



# THE SMILING PROJECT: PREVENTION OF FALLS BY A MECHATRONIC TRAINING DEVICE

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and  
the SMILING Consortium



- SMILING is a EU FP7 funded research project

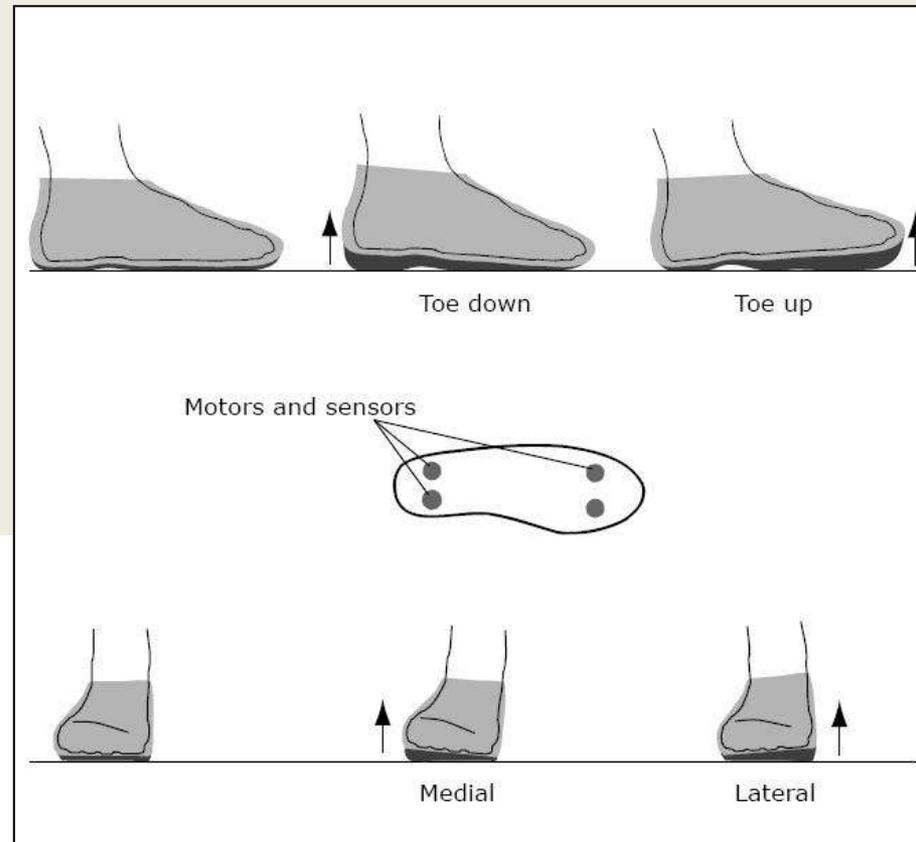
- SMILING stands for:

## **SELF MOBILITY IMPROVEMENT IN THE ELDERLY BY COUNTERACTING FALLS**

- SMILING aims at enhancing elderly persons capability to avoid falls thanks to a devoted walking training.

- SMILING walking training is based on perturbations of the gait cycle to empower reaction capabilities.

