

# New technologies in biomedical physics

# Schedule

- |                               |             |
|-------------------------------|-------------|
| 1. „Posturography”: Wii Board | (3 classes) |
| Presentations                 | (1 classes) |
| 2. „3D camera”: Kinect        | (2 classes) |
| Presentations                 | (1 classes) |
| 3. Raspberry Pi               | (8 classes) |

## Passing criteria:

1. Presentation of the results from „Posturography”
2. Presentation of the results from „3D camera”
3. Project on Raspberry Pi
4. 2 unwarranted absence at maximum

## Didactic materials:

[http://brain.fuw.edu.pl/edu/index.php/Nowe technologie w fizyce biomedycznej](http://brain.fuw.edu.pl/edu/index.php/Nowe_technologie_w_fizyce_biomedycznej)

# Posturography: Introduction

- examination of stability – ability to regain the state of balance
- based on recording and analysis of compensatory movements
- the stability is an effect of coordinated action of muscles, tendons, skin receptors, labyrinth and vision
- the disturbances in stability can be caused by damage of one of mentioned above components or some neurological diseases (e.g. Parkinson's disease)

# Posturography: Indicators

## Still standing with eyes opened and closed

- maximal sway from the state of balance (for x and y direction)
- path length
- mean velocity of movement (for x and y direction)
- analysis of spatial distribution of posturography points (the spatial histogram)
- Romberg indicator – ratio of difference between closed-eyes path length and opened-eyes path length to sum of closed-eyes path length and opened-eyes path length

# Posturography: Indicators

## Deliberate dynamic sway

- maximal sway in each direction
- graph of x and y components of the sway movement in relation to time and the resultant trajectory of center of gravity movement

# Posturography: Professional systems

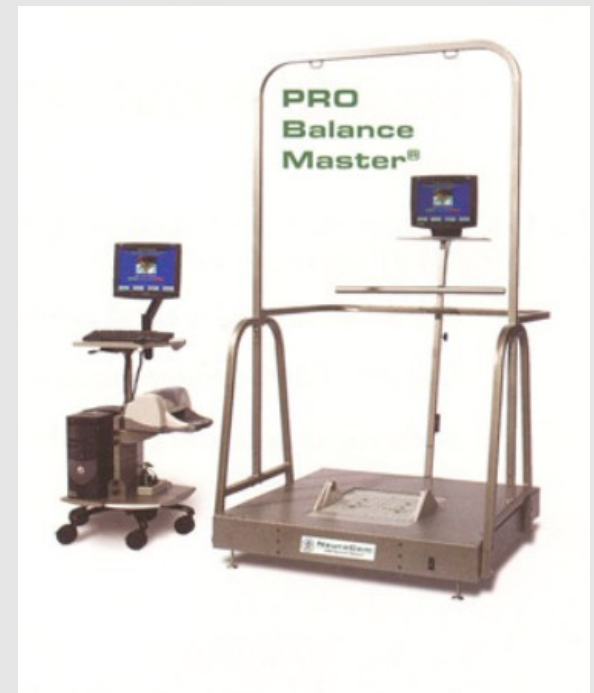
Professional systems for measuring the center of pressure



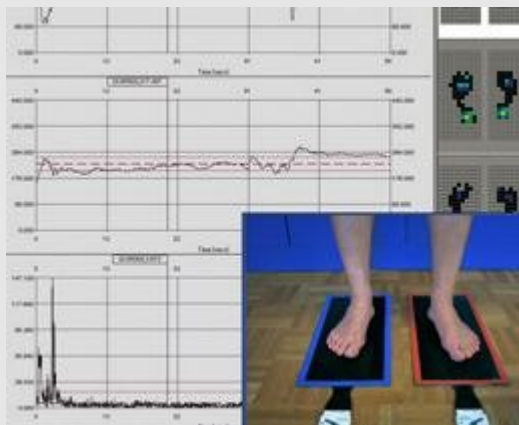
**MatScan® System**  
(<http://www.tekscan.com>)



