Evaluation of usability, acceptability, user experience and human device interaction of a Hybrid FES-Motorized trike for Sport-Therapy

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Background

As the **65+** population grows, aging-related issues like **muscle loss**, **cognitive decline**, and **cardiovascular problems** can impact well-being. **Regular physical activity reduces these effects**.

In this context, **FES-cycling** can be exploited as it has been shown to induce motor relearning [1] and increase both muscle size and force generation [2] .

Objective

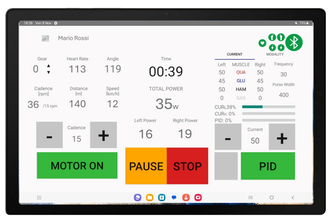
Assess **usability** and **acceptability** through validated questionnaires and semi-structured interviews of a **Hybrid FES and motor-assisted Trike** designed for **Sport-Therapy**.

Hybrid Trike

A fully mobile FES-cycling and motor-assisted device [3]



Android APP



Electric Motor
To provide assistance and ensure a minimum cycling cadence

FES
Up to 4 muscle group per leg to enhance proprioception and stimulate blood circulation

Methods

14 Elderly (age: 70 ± 5.24) participants without motor disabilities (Ethical Committee approval Nr 41/2024) and capable of moderate physical activity were recruited to test the Hybrid Trike.

Two training sessions with the Hybrid Trike, the first indoors and the second outdoors

FES, applied to the Quadriceps, Hamstrings, Tibialis A. and Gastrocnemius, manually adjusted at a tolerated level of intensity

Assessment through:
- Technological Acceptance Measure 3 (**TAM-3**)
- System Usability Scale (**SUS**)
- User Experience Questionnaire (**UEQ**)
- **ad hoc questionnaire** assessing human-device interaction from both physical and psychological perspectives.

Results

TAM3

Score*
6.18 (0.21)
on a 7-point Likert scale

SUS

Score*
92.5 (8.75)/100
Benchmark comparison: **Excellent**

UEQ

Item	Score*
Attractiveness	3.00 (0.17)
Perspicuity	3.00 (0.06)
Efficiency	2.75 (0.56)
Dependability	2.50 (0.56)
Stimulation	2.75 (0.25)
Novelty	2.25 (0.88)

Range (-3, +3)

Ad hoc questionnaires

Item	Score*
Setup and Accessibility	4.75 (0.45)
Perceived Benefits	4.83 (0.33)
Comfort	4.25 (0.75)
Usability and Interaction	4.58 (0.38)
Physical Effort	2.67 (0.42)
Fatigue	2.59 (1.50)

Range (0, 5)

0 Too low
2.5 Good
5 Too high

** Score computed as Median (Interquantile)*

Conclusions

The Hybrid Trike effectively promotes physical activity in aging adults, adapting to ability level and minimizing fatigue.

Top 10% designs
according to SUS

Strong user appreciation
according to TAM3 and UEQ

Highly satisfying and intuitive ad hoc questionnaires

References

1. Ambrosini et al., Cycling induced by electrical stimulation improves motor recovery in postacute hemiparetic patients: a randomized controlled trial. Stroke 42.4 (2011): 1068-1073.
2. Mastropietro et al., Multi-parametric MRI Assessment of Morpho-Functional Muscle Changes Following a 6-Months FES-cycling Training: A Pilot Study in People with Complete Spinal Cord Injury, Accepted in JMIR Rehabilitation and As sistive Technologies, 2024.
3. Savona D. et al., A Functional Electrical Stimulation and Motor-Assisted Trike for Sport Rehabilitation Therapy, Proceeding 10th IEEE RAS/EMBS BioRob, 1075–1080, 2024.

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Contacts and more

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