# How perturbing walking?

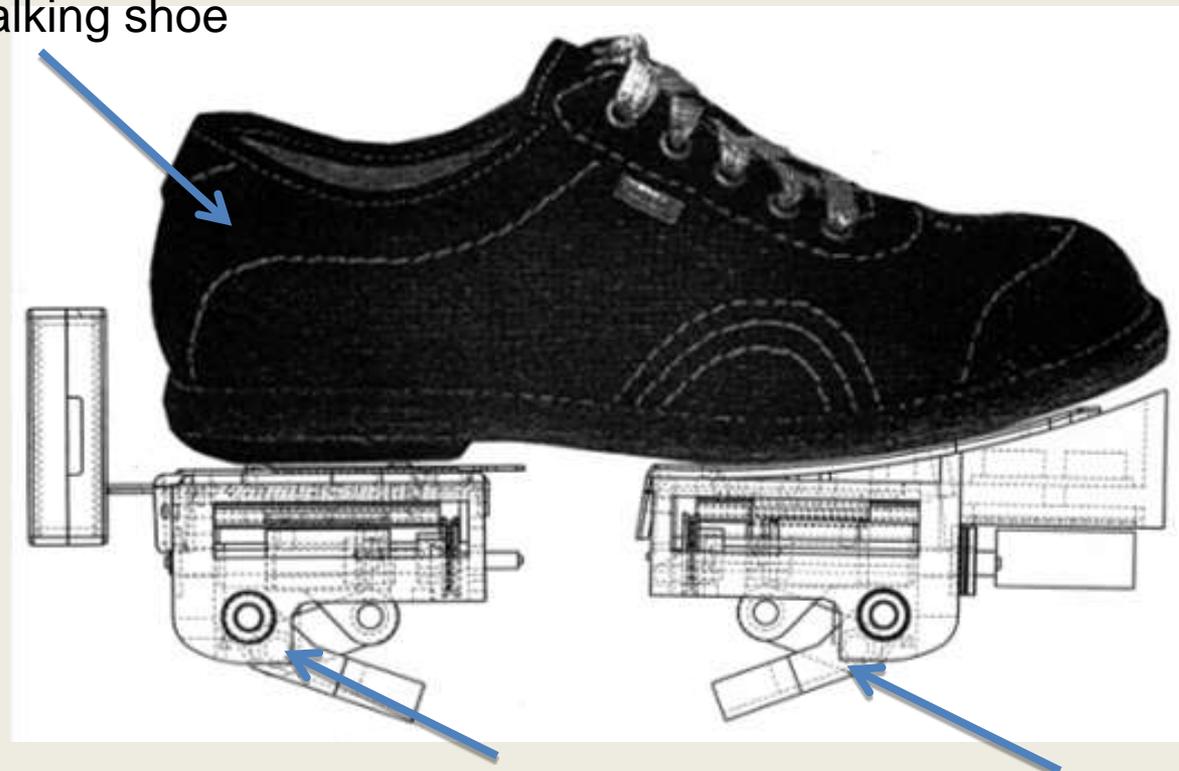


The basic idea was to design and develop a “shoe” able to change its height and inclination during the swing phase of gait