**pedar®** (<http://www.novel.de>)



**PRO Balance Master**  
(<http://www.resourcesonbalance.com>)



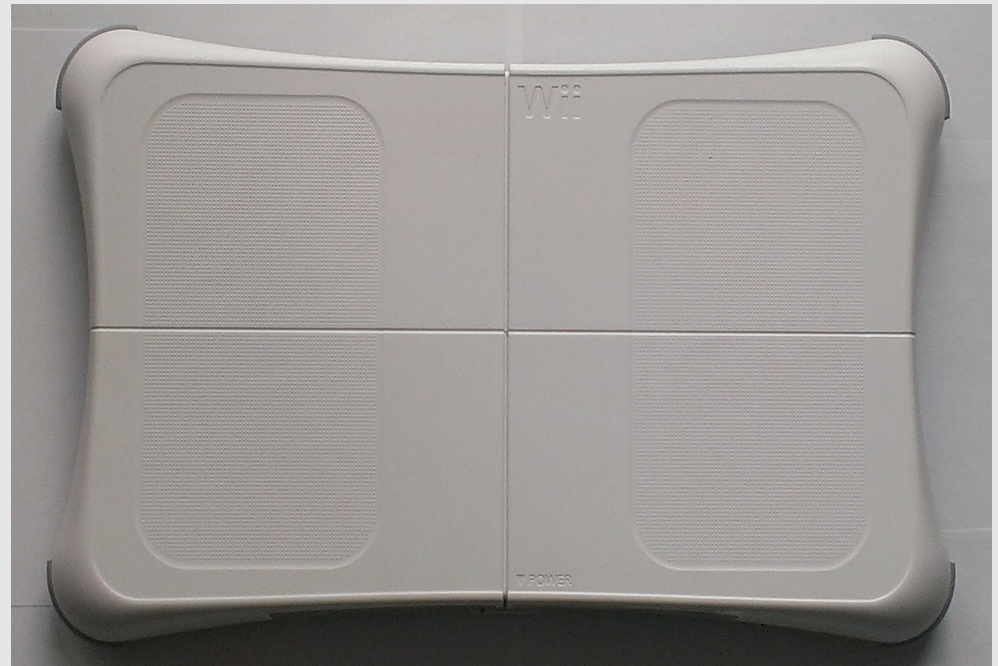
**emed®** (<http://www.novel.de>)

