cogniLink: A Non-Invasive Brain-Computer Interface That Enables Seamless Execution of Commands Through Thought Recognition

Project cogniLink

Abstract

Although great strides have been achieved in making computers more accessible, its indisputable that there remains huge prospects for improvement. Given that technology is designed for the masses, it offers every individual a platform to do what is needed; this includes, but isnt limited to, support for individuals with motor, dexterity, and/or speech impairments. In this proposal, we will discuss cogniLink, a tool that assists developers in making computers more accessible for persons with afflictions. cogniLink is a brain-computer interface that allows the user to trigger the execution of a command simply by thinking of the trigger. A training data set is to be collected from n-users in order to train n-models using an ElectroEncephaloGram (EEG). Each model is programmed to recognize one or more trigger thoughts. The same model interacts with a stack of software which allows it to map positive outputs from the model and transform it into an actionable command. For the purpose of demonstration, the model will be trained to recognize commands from one user which will be mapped to a virtualHID in such a way that allows the user to play Super Mario Bros. After an extensive process of training n-models, a universal model (UM) will be trained using data from the aforementioned n-models in order to have a simpler training process for new users. cogniLink will allow disabled people to execute commands in a very seamless and orderly fashion, thus making computers more accessible to persons with digital input impairments. Two of cogniLinks long term goals are to allow an amputee to be able to effortlessly be able to control a wheelchair in real time, and for someone suffering from Locked-In Syndrome to be able to interact with the world around them with ease.

1 Implementation

1.1 Tool Chain

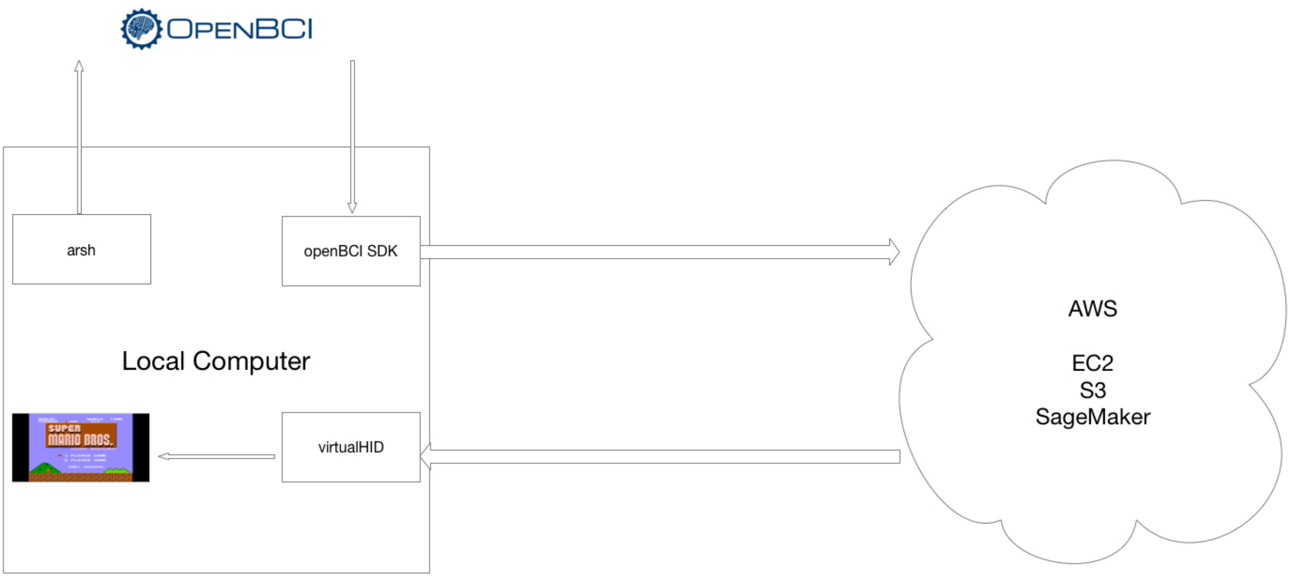

Figure 1: Tool Chain Diagram

Text about tool chain here Figure 1.