# How to implement it?



Standard walking shoe



Motorized actuators to change height and inclination

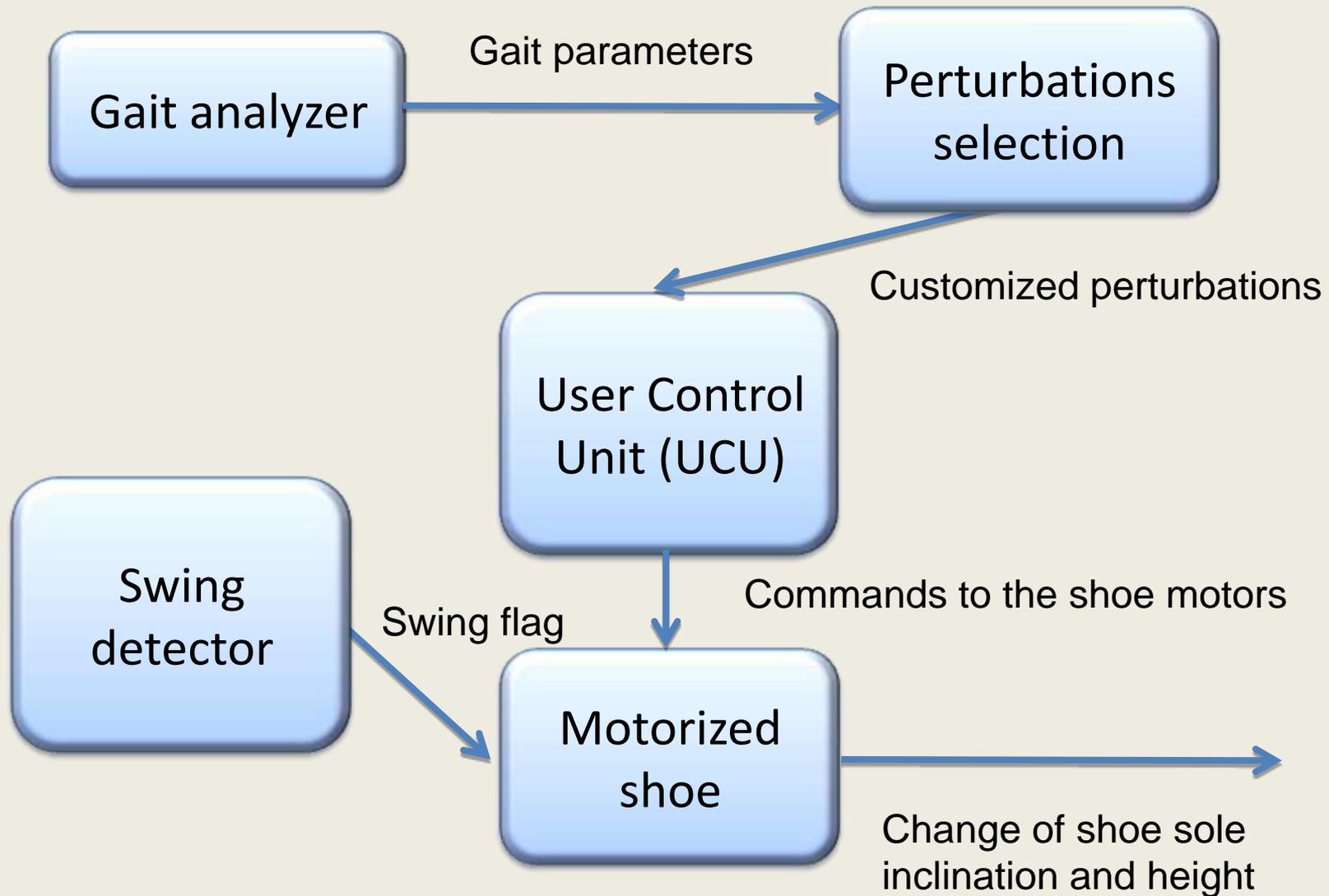
Perturbations are changes of inclination of the shoe sole in the range  $\pm 4.5$  degrees in sagittal and frontal plane and change of height up to 20 mm

# What are the needed features?



- ❑ Perturbation features have to be customized on the single elderly person walking capabilities
- ❑ The device has to be able to generate “perturbations” only during the swing phase
- ❑ The device has to be safe and reliable
- ❑ The device has to be usable with different shoes sizes
- ❑ The device has to be driven by the user him/herself
- ❑ The device has to be easy to wear and operate (no wires, no multiple parts, no complex user interface)

# Functional architecture



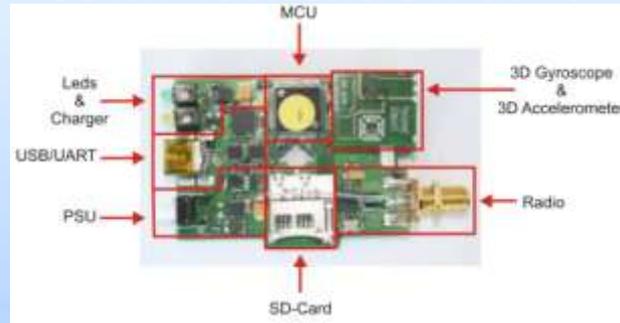
# Complete system architecture



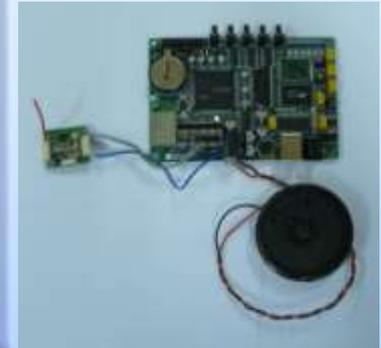
**Gait analyzer  
&  
perturbation  
generator**



