History, concept, functionalities and community

4th OpenViBE Workshop
@NeuroErgonomics21

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An open source software platform
for Brain-Computer Interfaces
and real-time neurosciences

http://openvibe.inria.fr

Enjoyed by research labs, clinicians, teachers, game developers and hobbyists worldwide
Brain-Computer Interfaces

Brain imaging → Signal denoising → Feature extraction → Command recognition → Execution

Feedback

OpenViBE workshop (NeuroErgonomics’21) - 3
Main funded project using OpenViBE

- **2005-2009**: ANR OpenViBE (RNTL, BCI and disabled people, partners: Inria-Rennes, INSERM, CEA, Orange, AFM, GIPSA-LAB)
- **May 2009**: First public release
- **2009-2011**: ADT LOIC (Rennes-Nancy, OpenViBE support and dev)
- **2009-2012**: ANR OpenViBE2 (Rennes, BCI and videogames)
- **2009-2012**: ANR Co-Adapt (Sophia, dynamic BCI)
- **2009-2011**: ADT Immersive BCI (Sophia, BCI and immersive display)
- **2009-2012**: ANR RoBIK (CEA/GIPSA, speller for disabled people)
- **2010**: First OpenViBE int. tutorial (BCI Meeting, Monterey, US)
- **2011**: Google Science Fair (student project congratulated by Obama)
- **2012-2013**: LIRA (Rennes-Bordeaux-Nancy, Stress and Relaxation)
- **2012-2015**: ADT OpenViBE-NT (Rennes-Bordeaux-Nancy-Sophia)
- **Nov 2012**: Creation of Mensia Technologies
- **2013-2016**: Labex CominLabs HEMISFER (Rennes, Neurofeedback)
- **2014-2017**: Labex CominLabs SABRE (Rennes, fast computation EEG)
- **2014**: First OpenViBE int. workshop (BCI Conference, Graz, Austria)
- **2014**: First contributions from Mensia to open-source project
- **2014-2016**: ADT OpenViBE-X (Sophia)
- **2015-2019**: IPL BCI-LIFT (Sophia-Rennes-Nancy-Bordeaux)
- **2015-2016**: Ilab CertiViBE (Hybrid-MENSIA)
- **2016**: 2nd OpenViBE workshop (BCI conference, Austria)
- **2016**: ANR REBEL
- **2017**: ATT CONSORVIBE
- **2018**: Medical Certification and first products from Mensia
- **2080**: Third OpenViBE int. tutorial (SMC, Japan)
- **2019**: ERC BrainConquest (user training)
- **2020**: ANR Grasp-IT (Feedbacks for Stroke patients)
- **2021**: ANR ABCIS (BCI acceptability by stroke patients)
- **2021**: ANR BETAPARK (Parkinson)
- ...
OpenViBE Concept
Concept: General Software Architecture

- OpenViBE application
- OpenViBE kernel
- OpenViBE API
- OpenViBE plugins
- Network Communication
- TCP/IP
- UDP
- LSL
- VRPN

Outside World Application

OpenViBE workshop (NeuroErgonomics’21)
## Concept: Plugins

<table>
<thead>
<tr>
<th>GDF file writer/reader</th>
<th>Temporal filtering</th>
<th>Spectral analysis</th>
<th>Signal and spectral visualisation</th>
<th>Matlab scripting</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDF file writer</td>
<td>Spatial filtering xDAWN, CSP</td>
<td>Classification LDA/SVM</td>
<td>2D and 3D topography map</td>
<td>Python scripting</td>
</tr>
<tr>
<td>CSV file writer/reader</td>
<td>Universal DSP</td>
<td>Auto-Regressive coefficients</td>
<td>Voxel display</td>
<td>Lua scripting</td>
</tr>
<tr>
<td>Generic network acquisition</td>
<td>Signal epoching</td>
<td>Windowing</td>
<td>Time/frequency mapping</td>
<td>VRPN input/output</td>
</tr>
</tbody>
</table>

