UNIVERSIDAD DE GUADALAJARA

CENTRO UNIVERSITARIO DE LOS VALLES

MAESTRÍA EN INGENIERÍA DE SOFTWARE

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Administración de la configuración del software

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Title

Design and implementation of a software for the mental control of terrestrial robots with therapeutic purposes

Introduction

The Cognidron-EEG system is a system that allows you to control certain movements of a drone, both physical and virtual, through an electroencephalogram that is previously placed on the patient by the therapist, with the aim of helping to train some cognitive functions by providing real-time feedback called neurofeedback. The present project consists of developing and integrating a module to the cognidron-EEG system that allows controlling some programmed movements of a terrestrial social robot through an electroencephalogram and showing feedback to the patient in real time.

Objectives of a system

General objective

Increase the functionality of the CogniDron-EEG system, through the design and implementation of new exercises to train the functions.

Specific objectives

- Study the CognoDron-EEG module that allows access to the Emotiv epoc+ electroencephalogram data and, if necessary, modify it to integrate the cognitive training exercises to be developed.
- Identify the necessary characteristics in a robot so that it can be considered a social robot.
- Implement in the robot the behaviors necessary for it to be considered a social robot and to be used in therapeutic exercises.
- Design and implement 5 therapeutic exercises.
- Integrate the modules developed in the CogniDron-EEG system.
- Design and implement functionality tests to validate the functionality of the developed modules.
- Design and implement integration tests to validate the correct integration of the modules developed within the CogniDron-EEG system.

Functional requirements

Code	**Name**		**Importance degree**
RF-01	Expression to indicate that the robot is ready to start therapy		High
Description	When choosing to carry out a therapy using the robot, it must make both a motor and an auditory expression indicating that the robot is ready to support the therapy. Additionally, the robot must voice a message that reinforces the movement it made		
Input	**Source**	**Output**	**Restrictions**

Confirmation of starting therapy	User	Auditory and motor expression	Motor and auditory expression will be limited according to the characteristics of the robot used
Process	Once the user selects and confirms the therapy, the robot will make a motor and auditory expression indicating that it is ready to start with the therapy.		

Code	**Name**		**Importance degree**
RF-02	Custom settings		High
Description	Before starting the session, you will have the option to make a custom configuration. That is, if the therapist chooses Personalize interaction, the robot must ask the patient what his name is. This information must be temporarily stored and used when the robot expresses phrases to motivate the patient. That is, the phrases must be personalized using the patient's name		
Input	**Source**	**Output**	**Restrictions**
Confirmation of Customize Interaction Patient Name	User	Temporary name storage patient	It will only be personalized if the therapist selects Personalize Interaction
Process	The therapist selects Personalize interaction and later the robot asks the patient for the name, which will be used by the robot when emitting phrases addressed to the patient		

Code	**Name**	**Importance degree**

RF-03	Obtaining information on brain activity		High
Description	Obtain the data of the patient's brain activity in real time using the electroencephalogram device Emotiv epoc+		
Input	Source	Output	**Restrictions**
brain activity data	User	Temporary storage of the patient's brain activity data	
Process	The patient puts on the EEG device and the system will obtain data on the patient's brain activity		

Code	**Name**		Importance degree
RF-04	Control certain programmed movements in the Nao robot according to the data obtained from the EEG		High
Description	The data obtained from the EEG device will be used so that the robot performs or not the programmed actions according to the therapeutic exercise.		
Input	**Source**	**Output**	**Restrictions**
brain activity data	User	Patient name storage	The movements to be controlled will be previously programmed
Process	The system obtains the data from the EEG device in real time, in turn, it sends them to the robot so that the robot performs or not the programmed actions according to the therapeutic exercise		

Code	**Name**		Importance degree
RF-05	Implement at least 5 therapeutic exercises		High
Description	At least 5 different therapeutic exercises should be implemented		
Input	**Source**	**output**	**Restrictions**
brain activity data	User	therapeutic exercises	Therapeutic exercises are limited by the characteristics of the robot
Process	At least 5 therapeutic exercises will be designed and implemented, of which the therapist will have the freedom to choose the exercise to be implemented		

