CogniDriver is a 3D mind-controlled car driving game. The player’s purpose is to compete themselves to finish the race in as short an amount of time as possible while also collecting road coins.

We have been using the Emotiv EPOC headset. Is is composed of 14 sensors which transmit raw EEG data and 2 reference sensors: CMS – Common Mode Sense which is the point on the scalp against which everything else is measured and DRL – Driven Right Leg which provides a feedback signal to cancel common mode noise in the electronics. Before using the headset, the felt pads need to be hydrated using saline solution. The data from the 14 sensors gets transmitted to the computer. Since we have used the developers’ SDK, we don’t have direct access to the raw data, but to its interpretations. These are split in 3 suites:

The Expressiv suite which detects 11 facial expressions: blinks, winks, looking left/right, raising or furrowing brows, smiles, teeth clenches, smirks and laughs.

The Affectiv suite which detect 4 emotions: engagement/boredom which are opposites, excitement, frustration and meditation. These are measured in both short and long term.

The Cognitiv suite which is the most interesting one. Here, the user is allowed to train 13 actions but only up to 4 can be recognised at any one time. These are rotations against the x, y and z-axis, movements: push, pull, left, right, lift, drop and disappear – which is more abstract because it is not tangible. Each training takes 8 seconds and there is a skill level which will tell you how good your previous training was. There is also visual feedback during the training based on whether an action is activated and the current action power. At the end of a training, the user can choose whether to accept or deny the training based on the visual feedback received.

There is also a 2-axis gyroscope which is placed on top of the headset which we have tried using as yet another way to control the game but it doesn’t seem useful since the player would have to move the head and implicitly the eyes away from the screen.

For developing the game, we have chosen to use the Unity game engine. The reason behind that is the fact that Unity does automatic object updates if the imported files are changed from the outside and it also allows easy deployment to a variety of platforms. The game physics engine is easy to use once one follows a few tutorials to get up to grips with it. Unity allows scripting in JavaScript, C# or Boo and for this project we have been using C#.

Now, to go to the real project, the first thing a player has to do is to select a user profile. There is a limit of 10 user profiles because Unity does not allow drop-down menus and the size of the Cognitiv training files is of a few megabytes generally. It depends on how many training session it takes to reach a good state.

Training is done in a similar way to the Emotiv EPOC Control Panel, the only difference being, the 4 actions are preselected. When training the neutral state, the player should relax and not do any particular activity. For push/pull/left/right, training most often works by imagining the car moving to the direction we are training for. There used to be a cube for training, in order to make it consistent with the Emotiv EPOC Control Panel, but during user testing, it was suggested to use an actual car as it is easier to imagine the action that way.

Just as shown in the Emotiv Control Panel, the player has access to the sensor contact quality information and the current action and its power.

After the player presses PLAY, they are prompted with a screen to select a car model and colour to use within the game. There are only 2 models at the moment. These are free online models from tf3dm.com and archive3d.net.

In **statistics**, the player will be able to see the top 10 highest scores for keyboard mode play and Cognitiv mode play. The data is saved using the PlayerPrefs module in Unity. It works by assigning pairs of keys and values and the saved data is accessible from a variety of platforms. CogniDriver has been deployed on Windows, Linux and MacOS.

In the **options** tab, the player can switch the play mode which by default is Cognitiv. They may also change the sound volume and whether the game is played in fullscreen or window mode.

In the actual gameplay, checkpoints have been inserted following a suggestion during user testing. Another suggestion was to have different speeds on grass and road. This has been implemented and the acceleration on grass is 2 time lower than that on the main road.

Difficulties

* Losing wireless connection
* Winks/blinks + laughs/smiles mistaken when no perfect sensor contact quality

To finish off, you will be able to observe one of my colleagues during Cognitiv play mode, firstly accelerating the car and then doing a left turn. Turning left/right is difficult because the player has to be quick in switching the mental state. Out of 13 testers, only 2 have been able to achieve this in the 2 hours slot. Now, I will show you the Keyboard play mode just so you can see more of the actual game play.

Left wink to change camera view

Clench teeth to action handbrake

Raining when frustrated

Move in reverse

Minimap

Speedometer

Elapsed time + coins

Thank you for watching!