# Posturography: Wii Balance Board

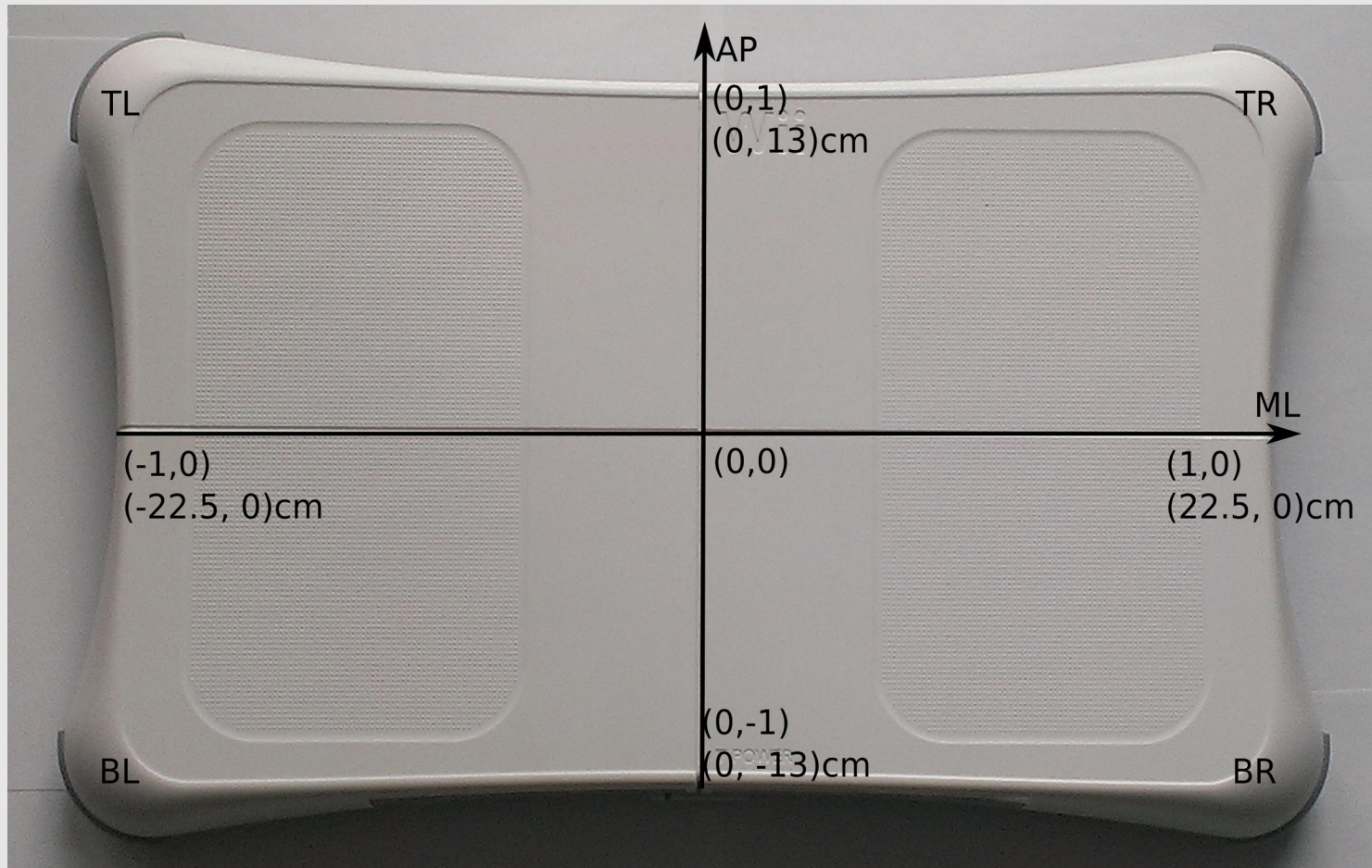
Measure of COP (center of pressure) – position of center of pressure of feet. In static conditions it is a projection of center of gravity on the support plane.

Construction of the Wii Balance Board:

- 4 pressure sensors in corners
- data acquisition with Bluetooth protocole



# Posturography: Wii Balance Board



Sway of COP in ML (medial-lateral) or X plane  
Sway of COP in AP (anterior-posterior) or Y plane



# Wii Balance Board: Application

## 1. Games



# Wii Balance Board: Application

## 2. Posturography:

Clark et al. conducted the experiment to exhibit the repeatability of Wii Balance Board measurements:

- two different posturographical tasks (still standing with eyes opened and closed) on one and two legs,
- they compared the indicator values obtained with Wii Balance Board and standard posturographical equipment,
- they showed that Wii Balance Board Measurements are credible and repeatable

# Wii Balance Board: Application

## 3. Rehabilitation of patients:

- after strokes,
- having troubles with stability  
(Spinocerebellar Ataxia, Huntington Disease, Multiple Sclerosis)

<https://youtu.be/TFjXJ8xPmz0>

# Wii Balance Board: Measurement

The goal is to learn the basics of posturography measurements and data analysis:

- still standing (eyes opened and closed),
- sway,
- sway and stay in the leaned position,
- examine whether feedback makes a difference in measured indicators