1.2 Project work plan

Work package description

Work package number	**WP1**	**Starting week**	1
Work package title	**Virtual HID, Data Collection, and ML Code**		
Participant number	**1**		
Short name	**georgio**		
Person-weeks	**2**		

Objectives

This work package has the following objectives:

1. To develop a Virtual Human Interface Device;
2. To develop an API that gathers raw data from the Cyton board and feeds it to a CSV file;

3. To write code needed to efficiently store and manage datasets;
4. To write code needed to start training Model 1 on Command A.

Description of work

Task T1.1: Task1 (W1-W1)
The virtualHID will be created using macOS' IOKit Library.

Task T1.2: Task2 (W1-W1)
The Cyton board will be programmed using arsh.

Task T1.3: Task3 (W1-W1)
API to gather data from Cyton Board will be built

Task T1.4: Task4 (W1-W2)
Code to manage raw EEG data will be done here.

Task T1.5: Task5 (W2-W2)
EC2, S3, and SageMaker instances will be configured.

Task T1.6: Task6 (W2-W2)
Code to feed raw data to S3 bucket will be done here.

Task T1.7: Task7 (W2-W2)
Code to start training the model will be done here.

Deliverables

D1.1 WP1 W1 Progress Report. **(M1)**

D1.2 Demonstration of APIs **(M2)**

D1.3 End of WP1 - Overall Progress Report. **(M2)**

D1.4 WP1 Code+Tools Merged to master. **(M2)**

Work package number	WP2		Starting week	2
Work package title	Model 1 Command A			
Participant number	1			
Short name	georgio			
Person-weeks	3			

Objectives

1. To collect training, validation, and test datasets for Model 1 Command A;
2. Training Model 1 using aforementioned data;
3. Testing/Patching Model 1.

Description of work

Description of work carried out in WP, broken down into tasks, and with role of partners list. Use the `\wptask` command.

Task T2.1: Task1 (W1-W12)
Here we will test the WP Task code.

Task T2.2: Task2 (W6-W9)
In this task UZH will integrate the work done in **??**.

Task T2.3: Task 3 (W9-W12)
Here all the WP participants will apply the results to...

Deliverables

D2.1 Report on the definition of the model specifications. **(M36)**

D2.2 Report on Feasibility study for the model implementation. **(M12)**

D2.3 Prototype of model implementation. **(M24)**

description

Work package number	**WP3**	**Starting week**	1
Work package title	**Model 1 n Commands**		
Participant number	**1**		
Short name	**georgio**		
Person-weeks	**12**		

Objectives

This work package has the following objectives:

1. Link the output from the Model to the virtual HID created in WP1;
2. Map trigger thoughts to button presses;
3. Play a game of 1P Super Mario Bros.

Description of work

Description of work carried out in WP, broken down into tasks, and with role of partners list. Use the `\wptask` command.

Task T3.1: Test (W1-W12)
Here we will test the WP Task code.

Task T3.2: Integrate (W6-W9)
In this task UZH will integrate the work done in T3.1.

Task T3.3: Apply (W9-W12)
Here all the WP participants will apply the results to...

Role of partners

Participant short name will lead Task T3.2.
georgio will..

Deliverables

D3.1 Report on the definition of the model specifications. **(M36)**

D3.2 Report on Feasibility study for the model implementation. **(M12)**

D3.3 Prototype of model implementation. **(M24)**

description

Work package number	WP4		Starting week	1
Work package title	**Model 2 n Commands**			
Participant number	**1**			
Short name	**georgio**			
Person-weeks	**12**			

Objectives

This work package has the following objectives:

1. Replicate all steps in WP2 and WP3 so that we get a Model 2 for a different individual trained on n the same n Commands as Model 1;
2. Play a game of 2P Super Mario Bros.

Description of work

Task T4.1: Task1 (W1-W12)
Here we will test the WP Task code.