**Swing detector/  
wireless  
communication unit**



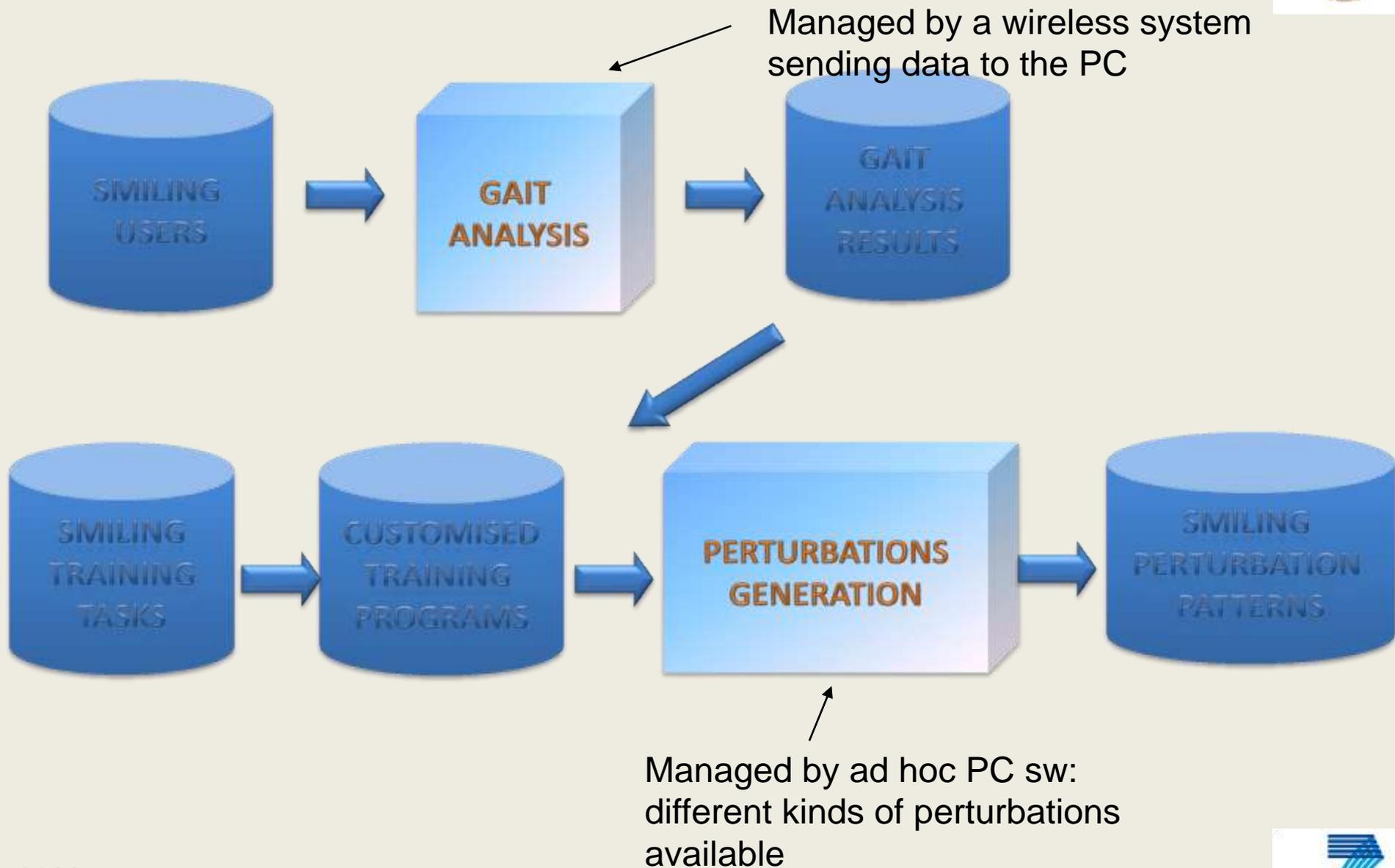
**User  
control  
unit**



**Shoe controller**



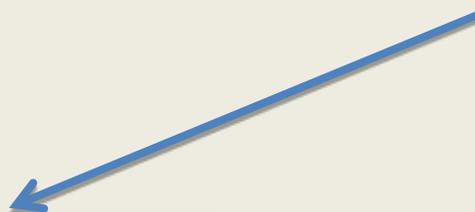
# Gait analysis and perturbation generation





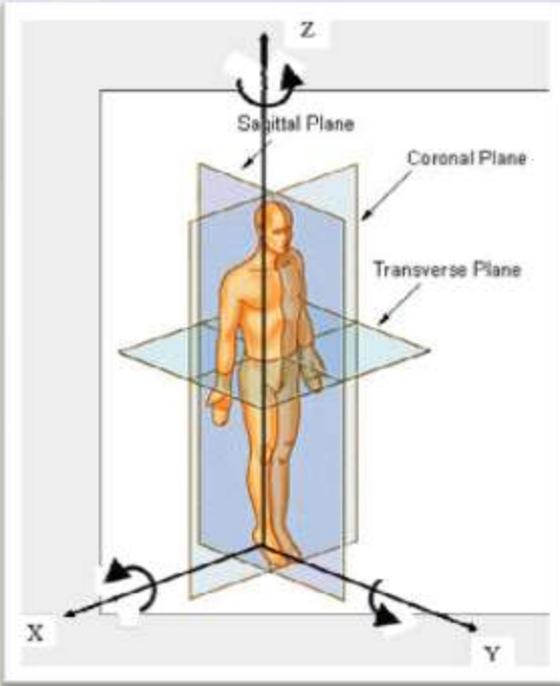
3D accelerometer  
+ 3D gyroscope

wireless communication



Basic gait  
parameters:  
Gait velocity  
Stride length  
%Swing time R/L  
%Total double  
support

# Perturbations generator



LEFT FOOT	Step 1	Step 2	Step 3	Step 4	Etc
X-rotation	X1 degs	X2 degs	X3 degs	X4 degs	Etc
Y-rotation	Y2 degs	Y2 degs	Y3 degs	Y4 degs	Etc
Z-translation	Z1 mm	Z2 mm	Z3 mm	Z4 mm	Etc



