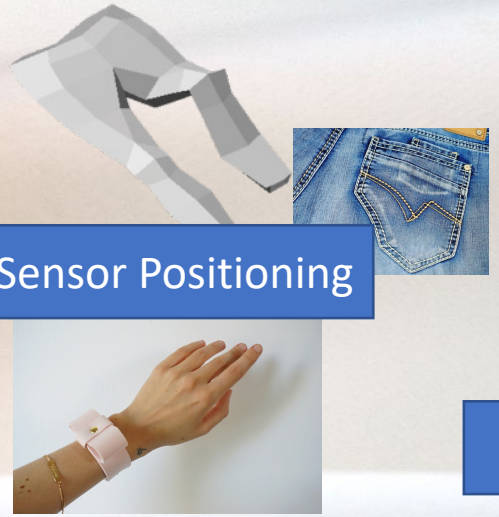
Inertial and Magnetic Measurement Units

Acc | Gyr

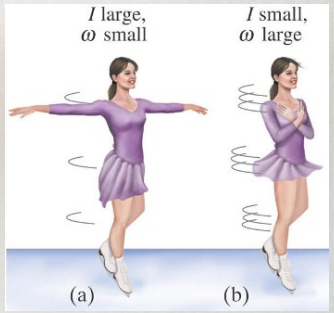
Mag

Sensor Calibration





Sensor Positioning



Body calibration

Data processing

Sensor fusion

Compensation algorithm

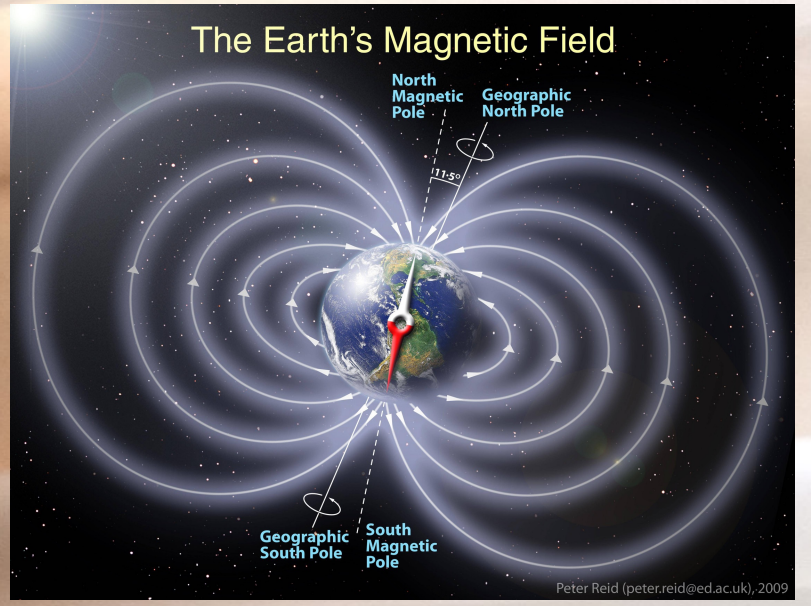
Data cleaning

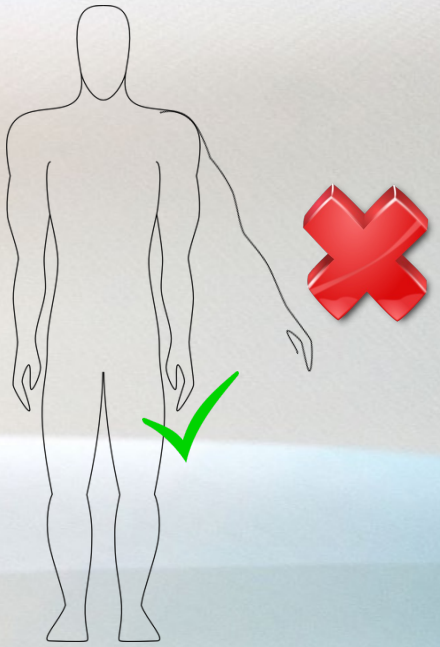
Requirements:

