



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee^{PhD}
information technology
electrical engineering



Fabrizio Lo Regio

Innovative interfaces and technologies for advanced sensing and communications

Tutor: Leopoldo Angrisani

Cycle: XVIII

Year: II

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Candidate's information

- MSc degree
 - Biomedical Engineering
- DIETI Research group/laboratory
 - Measurement group (Tutor Prof. Leopoldo Angrisani)
- PhD start date – end date
 - 01/01/2023 – 31/12/2025
- Scholarship type
 - PNRR, Partenariato Esteso PE14, RESearch and innovation on future Telecommunications systems and networks (RESTART)
- Period abroad
 - 02/2025 – 05/2025
- Abroad research institution
 - Biomimetics and Intelligent Systems Group, University of Oulu

Summary of study activities

Ad hoc PhD Courses	Strategic orientation for stem research & writing
Seminars	Quantum Nexus
	Elettronica superconduttiva basata sull'effetto Josephson
	Measurement Systems in Human Movement Analysis
	Qiskit Fall Fest 2024
Conferences	IEEE International Instrumentation and Measurement Technology Conference (I2MTC) 2024
	2024 IEEE International Conference on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering - IEEE MetroXRINE 2024

Research area

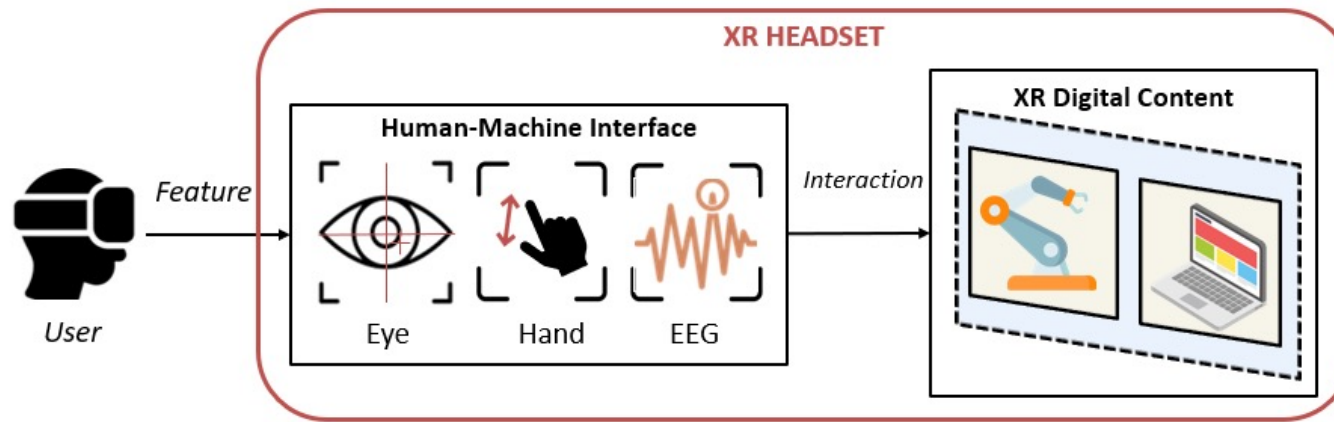
Innovative interfaces and technologies for advanced sensing and communications

Resources optimization and measurement for highly efficient sensing and communications

1. Highly wearable measurement systems embedded in XR devices
2. Quantum Technologies for strategic communications systems
 - Development of integrated sensing and communication systems: devices become nodes for data sensing and transmission
 - Performance characterization in terms of accuracy and precision
 - Ensure safety and reliability of communication operations in critical scenarios

Research area

1. Highly wearable measurement systems embedded in XR devices: Human-Machine Interaction (HMI)



- Develop a reliable method to characterize HMIs embedded in XR devices in terms of:
 - Intra- and inter-individual variability
 - New metric defining the maximum number of digital icons according accuracy and uncertainty
- Provide a benchmark dataset of Steady-State Visually Evoked Potentials acquired through XR devices

Research area

1. Highly wearable measurement systems embedded in XR devices: Human-Machine Interaction (HMI)

3- σ coverage interval of the distance error E , expressed in mm , for each NHMI and scenario.

NHMI	Long scenario	Medium scenario	Short scenario
Eye-tracking	15.61 $\div$ 22.67	12.60 $\div$ 17.31	12.15 $\div$ 14.53
Head-tracking	7.75 $\div$ 14.81	7.03 $\div$ 11.73	7.53 $\div$ 9.89

3- σ coverage interval of the Maximum Number of objects M_N , for each NHMI and scenario.

