Grant Agreement:	604102	Project Title:	Human Brain Project

Document Title:	Neurorobotics Platform v1 — Documentation
Document Filename:	SP10 D10.4.5 FINAL_A
Deliverable Number:	D10.4.5
Deliverable Type:	Report
Work Package(s):	WPs 10.1 - 10.7
Dissemination Level:	PU
Planned Delivery Date:	M30 / 31 Mar 2016
Actual Delivery Date:	M30 / 31 Mar 2016

Authors:	Axel VON ARNIM, FORTISS (P54), T10.2
Compiling Editors:	Axel VON ARNIM, FORTISS (P54), WP10.2, Marc-Oliver GEWALTIG (P1), WP10.1
Contributors:	Daniel PEPPICELLI, EPFL (P1), Task No. 10.1.3 Axel VON ARNIM, TUM (P53), Task No. 10.2.1 Florian ROEHRBEIN, TUM (P53), Task No. 10.4.1
Coordinator Review:	EPFL (P1): Jeff MULLER, Martin TELEFONT UHEI (P45): Sabine SCHNEIDER, Martina SCHMALHOLZ
Editorial Review:	EPFL (P1): Guy WILLIS, Lauren ORWIN, Colin McKINNON

Abstract:	This is the documentation reference for the first public release of the Neurorobotics Platform.
Keywords:	Neurorobotics, documentation
Available at:	www.humanbrainproject.eu/ec-deliverables

Table of Contents

1. The Aim of this Document

The aim of this document is to detail the technical and user documentation available to internal and external users of the Neurorobotics Platform, and to provide a roadmap describing plans for future Platform development.

Public release of a preliminary prototype of the Neurorobotics Platform is the subject of a separate Deliverable (D10.4.4 – Neurorobotics Platform v1), to be published simultaneously with this one. The Platform is accessible via the HBP Collaboratory web interface at:

https://collab.humanbrainproject.eu/#/collab/71/nav/405

Users need special rights to be able to launch experiments that may be requested on our public home page:

http://www.neurorobotics.net/fileadmin/platform

2. Technical and User Documentation

All the documentation relating to the use of the Neurorobotics Platform is available on the Platform itself:

https://collab.humanbrainproject.eu/#/collab/71/nav/1610

2.1 Technical Documentation

The developer manual is available from the main documentation URL:

https://collab.humanbrainproject.eu/#/collab/71/nav/1610

2.2 User Manual

The Neurorobotics Platform User Manual gives detailed guidance on how to use the Platform. Please see:

https://collab.humanbrainproject.eu/#/collab/71/nav/1610

3. Help and User Feedback

To obtain user assistance, to provide user feedback or to contribute to the on-going development of the platform, please contact: neurorobotics@humanbrainproject.eu

The neurorobotics team is also monitoring the HBP forums where question can be shared with the community: https://forum.humanbrainproject.eu/

The user is invited to submit also bug reports or fill in a user survey, both of which are linked on our home page.

All these links can be found on the Neurorobotics collab page under “Support”.

4. Future Development of the Platform

Strategic closed-loop experiments will be developed in which data-driven scaffold brain models from SP6 are connected to body models. The experiments are chosen to reconstruct the sensory motor loops (between brain and body models) for the most important systems.

In addition, the strategic experiments help to define and develop the Neurorobotics Platform and to define priorities for research in SPs 1-6. This work will include:

- **Locomotion and posture**
- **Sensory-motor integration**
- **Cortico-spinal integration**
- **Cerebellar motor control**
- **Sensory-guided neuromotor control (part of CDP4)**
- **Simulation of motor rehabilitation experiments rodents (part of CDP1)**

Many components like robots, bodies, sensors, actuators and environments that are needed in these closed-loop experiments as well as in the Co-Design Projects have to be provided. Where possible, we will collect community models of bodies, robot and environments and integrate them into the Neurorobotics Platform. We will also develop strategically important new models, such as a biologically realistic model of a rodent, including its musculo-skeletal system, i.e.:

- **Rodent body model**
- **Musculo-skeletal models**
- **Models of robots, sensors and environments**
- **Benchmarking and validation of NR models**

A suite of tools and workflows to plan, run and analyse *in silico* experiments with Neurorobotics Systems have to be build. The requirements for these tools are provided by the Closed-loop experiments (see above), the HBP Co-Design Projects, and operational requirements of the Neurorobotics Platform as well as feedback from its users. We will develop the simulation technology for robots and sensory rich environments. This Task develops the server and middleware layers of the Neurorobotics Platform, which integrates all components of the Neurorobotics Platform. It is also responsible for integrating all tools into installable Neurorobotics Platform packages:

- **Simulation of physics (mechanics, kinematics, sensor models etc.)**
- **World Simulation and Closed-loop engine**
- **NRP User Experience (NRP Cockpit)**
- **Environment and experiment designer**
- **Robot designer**
- **Brain-Body Integrator**
- **Virtual coach**
- **Benchmarking and validation of physics and light simulation**
- **Software integration, packaging and release**

Future developments also include the provision of community access to the Neurorobotics Platform; provide documentation, training and support for users; integrate with the Collaboratory; enable a new paradigm of *in silico* research for investigations of the links between the multi-level structure of the brain, cognition and behaviour; enable industry to develop new Neurorobotic applications; woordinate platform testing, software development and user engagement; will be part of a committee of platform SP technical coordinators.

Annex: Description of Functionalities

The Neurorobotics Platform (NRP) is an open source cloud based system for neurorobotic simulations that aims to provide researchers with software and hardware tools to aid in the investigation of the intersection between computational neuroscience and robotics. The hardware tools include supercomputing cluster nodes at several sites within Europe including the Swiss National Supercomputing Center in Lugano, Switzerland. The software tools include a web-based user interface designed to develop brain models, build and edit virtual environments, equip robots with sensors and actuators, and link robot components to brain models.

It can be thought of as a virtual lab, where neuroscientists can exploit these tools to perform simulated experiments within sensory-rich environments. Moreover, the NRP also supports roboticists by providing the ability to investigate the use of brain models instead of traditional controllers for robotic locomotion and manipulation tasks using traditional robotic platforms.

This virtual lab is made possible through nine software components that include four designers:

- Robot Designer
- Environment Designer
- Experiment Designer
- Brain Interfaces & Body Integrator;

three simulation components:

- World Simulation
- Brain Simulation
- Closed Loop Engine;

and an Experiment Simulation Viewer as well as a Web Cockpit. These nine components allow users to design experiments from scratch, re-run previous experiments with different parameters, robots, or brain models, visualize experiments in real time, and analyze and share experiment results. They are described in the Annex to deliverable 11.4.4.

Researchers and the general public can request an account to access the NRP, more information can be found by visiting http://neurorobotics.net.

Specifically, the roadmap for 2015 is structured as follows:

- Experiment Simulation Viewer Web based
- Braitenberg Experiment with Husky robot
- Spike train live view
- Integration into the Collaboratory
- Multiple environments (rough land field, virtual room)
- Edition of experiments
- Multiple robots (including iCub humanoid)
- Multiple template experiments, e.g. eye tracking on iCub humanoid
- Robot metrics (dynamic state) monitoring
- Environment designer
- New experiments: empty templates with predefined robots

- New experiment: virtual mouse with soft skin animation
- Saving, loading and sharing of edited experiments
- First version of experiment designer: state machine editor