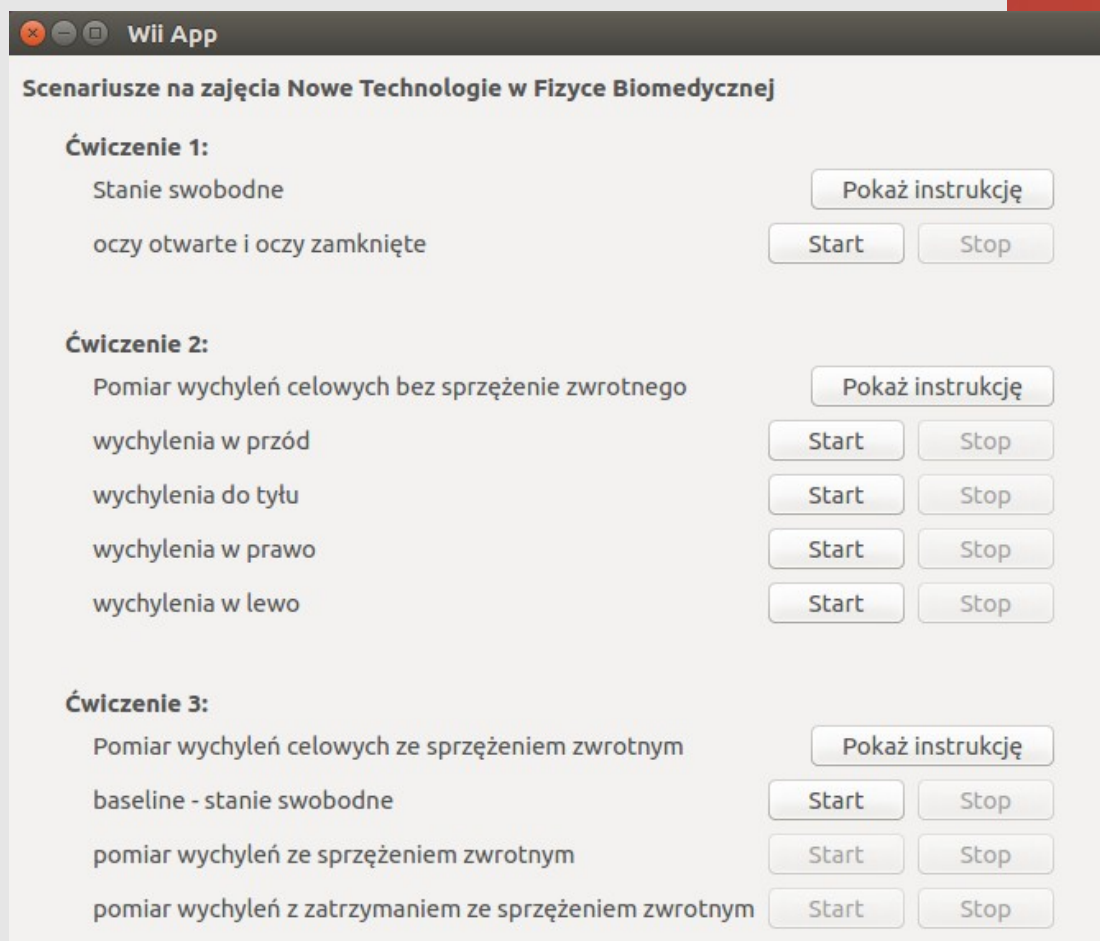
# Wii Balance Board: Measurement

General rules for measurements :

- standing on Wii Balance Board without shoes,
- **no detaching feet from board,**
- measurements are performed in one block – **no getting off the Board before the end of experiment**
- the experimentator informs about ongoing experiment and required tasks