Code	Name		Importance degree
RF-06	Therapeutic exercise "Score goal"		High
Description	One of the 5 therapeutic exercises will consist of creating the allusion to the patient that the Nao robot scores a goal. The robot movements necessary to score a goal will be previously programmed and will be executed according to the general information		
Input	**Source**	**Output**	**Restrictions**
brain activity data	User	Therapeutic exercise "Score goal"	The therapeutic exercise will be executed according to the information received from the EEG and the type of exercise (excitatory or inhibitory)
Process	The EEG device will send the data to the computer and the computer will process and send it to the robot, the robot will execute the exercise according to the data received and obtained from the EEG		

Code	Name		Importance degree
RF-07	Therapeutic exercise "Score goal"		High
Description	One of the 5 therapeutic exercises will consist of creating the allusion to the patient that the Nao robot scores a goal. The robot movements necessary to score a goal will be previously programmed and will be executed according to the general information		
Input	**Source**	**Output**	**Restrictions**
brain activity data	User	Therapeutic exercise "Score goal"	The therapeutic exercise will be executed according to the information received from the EEG and the type of exercise (excitatory or inhibitory).

Process	The EEG device will send the data to the computer and the computer will process and send it to the robot, the robot will execute the exercise according to the data received and obtained from the EEG

Code	**Name**		**Importance degree**
RF-08	show exercises		High
Description	The user will be able to visualize the available exercises and select the one that he deems convenient to carry out the therapy		
Input	**Source**	**Output**	**Restrictions**
List of exercises with a description of what each exercise does	Database	List of therapeutic exercises displayed on the screen	
Process	The EEG device will send the data to the computer and the computer will process and send it to the robot, the robot will execute the exercise according to the data received and obtained from the EEG		

Code	**Name**		**Importance degree**
RF-09	Show the next move to be made by the robot		Medium
Description	The user will be able to visualize the next movement that the robot will perform once the patient reaches the expected threshold		
Inputs	**source**	**Outputs**	**restrictions**
brain information	Electroencephalogram	The display will show the next exercise to be performed	The exercise will be displayed on the therapy screen and this movement will be executed as long as the threshold is reached by the patient.

Process	An image will be displayed in the central part of the exercise screen that indicates what the robot's next movement will be, once the patient reaches the desired threshold and depending on whether the exercise is inhibitory or excitatory, the image will be updated showing the following movement

Code	**Name**		**Importance degree**
RF-10	Implement the “generate” and “consult reports” functions		Medium
Description	The functions of "generating" and "consulting reports" will be integrated into the module		
Input	**Source**	**Output**	**restrictions**
Data regarding therapy	Database	A report with the data corresponding to the therapy that can be viewed by the therapist	
Process	The user will see an option on the screen that will allow him to generate a report with relevant data from the therapeutic session and can consult it in the section corresponding to the reports		

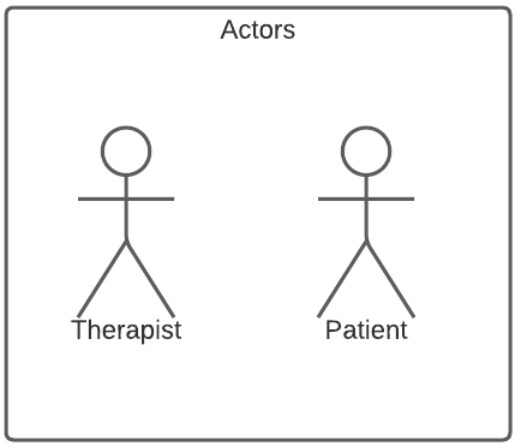
Code	**Name**		**Importance degree**
RF-11	Implement existing function to change threshold parameters		High
Description	The therapist will be able to change the parameters of the indicated threshold with an integer numerical value between 0 and 100		
Input	**Source**	**Output**	**Restrictions**
Whole number between 0 and 100	Therapist	Change of position of the line representing threshold and threshold for therapy	Threshold values can only be integers between 0 and 100
Process	The therapy threshold represented by a red line located on the neurofeedback bar will be positioned on the bar according to the value corresponding to the one entered by the therapist,		