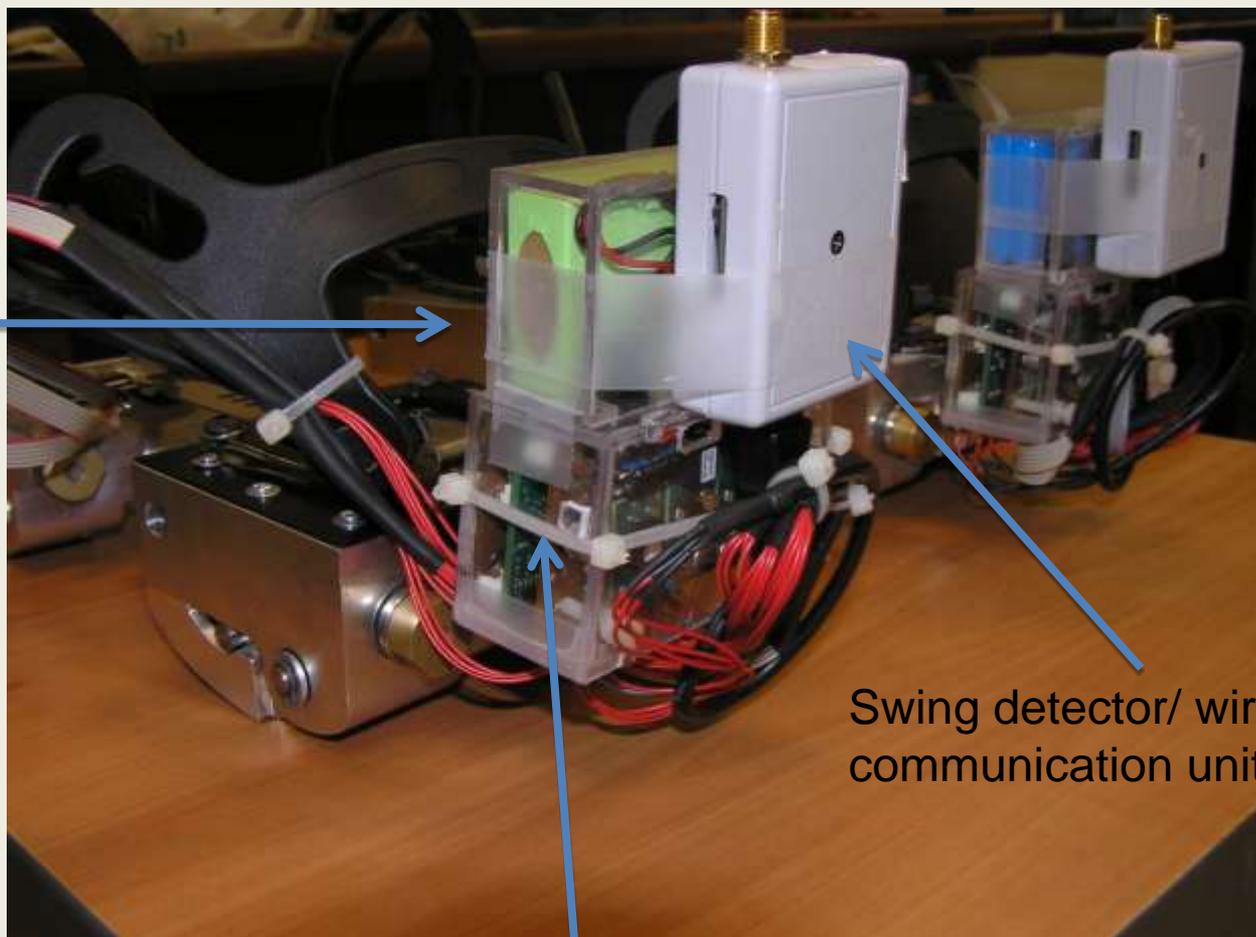
LEFT FOOT	Step 1	Step 2	Step 3	Step 4	Etc
Motor 1	ML1-1mms	ML1-2mms	ML1-3mms	ML1-4mms	Etc
Motor 2	ML2-1mms	ML2-2mms	ML2-3mms	ML2-4mms	Etc
Motor 3	ML3-1mms	ML3-2mms	ML3-3mms	ML3-4mms	Etc
Motor 4	ML4-1mms	ML4-2mms	ML4-3mms	ML4-4mms	Etc



- Upload of perturbations by the PC
- Download of perturbations to the shoe
- Start/stop command by the user



