Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
36th cycle

SYSBIO GROUP
SYSTEMS BIOLOGY AND BIOINFORMATICS

Supervisor
Prof. Gabriella Olmo

Sleep and Motor Disorder Biomarkers in Neurodegenerative Diseases Exploiting Integrated EEG-EOG-EMG-inertial data

PhD Candidate: *Irene RECHICHI* Email: irene.rechichi@polito.it

1. Sleep and Neurodegeneration

The investigation of sleep disorders (SD) is increasingly gaining attention, due to their role in the development of neurodegenerative diseases.

SD are listed among the earliest prodromes of tauopathies and alpha-synucleinopathies (α-syn), such as Alzheimer's Dementia and Parkinson's Disease (PD), with REM Sleep Behaviour Disorder featuring a 90% conversion rate to α-syn at a 14-year follow-up. Prodromal RBD offers a window for disease-modifying interventions: early detection is pivotal for adopting prevention strategies.

State-of-the-art diagnosis methods are complex and rely on visual-based metrics, often prone to inter-rater variability. Finally, sleep-related motor manifestations, such as nocturnal akinesia, are also prevalent in early PD, but assessment is challenging and subject to symptoms fluctuations.

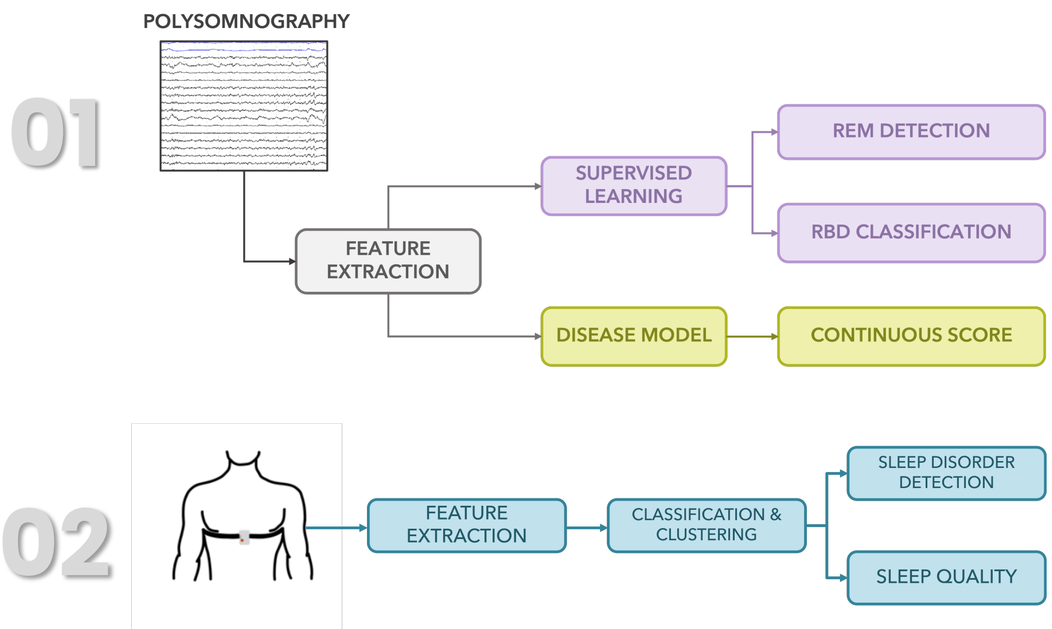
2. Challenges & Goal

This suggests the need for early detection, as well as objective, continuous monitoring of sleep dysfunctions.

This PhD project focused on the feasibility of minimally-invasive sleep studies, for the:

(1) Automatic detection and monitoring of RBD, allowing for a faster diagnosis and the quantitative assessment of the disease progression,

(2) Home-based sleep monitoring in PD, through wearables and lightweight solutions.



3. Methodology

Bio-signals (EEG, EMG) and motility data recorded during sleep were processed and employed in Machine Learning (ML) frameworks to tackle the following challenges:

Automatic Sleep Staging

For minimally-invasive polysomnography, based on single-channel EEG

Quantification of REM Without Atonia

Automatic assessment of RWA to minimize inter-rater variability and facilitate diagnostics

Automatic detection of RBD

ML-based classification of RBD subjects through a minimal set of sensors (EEG or EMG)

Assessment of the disease progression

Continuous metric designed for personalised follow-up procedures

Home-monitoring of sleep disorders

Low-cost monitoring of overnight motility and sleep disorders in PD through wearable IMUs.

4. Outcome and Future Trajectories

The explored methodology **(1)** provided robust frameworks for minimally-invasive sleep studies and automatic RBD classification, and **(2)** proved the feasibility of home-based, continuous solutions for SD monitoring. Future trajectories suggest adopting wearable technology in sleep for population screening studies and neurodegenerative risk prediction.

5. References

1. Rechichi, I. et al., **Towards Fully-Automatic Quantification of REM Sleep Without Atonia According to the Sleep Innsbruck Barcelona (SINBAR) Method**, 2023, 17th World Sleep Congress
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