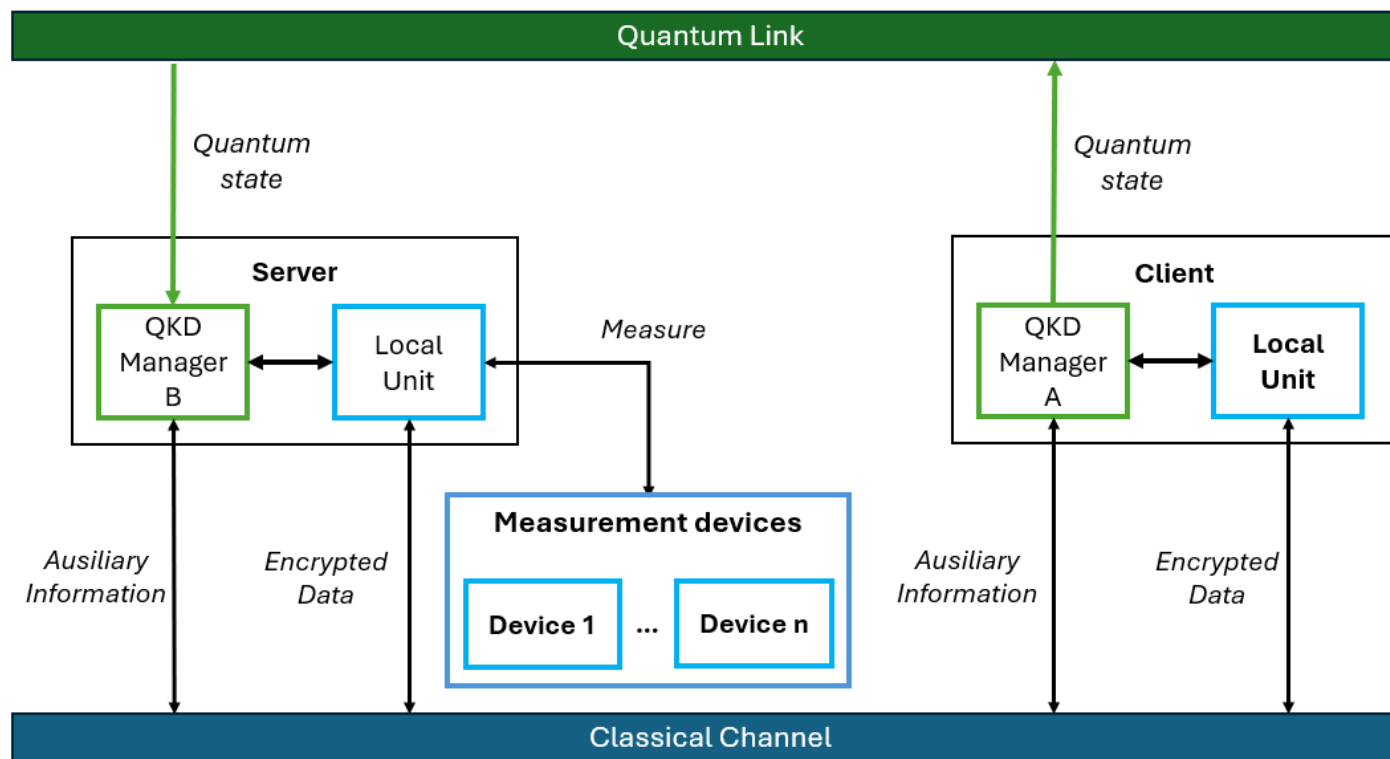
NHMI	Long scenario	Medium scenario	Short scenario
Eye-tracking	267 $\div$ 580	211 $\div$ 405	79 $\div$ 113
Head-tracking	456 $\div$ 1985	391 $\div$ 1177	164 $\div$ 287

Research area

2. Quantum Technologies for strategic communications systems

Evaluate the integration of quantum technologies with traditional communication infrastructures and characterize them

- Development of a distributed measurement system based on Quantum Key Distribution (QKD) for secure data transmission



Research area

2. Quantum Technologies for strategic communications systems

Evaluate the integration of quantum technologies with traditional communication infrastructures and characterize them

- Integration of QKD protocols with TLS
- Performance evaluation in critical scenarios
 - Key Generation Rate (bps)
 - Quantum Bit Error Rate
 - Key generation latency
 - Quantum Link Stability and uptime

Research area

Future activities

1. XR devices as wearable measurement systems that provide reliable measures
 - User as part of the measurement process
2. Robots as distributed mobile sensors
 - Autonomous network configuration to minimize measurement uncertainty
3. Quantum Technologies
 - Development and characterization of a fully integrated hybrid network
 - Characterization of ultra-sensitive devices for quantum sensing

Research products

[P1]	L. Angrisani, M. D'Arco, E. De Benedetto, L. Duraccio, F. Lo Regio, A. Tedesco <i>A novel measurement method for performance assessment of hands-free, XR-based Human-Machine Interfaces</i> IEEE Sensors Journal, Vol. 24 (19), pp. 31054 - 31061, 2024
[P2]	Angrisani, L., D'Arco, M., De Benedetto, E., Duraccio, L., Lo Regio, F., Tedesco, A. <i>A method for the metrological characterization of eye-and head-tracking interfaces for human-machine interaction through eXtended Reality head-mounted displays</i> Measurement, Vol. 245, 2024
[P3]	Lo Regio, F., Angrisani, L., D'Arco, M., De Benedetto, E., Duraccio, L., Tedesco, A. <i>Experimental procedure for metrological characterization of AR-based eye-tracking interfaces</i> IEEE International Instrumentation and Measurement Technology Conference (I2MTC) 2024 Glasgow, UK, May 2024
[P4]	Angrisani, L., Arpaia, P., D'Arco, M., De Benedetto, E., Duraccio, L., Lo Regio, F., Tedesco, A. <i>A Metrological Approach to the Performance Characterization of Eye- and Head-tracking Interfaces in eXtended Reality</i> IEEE International Conference on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering - IEEE MetroXRINE 2024, Saint Albans, UK, October 2024
[P5]	Angrisani, L., De Benedetto, E., Duraccio, L., Lo Regio, F., Sansone, M., Tedesco, A. <i>Exploring Variability in Human-Machine Interaction through Gesture Recognition based on Hand-Tracking within XR</i> IEEE International Conference on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering - IEEE MetroXRINE 2024, Saint Albans, UK, October 2024