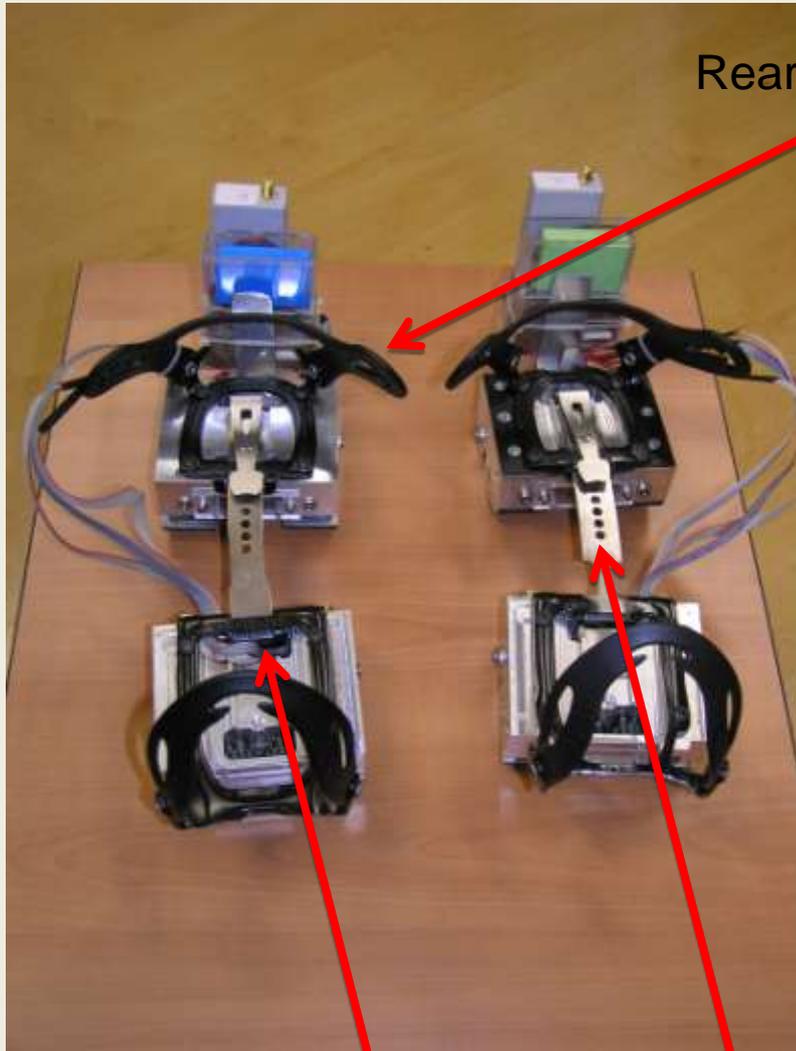
Battery



Swing detector/ wireless communication unit

Shoe controller

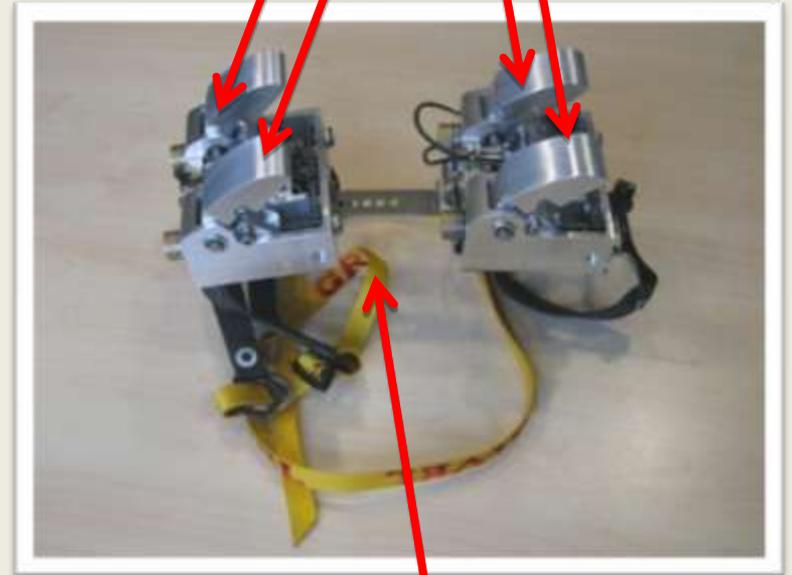
# Shoe mechanics



Rear foot unit

Fore foot unit

