TOWARDS THE PARTICIPATION TO CYBATHLON 2024 FES-BIKE RACE: A CASE REPORT

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BACKROUND

Cybathlon is an international competition promoting inclusion and assistive technology. Among its disciplines is **FES-cycling**, a race where **complete spinal cord injured** use functional electrical stimulation to propel a tricycle.

This work presents our journey to the 2024 edition, where the goal was to cover **1960 m** in **8 minutes.**

THE PILOT

ANDREA

Age	43
Weight	76 kg
Height	175 cm
Injury level	T5
Asia	A
Years from lesion	5.6

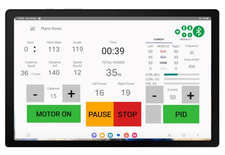
Ethical Committee approval Nr 50/2023, Politecnico di Milano

THE TRIKE

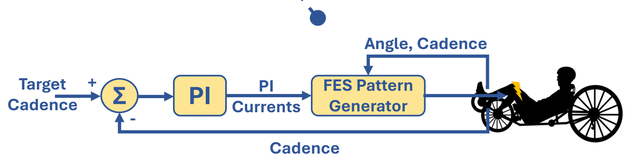
A fully mobile FES-cycling prototype comprising an **8-channel neurostimulator**, a **crank encoder**, and an **electric motor** capable of assisting the legs during cycling [1].



The DC motor enable assistance and legs passive movement. Valuable feature during trainings, **unmounted for the race!**



All the aspect of the trainings can be controlled through the **Android APP**



The **custom software** integrates a proportional integral (PI) controller that modulates the current amplitude to maintain a desired cadence

PERSONALIZATION

To derive the optimized stimulation angular ranges for the pilot, a procedure exploiting the electric motor of the trike was used [2].

1. Tangential pedal forces were recorded during 1 minute of **"passive cycling"** (motor-driven leg movement) using sensorized pedals.
2. Each muscle group per time was then **continuously stimulated** for 2 minutes through the **entire pedal revolution**.
3. For each muscle group, the **active force profile** during FES-cycling was calculated by subtracting the passive cycling force profile from the force profile acquired at point two **in function of the crank angle**.

To verify the validity of the procedure-based pattern, these ranges were compared to the previously used and validated in terms of **time to PI-saturation** (time to reach the maximum output from the PI-controller) and **steady-state cadence** error.

+99%

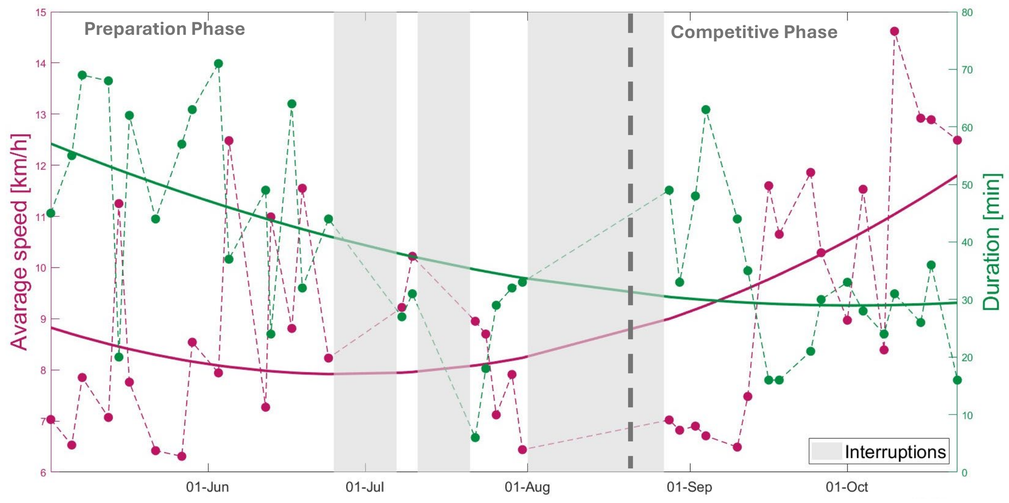
Time to PI-saturation approximately doubled

-42%

Error between steady-state mean and target cadence notably decreased.

TRAINING PROTOCOL

A 6-month macrocycle before the race was divided into two mesocycles, following a **linear periodization strategy** [3]



Preparation Phase

Low intensity and endurance-focused sessions with moderate effort and longer durations, using low cadences and gears.

Competitive Phase

High intensity training with short, explosive repetitions performed at higher cadences and gears.

RACE RESULTS

Andrea qualified for the final, secured **third place**, and set a personal best by covering the 1960m target distance in **7 min and 34 s**



2024 ETH Zurich / Cybathlon / Alessandro Della Bella

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CONTACTS AND MORE

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