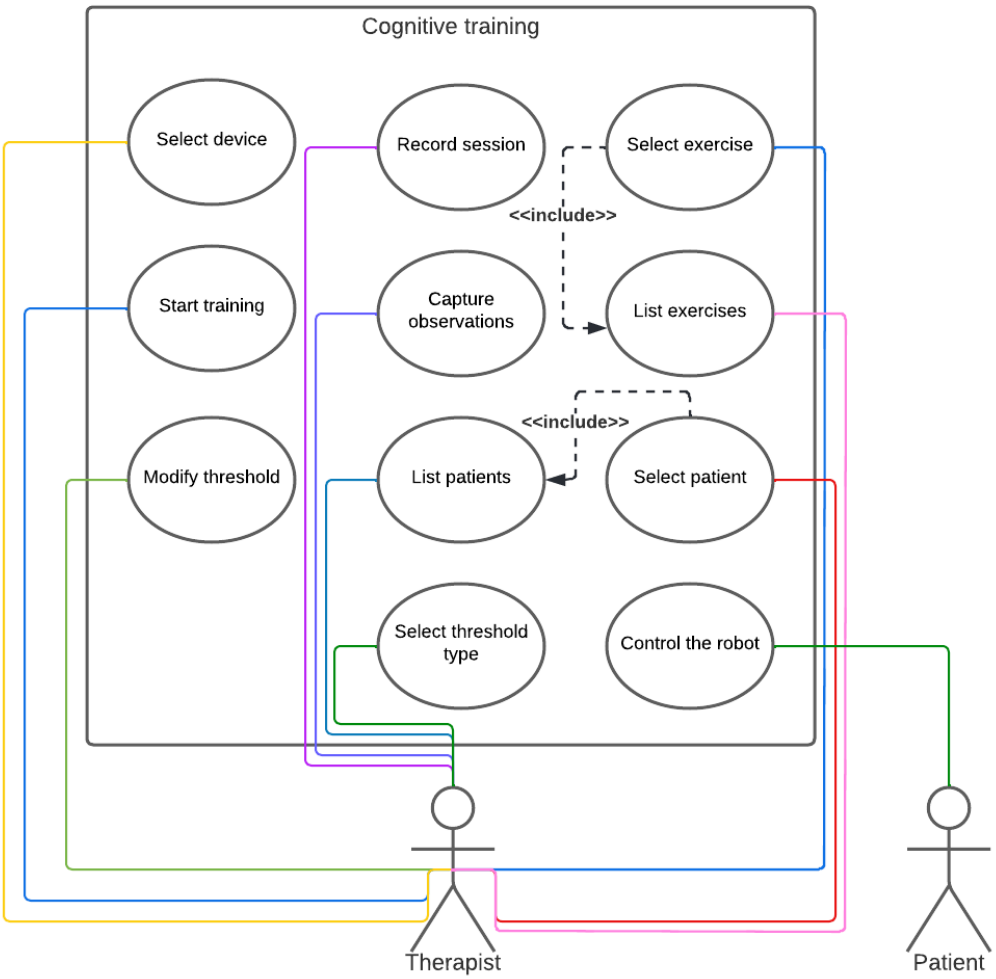
	visually indicating the threshold value that the user must reach for the robot to perform the next move

Code	**Name**		**Importance degree**
RF-12	Integrate the option to choose the type of exercise "excitatory or inhibitory"		High
Description	The therapist will be able to choose whether the therapeutic exercise will be inhibitory or excitatory.		
Input	**Source**	**Output**	**Restrictions**
Type of exercise: Excitatory or inhibitory	Therapist	The movements of the robot will be executed according to the type of exercise	The type of exercise will be selected by the therapist before starting therapy
Process	Before starting the cognitive training exercise, the therapist should indicate whether the exercise is inhibitory or excitatory. The behavior of the robot will be according to the type of therapeutic exercise		

System design

The use cases of the system are shown below


Actors
Therapist
Patient


Cognitive training
Select device
Record session
Select exercise
<<include>>
Start training
Capture observations
List exercises
<<include>>
Modify threshold
List patients
Select patient
Select threshold type
Control the robot
Therapist
Patient

Test design

Static tests will be carried out on the documentation and requirements in order to find possible inconsistencies, unit tests testing each function individually, functional tests to test if the system meets the requirements and integration tests to verify the correct integration of the module to the system. cognidrone-EEG.

Static tests: Static tests will be performed by the developer and the project advisor throughout the documentation process.

Unit tests: they will be carried out by the developer and will be white box. These tests will be performed during the coding stage. The release of functions and methods will be conditional on the success of the unit tests.

Functional tests: The functional tests will be carried out by the developer and will be a positive and a negative at least for each functional requirement.

Integration tests: These tests will be carried out by the developer and will verify the correct integration of the module to the cognidron-EEG system. They will be carried out once the first prototype of the module to be developed has been completed.

The tests will be limited by time, it is estimated that the first prototype of the module will be finished in January 2023, however, this may be subject to change.