



# DEVELOPMENT OF A BRAIN-COMPUTER INTERFACE (BCI) BASED ON VIRTUAL REALITY TO IMPROVE TRAINING TECHNIQUES

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1. Introduction
2. Objectives
3. Developed system
4. Experiments and Results
5. Conclusions





# Introduction

- ◆ BCI is based on the analysis of the electroencephalograph (EEG) signals recorded during some mental activity.
- ◆ Its main use: Medicine and especially in rehabilitation.
- ◆ It helps to establish a new communication and control channel.





# Introduction

- ◆ BCI is based on ability of people to control some features of EEG activity.
- ◆ Necessary to provide a suitable training.
- ◆ Very important to provide some type of feedback.





# Introduction

- ◆ Actually, researchers work to improve EEG signal processing methods and classifications algorithms.
- ◆ Inappropriate training + difficulty of controlling EEG signals



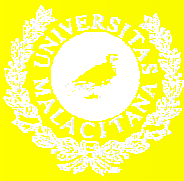
Frustration and Retirement of many subjects



**Working on training techniques is necessary**



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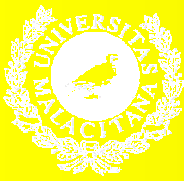
# Introduction

◆ To define a suitable training protocol, a lot of parameters must be considered:

- Mental tasks
- Training paradigm
- Feedback provided →
  - Session with or without feedback.
  - Continuous or discrete feedback.
  - Type of feedback.

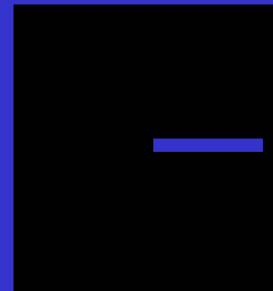
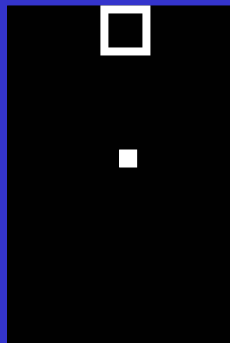
◆ Feedback makes sessions more attractive and interesting, but sometimes its effects can be frustrating or can cause some boredom, leading to a lack of motivation





# Introduction

◆ Nowadays, conventional systems of feedback are based on cursor control and horizontal bar extension



◆ Using techniques based on VIRTUAL REALITY, a more natural interaction can be achieved, isolating subject from distraction, and providing a more immersed and motivating effect.





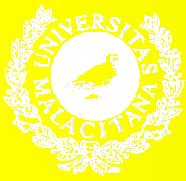
# Objectives

◆ A new type of BCI system, based on virtual reality techniques:

- Enable fast and easy configuration of different training protocol.
- Enable to establish the appropriate feedback allowing subjects to get better control of EEG signals.