# Wii Balance Board: Measurement

1. Run the Brain4edu application
2. Choose the Wii App
3. Launch the following scripts:



**Wii App**

Scenariusze na zajęcia Nowe Technologie w Fizyce Biomedycznej

**Ćwiczenie 1:**

Stanie swobodne Pokaż instrukcję

oczy otwarte i oczy zamknięte Start Stop

**Ćwiczenie 2:**

Pomiar wychyleń celowych bez sprzężenia zwrotnego Pokaż instrukcję

wchylenia w przód Start Stop

wchylenia do tyłu Start Stop

wchylenia w prawo Start Stop

wchylenia w lewo Start Stop

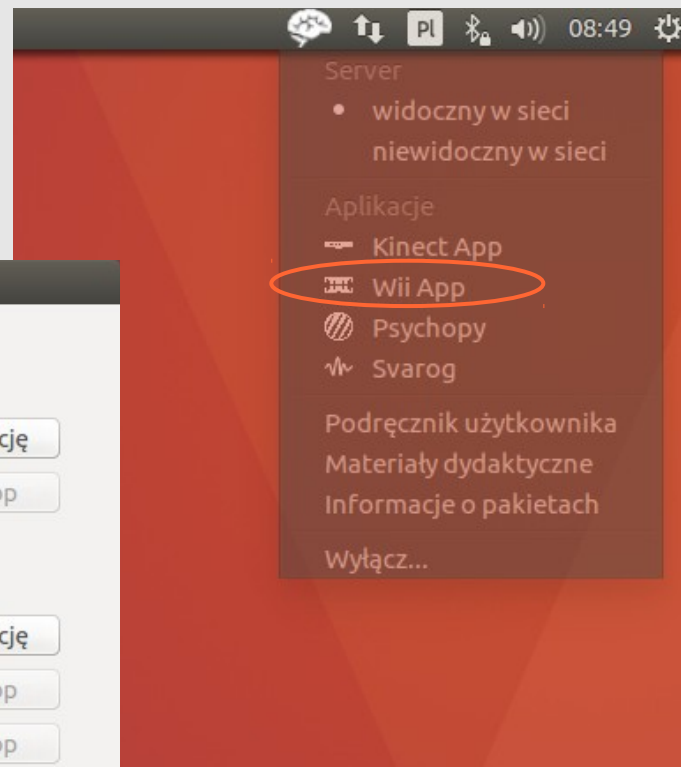
**Ćwiczenie 3:**

Pomiar wychyleń celowych ze sprzężeniem zwrotnym Pokaż instrukcję

baseline - stanie swobodne Start Stop

pomiar wychyleń ze sprzężeniem zwrotnym Start Stop

pomiar wychyleń z zatrzymaniem ze sprzężeniem zwrotnym Start Stop



Server

- widoczny w sieci
- niewidoczny w sieci

Aplikacje

- Kinect App
- Wii App**
- Psychopy
- Svarog

Podręcznik użytkownika

Materiały dydaktyczne

Informacje o pakietach

Wyłącz...

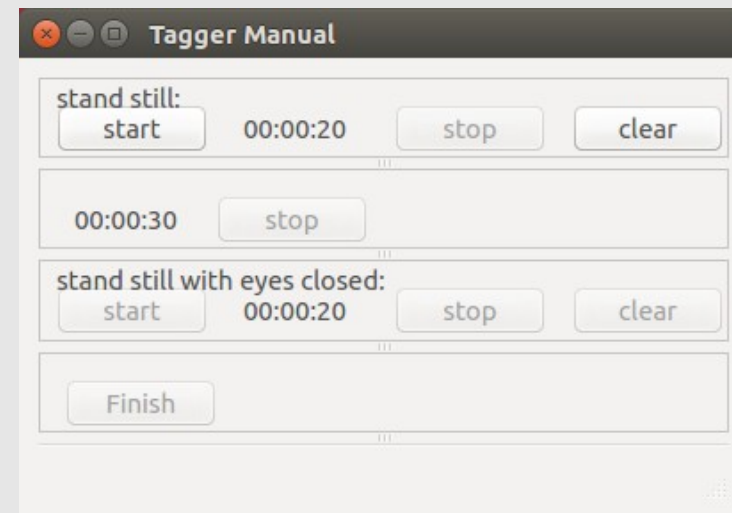
# Wii Balance Board: Measurement

## Task 1 – still standing

The goal is to measure standing still in two conditions: eyes opened and closed.