- **Up to 15-30 minutes**
- **Continuous quality monitoring**
- **Technical personnel**

→ LABS

MAGNETIC DISTURBANCE





Magnetometer limitations:

- They require calibration
- They are sensitive to ferromagnetic materials
- They require complex algorithms

METHODS

- A magnetometer-free sensor fusion algorithm based on inertial sensors
- Only accelerometer and gyroscope are used
- No magnetometer
- A quick and easy sensor and body calibration procedure for non technical end user
- Smart clothes (shirt and pants using STMicroelectronics inertial sensors integrated) (https://pivot.yoga/)
- Quick learning curve of the system (1 trial)

SMART CLOTHING

SENSOR AND BODY CALIBRATION

STEP 1 STEP 2 STEP 3 STEP 4

Ligorio, Gabriele, et al. ”A wearable magnetometer-free motion capture system: Innovative solutions for real-world applications.” IEEE Sensors Journal, 2020.

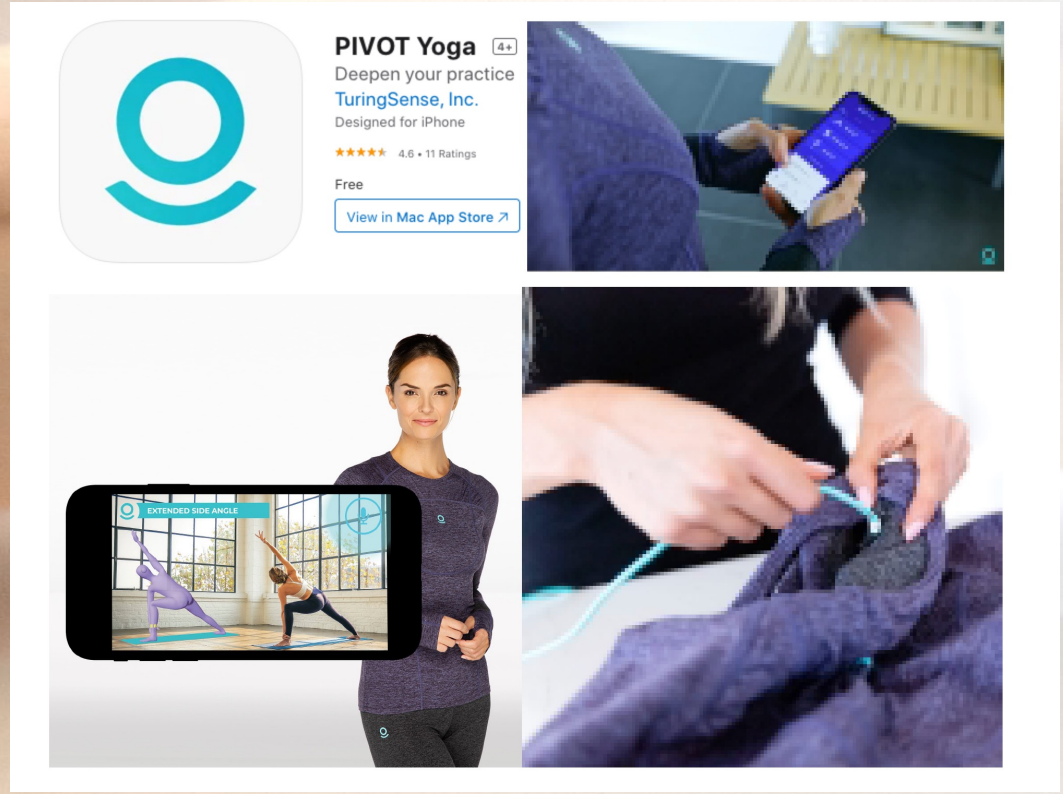
Turingsense EU LAB

https://sites.google.com/view/turingmotion/home-page

www.turingsense.eu

turingsenseeulab@gmail.com

RESULTS



	N-poses	Arms	Lleg	Rleg	Full procedure
#	37	39	42	42	34
%	82	86	93	93	75

# user	N-pose	Arms	Lleg	Rleg	Full procedure
1	87.5	100	100	100	87.5
2	87.5	87.5	87.5	100	87.5
3	75	62.5	87.5	87.5	50
4	62.5	100	100	100	62.5
5	87.5	87.5	87.5	87.5	87.5
6	100	87.5	100	100	87.5
7	87.5	100	100	100	87.5
8	75	87.5	87.5	87.5	75
9	87.5	100	100	100	87.5
10	87.5	100	100	100	87.5
11	87.5	87.5	100	100	75