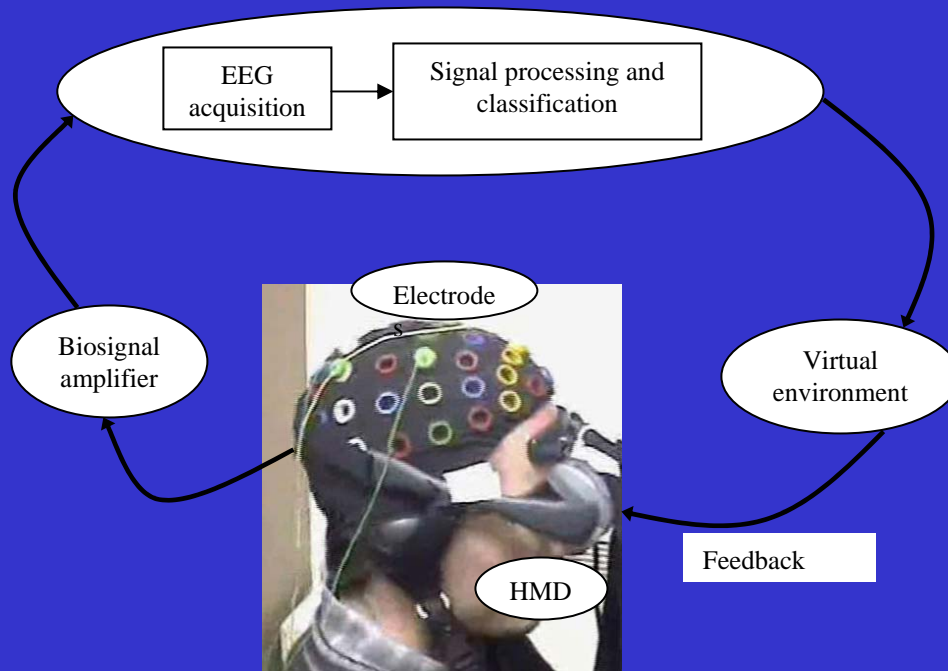




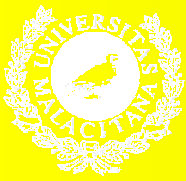


# Developed System

## ◆ BCI Prototype.



- Visual C++.
- WorldToolkit to developed virtual world.
- Different scenes.



# Developed System

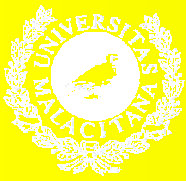
## ◆ Different scenes.

### 1. Car avoiding a puddle.



### 2. Car crashing into a wall .





# Developed System

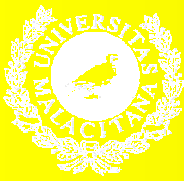
## ◆ Different scenes.

### 3. Car jumping a log .



### 4. Car jumping a ramp .





# Experiments and Results

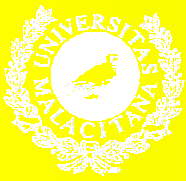
## ◆ Subject.

- BAR group subjects (8 subjects): ➡ system equivalent to Graz BCI which use conventional feedback.
- RV group subjects (8 subjects): ➡ the proposed system (subjects were instructed to avoid only the puddle).

## ◆ Training protocol.

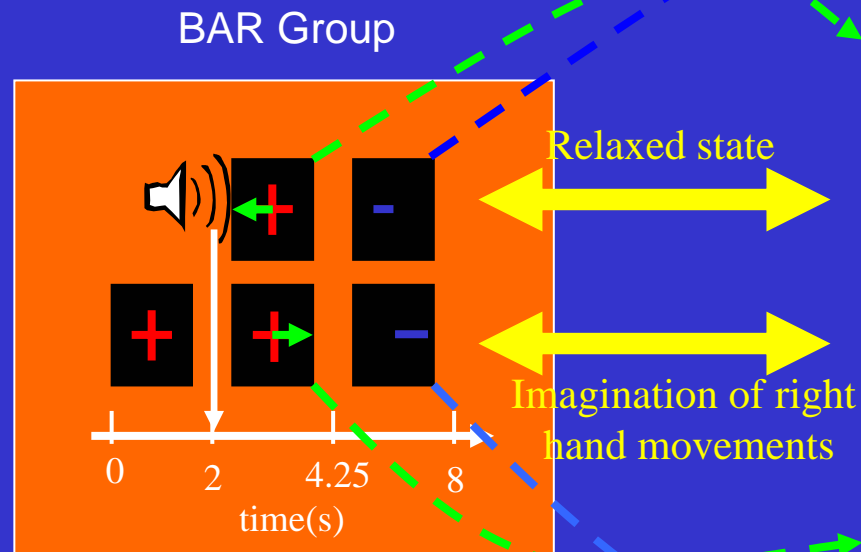
- Each session ➡ 160 trials.
- 7 sessions ➡ 2 without feedback, 5 with continuous feedback.