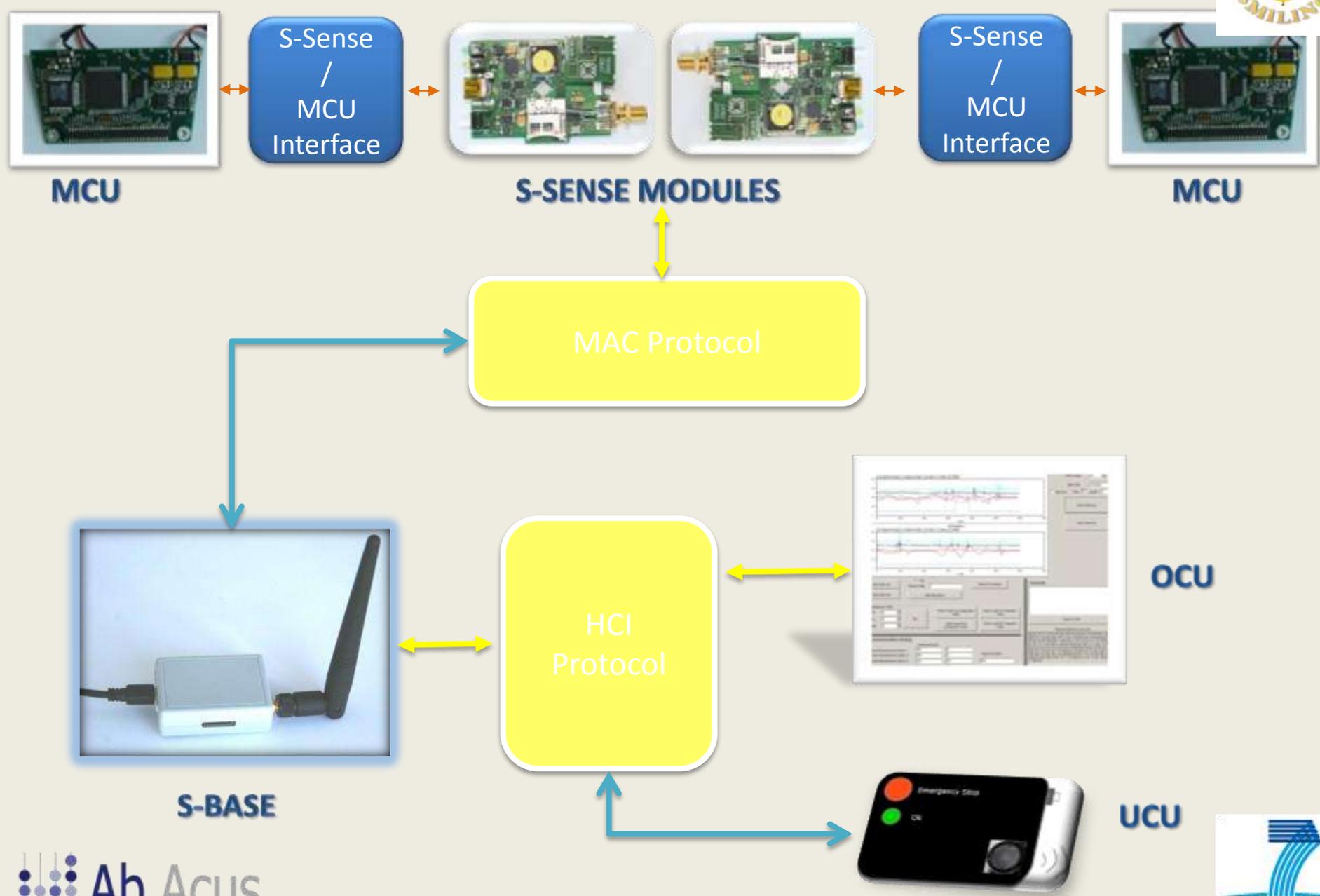
Adjustable length



Actuators

Strip to fix to the shoe

# Communication /interfacing issues



# The SMILING consortium





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