Task T4.2: Task2 (W6-W9)
In this task UZH will integrate the work done in **??**.

Task T4.3: Task3 (W9-W12)
Here all the WP participants will apply the results to...

Deliverables

D4.1 Report on the definition of the model specifications. **(M36)**

D4.2 Report on Feasibility study for the model implementation. **(M12)**

D4.3 Prototype of model implementation. **(M24)**

description

Work package number	WP5	Starting week	1
Work package title	Optimizations		

Participant number	**1**	
Short name	**georgio**	
Person-weeks	**12**	

Objectives

This work package has the following objectives:

1. Optimizing the code in such a way that a trigger thought is recognized in realtime.

Description of work

Task T5.1: Task1 (W1-W12)
Here we will test the WP Task code.

Task T5.2: Task2 (W6-W9)
In this task UZH will integrate the work done in **??**.

Task T5.3: Task3 (W9-W12)
Here all the WP participants will apply the results to...

Deliverables

D5.1 Report on the definition of the model specifications. **(M36)**

D5.2 Report on Feasibility study for the model implementation. **(M12)**

D5.3 Prototype of model implementation. **(M24)**

description

Work package number	WP6		Starting week	1
Work package title	Real Life Application			
Participant number	1			
Short name	georgio			
Person-weeks	12			

Objectives

This work package has the following objectives:

1. Implement cogniLink to work on a controller of a wheelchair;
2. Implement cogniLink to identify a thought and provide a way to communicate for a person suffering from Locked-In Syndrome.

Description of work

Task T6.1: Task1 (W1-W12)
Here we will test the WP Task code.

Task T6.2: Task2 (W6-W9)
In this task UZH will integrate the work done in **??**.

Task T6.3: Task3 (W9-W12)
Here all the WP participants will apply the results to...

Deliverables

D6.1 Report on the definition of the model specifications. **(M36)**

D6.2 Report on Feasibility study for the model implementation. **(M12)**

D6.3 Prototype of model implementation. **(M24)**

description

Work package number	WP7	Starting week	1
Work package title	Universal Model, n Commands		

Participant number	1	
Short name	georgio	
Person-weeks	12	

Objectives

This work package has the following objectives:

1. To develop a Virtual Human Interface Device;
2. To develop an API that gathers raw data from the Cyton board and feeds it to a CSV file;
3. To write code needed to efficiently store and manage datasets;
4. To write code needed to start training Model 1 on Command A.

Description of work

Task T7.1: Task1 (W1-W12)
Here we will test the WP Task code.

Task T7.2: Task2 (W6-W9)
In this task UZH will integrate the work done in **??**.

Task T7.3: Task3 (W9-W12)
Here all the WP participants will apply the results to...

Deliverables

D7.1 Report on the definition of the model specifications. **(M36)**

D7.2 Report on Feasibility study for the model implementation. **(M12)**

D7.3 Prototype of model implementation. **(M24)**

List of work packages

Table 1.2b: List of work packages

Work package number	Work package title	Lead participant no.	Lead participant name	Person-weeks	Start week	End week
WP1	Virtual HID, Data Collection, and ML Code	1	georgio	2	1	2
WP2	Model 1 Command A	1	georgio	3	2	36
WP3	Model 1 n Commands	1	georgio	12	1	36
WP4	Model 2 n Commands	1	georgio	12	1	36
WP5	Optimizations	1	georgio	12	1	36
WP6	Real Life Application	1	georgio	12	1	36
WP7	Universal Model, n Commands	1	georgio	12	1	36
	TOTAL			65		

List of deliverables

[1]