DISCUSSION AND CONCLUSIONS (1/2)

- The calibration steps implemented are easy to perform by non-technicians
- The given instructions allow the user to reach Motion Capture rapidly
- The framework can be adapted to new scenarios

DISCUSSION AND CONCLUSIONS (2/2)

- The availability of smart clothing largely simplifies the approach and the acceptability of the user → THE TECHNOLOGY BECOMES INVISIBLE

- Many different scenarios of application:
  - Fitness and Yoga
  - Rehabilitation (Digital)
  - Ergonomics at workplace and Ergonomics evaluation
  - Exoskeletons development
  - Sports Medicine and Injury prevention
  - Metaverse and VR/AR

SOME OF OUR PARTNERS

MAJOR REFERENCES

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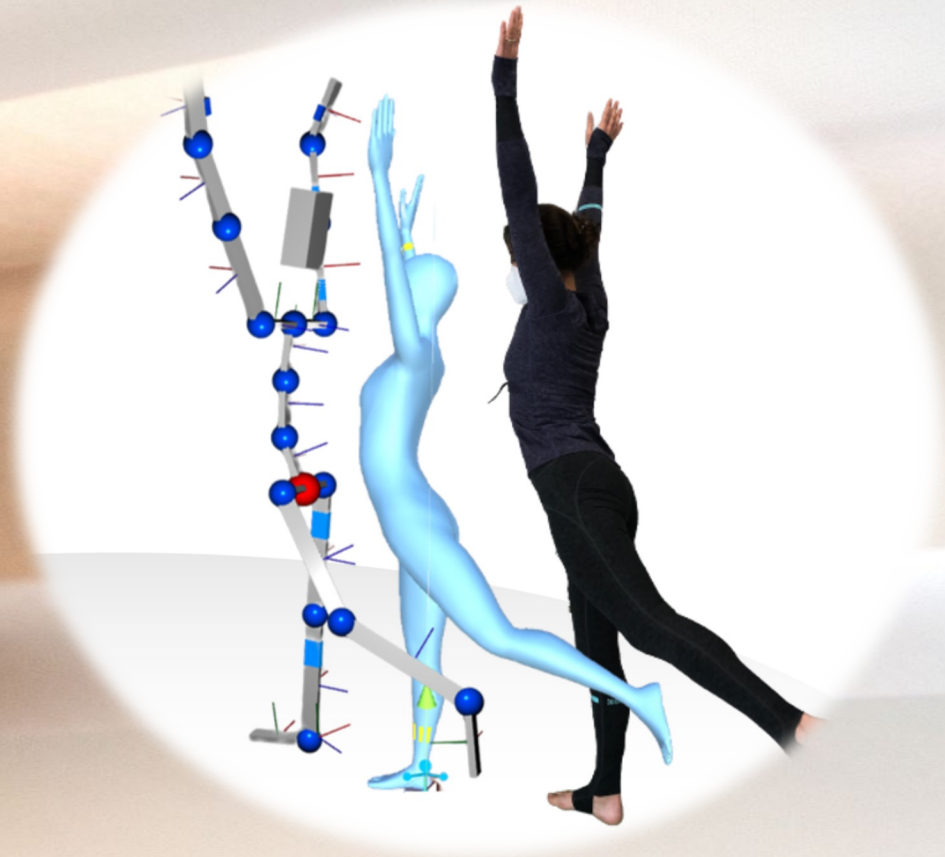

THANK YOU

HOW TO CONTACT US:

- info@turingsense.eu
- www.turingsense.eu