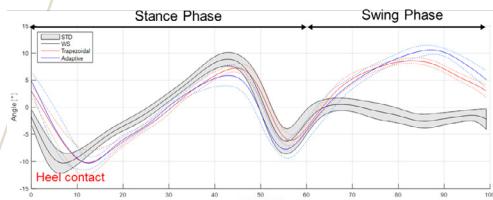


## AFES ADAPTATIVE FUNCTIONAL ELECTRICAL STIMULATION

Adaptive Functional Electrical Stimulation (AFES) based on knee kinematics to assist foot dorsiflexion in hemiparesis with adaptative stimulation.

### PRESENTATION

1.5M patients / year (EU) suffer spastic paresis, particularly stroke-related 'Foot Drop' syndrome, i.e. insufficient active dorsiflexion that causes abnormal gait pattern and increases the risk of falls. Treatments are often unsatisfactory: surgery, rehabilitation, passive orthoses (ankle foot orthosis). Conventional functional electrical stimulation (FES) systems only provide ON and OFF stimulation, without ability to individualize the stimulation pattern or amplitude based on the subject kinematics. In this proposal, Adaptive Functional Electrical Stimulation (AFES) detects onset and end of swing phase without using a foot switch, to stimulate tibialis anterior and evertor muscles by adapting the stimulation intensity (compared to conventional FES) to the level of knee flexion, to help activate dorsiflexors and ensure smooth ground clearance during the swing phase of gait. The algorithm should help hemiparetic patients walk more comfortably and naturally by delivering stimulation as needed during the swing phase.



Preliminary data demonstrate that, compared to sham FES, AFES strategy provides an improvement of ankle dorsiflexion  $\geq 900 \text{ ms}^* \text{deg}$ , i.e. an average increase in dorsiflexion amplitude  $\geq 3$  degrees during 300 ms of swing phase, in 80% of cases. This is sufficient to better clear the ground and is associated with an increase in walking speed through an increase in cadence.

Credit : Erganeo

Stroke - Foot Drop - Functional Electrical Stimulation  
Adaptative stimulation pattern - Knee joint angle  
Stance and swing phase detection

### COMPETITIVE ADVANTAGES

- Adaptive stimulation Fast to use
- Usable bare foot (no need for foot switch)
- Greater walking confort
- Reduction of consumption

### APPLICATIONS

Treatment of paresis-related foot drop related to :

- Stroke
- Brain Trauma
- Multiple sclerosis
- Spinal cord injury

### DEVELOPMENT PHASE

- Pilot Study against Walkaide (n=38)

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Ref. project : 324

### INTELLECTUAL PROPERTY

Patent applications: US/EP/France  
WO2018054764 (A1)

### PUBLICATIONS

- [1] S Mohammed, Y Amirat, JM Gracies. Stimulation Device For Activating At Least One Muscle Involved In Raising The Foot. - WO2018054764 (A1) 2018-03-29
- [2] Arnez-Paniagua V, Rifaï H, Amirat Y, Ghedira M, Gracies JM, Mohammed S. Adaptive control of an actuated ankle foot orthosis for paretic patients. Control Engineering Practice 2019;90:207-220
- [3] Huo W, Arnez-Paniagua V, Ghedira M, Amirat Y, Gracies J, Mohammed S. Adaptive FES Assistance Using a Novel Gait Phase Detection Approach. 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Madrid, 2018, pp. 1-9, doi: 10.1109/IROS.2018.8594051.