Table 1.2c: Deliverable list

Deliverable number	Deliverable name	WP no.	Lead participant name	Nature	Dissemination Level	Delivery date (proj. week)
D1.1	WP1 W1 Progress Report.	WP1	georgio	R	PU	1
D1.2	Demonstration of APIs	WP1	georgio	D	PU	2
D1.3	End of WP1 - Overall Progress Report.	WP1	georgio	R	PU	2
D1.4	WP1 Code+Tools Merged to master.	WP1	georgio	P	PU	2
D2.2	Report on Feasibility study for the model implementation.	WP2	georgio	R	PU	12
D3.2	Report on Feasibility study for the model implementation.	WP3	georgio	R	PU	12
D4.2	Report on Feasibility study for the model implementation.	WP4	georgio	R	PU	12
D5.2	Report on Feasibility study for the model implementation.	WP5	georgio	R	PU	12
D6.2	Report on Feasibility study for the model implementation.	WP6	georgio	R	PU	12
D7.2	Report on Feasibility study for the model implementation.	WP7	georgio	R	PU	12
D2.3	Prototype of model implementation.	WP2	georgio	R	PU	24
D3.3	Prototype of model implementation.	WP3	georgio	R	PU	24

Continued on next page

[1] If your action taking part in the Pilot on Open Research Data, you must include a data management plan as a distinct deliverable within the first 6 weeks of the project. This deliverable will evolve during the lifetime of the project in order to present the status of the project's reflections on data management. A template for such a plan is available on the Participant Portal (Guide on Data Management).

Table 1.5a: Summary of staff effort

Partic. no.	Partic. short name	WP1	WP2	WP3	WP4	WP5	WP6	WP7	Total person weeks
1	georgio	**2**	**3**	**12**	**12**	**12**	**12**	**12**	65
Total		2	3	12	12	12	12	12	65

D4.3	Prototype of model implementation.	WP4	georgio	R	PU	24
D5.3	Prototype of model implementation.	WP5	georgio	R	PU	24
D6.3	Prototype of model implementation.	WP6	georgio	R	PU	24
D7.3	Prototype of model implementation.	WP7	georgio	R	PU	24
D2.1	Report on the definition of the model specifications.	WP2	georgio	R	PU	36
D3.1	Report on the definition of the model specifications.	WP3	georgio	R	PU	36
D4.1	Report on the definition of the model specifications.	WP4	georgio	R	PU	36
D5.1	Report on the definition of the model specifications.	WP5	georgio	R	PU	36
D6.1	Report on the definition of the model specifications.	WP6	georgio	R	PU	36
D7.1	Report on the definition of the model specifications.	WP7	georgio	R	PU	36

1.3 Management and risk assessment

List of milestones

Table 1.3a: List of milestones

Milestone number	Milestone name	Related WPs	Estimated date	Means of verification
M1	Completed simulator development	1	24	Software released and validated
M2	Final demonstration	WP **??**	36	Application of results

Critical risks for implementation

Table 1.3b: Critical risks for implementation

Description of Risk	WPs involved	Proposed risk-mitigation measures
The dedicated chip sent to fabrication is not functional.	WP **??**	Resort to Software simulations

1.4 Consortium as a whole

1.5 Resources to be committed

Summary of staff efforts

Other direct cost items (travel, equipment, other goods and services, large research infrastructure)

Participant no. 1 (georgio)	Cost (EUR)	Justification
Travel	2500	3 pairwise meetings for 2 people, 2 conferences for 3 people, 3 internal project meetings for 3 people
Equipment	3000	CAD workstation for chip design
Other goods and services	60000	Fabrication of 2 VLSI chips
Total	65500	

Participant no. 1 (georgio)	Cost (EUR)	Justification
Large research infrastructure	400000	Synchrotron

2 Ethics and Security

2.1 Ethics

2.2 Security

[2]

[2] Article 37.1 of the Model Grant Agreement: Before disclosing results of activities raising security issues to a third party (including affiliated entities), a beneficiary must inform the coordinator – which must request written approval from the Commission/Agency. Article 37.2: Activities related to "classified deliverables" must comply with the "security requirements" until they are declassified. Action tasks related to classified deliverables may not be subcontracted without prior explicit written approval from the Commission/Agency. The beneficiaries must inform the coordinator – which must immediately inform the Commission/Agency – of any changes in the security context and –if necessary – request for Annex 1 to be amended (see Article 55).