Procedure of measurement:

- stand still with eyes opened for 20 s
- brask 30s
- stand still with eyes closed for 20 s



During standing the arms should be lowered alongside the body and the eyes should be fixated on the point in front

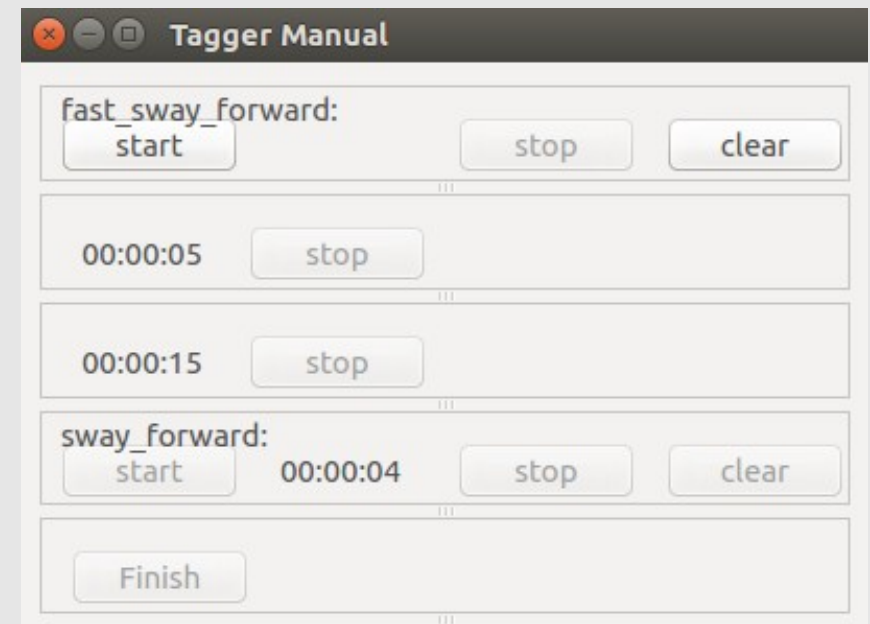
# Wii Balance Board: Measurement

## Task 2 – deliberate sways without feedback

The goal is to find the maximal sway in all four directions without feedback in two tasks: sway&go back and sway&stay.

Procedure of measurement:

- repeat 3 times: (sway maximally in denoted direction, go back, break 5s)
- break 15s
- sway maximally in denoted direction and stay until the sound

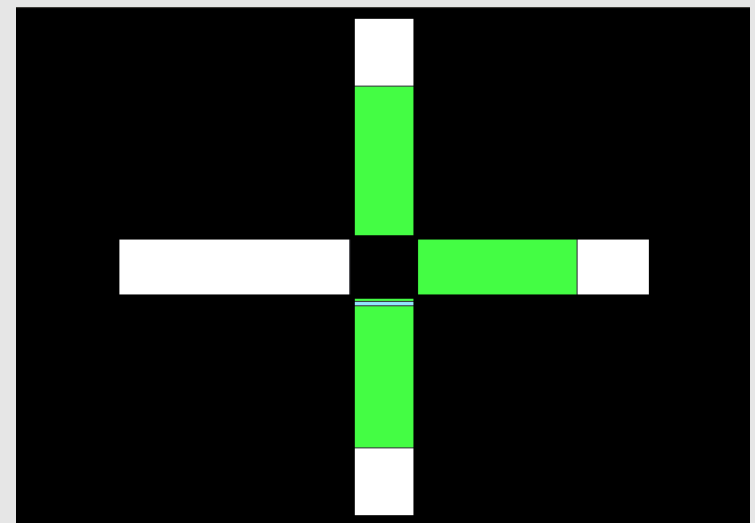
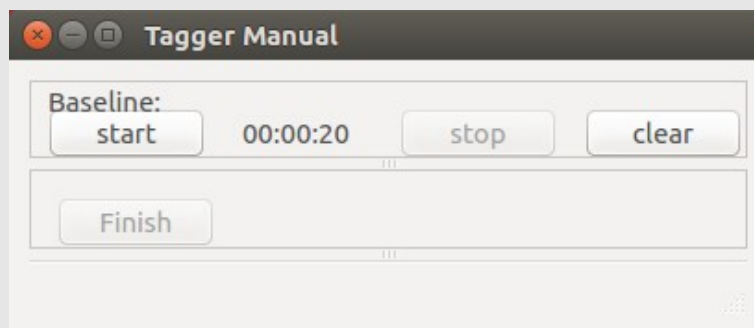




# Wii Balance Board: Measurement

## Task 3 – deliberate sways with feedback

The goal is to find the maximal sway in all four directions with feedback in two tasks: sway&go back and sway&stay.