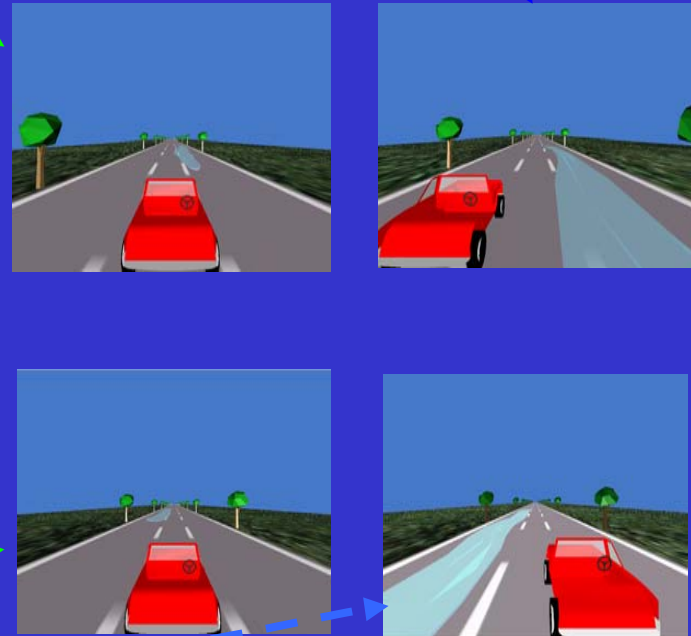


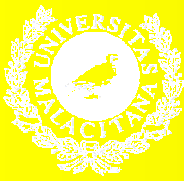
# Experiments and Results

## ◆ Trial time.



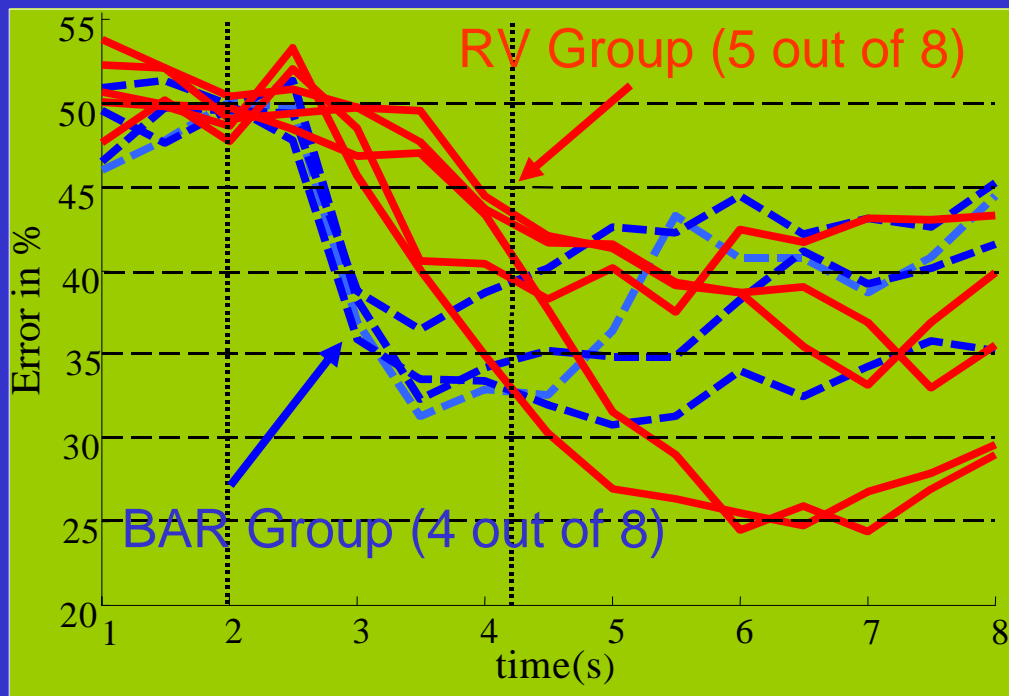
RV Group





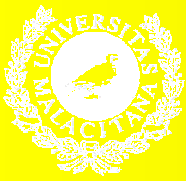
# Experiments and Results

## ◆ Error percentages in the classification results.



-Only subjects whose average error curves during feedback period are below error of 45% are considered.

-During feedback period (4.25s-8s), BAR group subjects tend to get their error percentage worse, while RV group tend to improve their error percentage.



# Experiments and Results

- 1- Error increase during the feedback period for GRAZ group subjects may occur due to a lack of motivation while feedback takes place.
- 2- On the contrary, RV group subjects feel immersed and to be taking part in the task of avoiding the puddle, motivated throughout the feedback period to control the car.
- 3- A big difference of this new system based on virtual reality, is that it offers its subjects visual information on timing.





# Conclusion

- 1- The study carried out shows how appealing feedback for subjects can achieve better classification results.
- 2- Virtual reality such as multi-modal interface seems a good option for this. It can combine 3D display, sound and isolation, developing training techniques presenting feedback whose effects are more immersive and motivating.