### Connectivity measure

<table>
<thead>
<tr>
<th>Connectivity measure</th>
<th>Multiclass classifiers</th>
<th>LSL Input/output</th>
</tr>
</thead>
</table>

### Artefact detection

<table>
<thead>
<tr>
<th>Artefact detection</th>
<th>Riemmanian geometry</th>
</tr>
</thead>
</table>
Concepts: modularity and reusability

- quickly and efficiently arrangement of small processing components into a high level / complex composition
Concepts: different users

Author’s view

Make your own DSP chains

Operator’s view

Subject’s view

Interactive Application

Neurofeedback

No programming skills required
• A scenario designer
• Graphical User Interface
• WYSIWYG (What You See Is What You Get)
OpenViBE Functionalities
Functionalities: An acquisition device abstraction

- Allows any device to be integrated, through the development of a C++ driver
- Already supported:
  - All Brain Products devices (VAMP, Brainamp series, Quickamp)
  - Brainmaster (Atlantis, Discovery)
  - Cognionics (all?)
  - EGI (Netamps 300)
  - Emotiv (EPOC)
  - g.Tec (g.USBam, g.Mobilab+, gNautilus)
  - All Micromed devices (through SystemPlus Evolution s/w)
  - OpenBCI (cyton+daisy)
  - OpenEEG (modularEEG, monolithEEG)
  - Neurosky (Mindset, MindWave)
  - Most TMSi devices (including Porti, Refa, and derived Mindmedia NeXus, ANT Neuro ASALAB...)

+ many others (check the full list on http://openvibe.inria.fr/supported-hardware/)
Functionalities: Paradigms

- **P300**
- **SSVEP**
- **Motor Imagery**
- **Neurofeedback**
Functionalities: stimuli

• **Visual Stimulus:**
  
  Included in the release
  
  done by users

• **Audio Stimulus:**
  
  • Sound Player box

• **Keyboard Stimulus**
Functionalities: Various real-time displays
Functionalities: Interaction with other software

• VRPN plug-in
  - OpenViBE can be considered as an external peripheral
  - Immediate compatibility with most VR software / tools
• Matlab plug-in
  - OpenViBE can call Matlab code
• Lua plug-in
  - Experiment protocol can be implemented with Lua scripts
• Python plug-in
  - OpenViBE can call Python code for signal processing as well as implementing experiment protocols
• File reader / writer plug-in
  - The signals can be imported / exported with different formats (gdf, edf, csv, ...)
• External configuration files
  - Each box configuration can be defined in a file
    For example, write your own spatial filter in Matlab and use it in OpenViBE
Functionalities: predefined applications

• Several predefined and ready to use scenarios:
  1. Neurofeedback with the *Tie Fighter* VR game
  2. BCI based on motor activity (Graz-BCI, handball)
  3. BCI based on P300 (*Speller, Magic Card*)
  4. BCI based on SSVEP (*Spaceship Shooter*)

• Lots of *box tutorials* scenarios to showcase specific features (read EEG from a file, compute a topographic map, filter signal, etc.)
OpenViBE Community
Oct 2018: Come check the OpenViBE workshop at IEEE SMC 2018, Japan
Latest News (see all)

The 4th International OpenViBE workshop

Location: Online Date: September 11, 2021 Workshop of the 3rd Neuroergonomics Conference (NEC’21) Time: 14:00 – 18:00 CET Organisers: Fabien Lotte Laurent Bougrain Hakim Si-Mohammed Léa Pillette Aline Roc Description: Brain-Computer Interfaces (BCI) are innovative Human-Computer Interaction Systems for recovery, monitoring, evaluation and … Continue reading →
OpenViBE source code is hosted on the inria gitlab in a Git repository https://gitlab.inria.fr/openvibe

Since OpenViBEv1.18.0 Gitlab replaces Gforge.