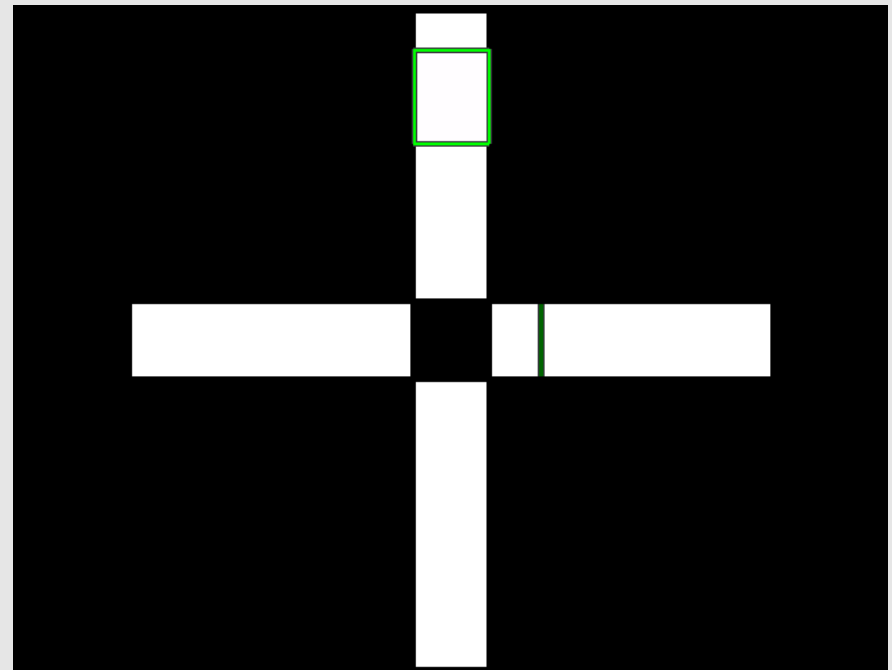
Procedure of measurement:

- stand still for 20 s - baseline
- the task is to fill the cross with green color by swaying in four directions

# Wii Balance Board: Measurement

## Task 3 - deliberate sways with feedback

In this part of task 3, the green rectangle will show up in different locations of the white cross. Your task is to put the indicator of your COP inside the green rectangle and keep it there for at least 3 s. After each try, quickly go back to stable position to be ready for the next trial.



# Data analysis: Task 1

## Eyes opened

Calculate parameters:

- maximal sway in AP and ML plane
- mean velocity of locomotion in AP and ML plane
- path length in AP and ML plane

Draw:

- graph of COP locomotion in AP, ML and AP/ML plane
- spatial histogram of COP posturography points

# Data analysis: Task 1

## Eyes closed

Calculate parameters:

- maximal sway in AP and ML plane
- mean velocity of locomotion in AP and ML plane
- path length in AP and ML plane

Draw:

- graph of COP locomotion in AP, ML and AP/ML plane
- spatial histogram of COP posturography points

## Comparison of conditions:

- Romberg indicator:  $(S_{ZAM} - S_{OTW}) / (S_{ZAM} + S_{OTW})$

# Data analysis: Task 2

Without feedback

Sway and sway&stay:

- maximal sway in each direction **in respect to location of state of balance calculated in task 1**
- graph of x and y components of the sway movement in relation to time for each direction and the resultant trajectory of center of gravity movement for each direction

# Data analysis: Task 3

With feedback

Sway:

- maximal sway in each direction **in respect to location of state of balance calculated from recorded baseline**
- graph of x and y components of the sway movement in relation to time for each direction and the resultant trajectory of center of gravity movement for each direction

# Data analysis: Task 3

With feedback

Sway&stay (only for succesfull sway with maximal difficulty level):

- maximal sway in each direction **in respect to location of state of balance calculated from baseline**
- graph of x and y components of the sway movement in relation to time for each direction and the resultant trajectory of center of gravity movement for each direction

Comparison:

- is there an improvement when feedback is available ?