• Getting the **latest** (unstable) version on a development branch
• **Build status** on https://gitlab.inria.fr/openvibe/meta
• **Push updates. Only for developers with account on gitlab.inria.fr**
• **Previous** Gforge (v0.17.0 – v1.3.0) and SVN (v0.1.0 – v0.16.0) repositories
Benefits of bug tracking / feature request tracking:

- Report information about what does not work
- Report information about what should work in a different manner
- Report information about what could be added to make the software better
- Following how those issues are solved by the developers
- This tool becomes more and more valuable as the community grows

Use tickets on gitlab.
Bugs can also be reported on the forum. They are turned then into tickets on gitlab.
The OpenViBE forum (http://openvibe.inria.fr/forum) should replace the mailing lists:

- General discussion about OV
- General discussion about BCI
- Feature Requests
- OpenViBE development
- OpenViBE use
- OpenViBE scenarios
What is Free Software?

• Free software supposes 4 basic rules:
  • You are free to use the software for any purpose
  • You are free to study the source code and modify it for your own needs (that is the software must be open-source)
  • You are free to re-distribute copies of the software
  • You are free to distribute modified versions of the software but you have to keep them free as in freedom!

• Usually there is a community and an ecosystem around the free software that can
  • Provide Support
  • Share experience and ideas
  • Help in solving scientific or technical challenges
  • Give continuous guidelines
What OpenViBE can do for you?

- Acquire, process and visualize brain activity in real-time
- Extract, analyze and visualize evoked potentials in real-time
- Offer flexibility for designing, testing and using new brain signal pattern detection

How you can contribute and get involved in OpenViBE?

- Provide feedback about your use of the software
- Express needs for adapting the tool to your field
- Support the developments by funding OpenViBE experts for creating the features you need
- Create and share OpenViBE additions with the community
OpenViBE Consortium
http://openvibe.inria.fr/consortium/
Consortium benefits

• Reliability and long-term support for OpenViBE
• Influence on future developments
• Engineering time allocation
• Visibility
• Marketing of opportunities
• Network
Consortium organization

General assembly:

- Development directions
- Organizational changes

Executive Committee:

- implements decisions

Scientific and Technical Committee

- 3 to 5 academics
- Definition of the roadmap
## Consortium fees

<table>
<thead>
<tr>
<th>Title</th>
<th>Silver</th>
<th>Gold</th>
<th>Platinum</th>
<th>INRIA members</th>
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</thead>
<tbody>
<tr>
<td>Fee / year</td>
<td>5,000 €</td>
<td>10,000 €</td>
<td>20,000 €</td>
<td>N/A</td>
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<tr>
<td># items nominated for review by STC (twice a year)</td>
<td>2</td>
<td>4</td>
<td>8</td>
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<tr>
<td>Engineering allocation</td>
<td>4 days</td>
<td>8 days</td>
<td>20 days</td>
<td>20 days</td>
</tr>
<tr>
<td>General Assembly</td>
<td>1 vote</td>
<td>2 votes</td>
<td>3 votes</td>
<td>3 votes</td>
</tr>
</tbody>
</table>
OpenViBE Key Features
Key features

- Modular and reusable framework (GTK/C++), portable (Linux/Windows)
- Free and open-source (AGPL license)
- Simple to download and install (install kits, on-line doc, tutorials)
- Graphical User Interface (user-friendly, non-programmers)
- Generic acquisition server (compatible with many EEG devices)
- Available scenarios for starters: P300, Motor Imagery, SSVEP, etc.
- Various users: research, clinical, industry, programmers vs non
Key figures

- Releases: #32: OV 3.1.0: Avril 2021
- Website: ~110,000 Unique visitors / ~300,000 visits in 2020
- Downloads: ~5500 downloads in 2020 (~3000 downloads per release)
- Forum members: ~1200 users total
- Forum posts: ~6700 posts total
- Citations: ~709 citations
  (OpenViBE paper 2010, google scholar)
- ~170k lines (C++)