Japanese Neuroinformatics Node: Future Perspectives

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Abstract. There is a global trend to pull together research resources of the brain in the hope that these collaborations will provide critical information to the understanding of the brain as a system and its functions. Japan, among several countries, is committed to actively participate in this process with the hope that millions of people will greatly benefit from this activity. Currently, we are formulating plans and strategies in order to carry out this objective. I would like to discuss in this paper my perspectives about the Japanese neuroinformatics node.

1. Introduction

With the advent of information era, there is a growing trend of global cooperation among communities around the world to tackle issues confronting human society. One of these very important challenges of the 21st century is the study of the human brain. The task of understanding a functional brain system is hindered by the inevitable necessity of tight focus and specialization of researches in the field. This fragmentation makes the synthesis and integration of disparate lines of evidence exceptionally difficult. In order to address this difficulty, an organized framework is needed that facilitates integration and provide a fertile ground for sharing information. This agenda requires the establishment of a new discipline, aptly named "Neuroinformatics". Neuroinformatics undertakes the challenge of developing the mathematical models, databases, data analyses, and tools necessary for establishing such a platform.

The major emphasis of the neuroinformatics platform is the organization of neuroscience data and knowledge-bases to facilitate the development of computational models and tools. An additional aim is to promote international interdisciplinary cooperation. This becomes especially important with regards to the emerging realization that understanding and developing models of brain processes of one functional area can be significantly facilitated by knowledge of processes in different functional areas. These efforts to integrate the diverse methodologies of neuroscience, if properly carried out, will assist in improving the utility and availability of the vast quantities of high quality data, models, and tools being developed by brain and neuroscience researchers. In turn, this will result in further advancement of scientific research in many disciplines, stimulate promotion of technological and sustainable development, and facilitate the equitable sharing of high quality databases in the brain sciences.

The necessity for the framework to foster international collaboration and sharing of research data was recognized by many countries leading to the establishment of INCF (International Neuroinformatics Coordinating Facility) under the auspices of GSF (Global Science Forum) of the OECD (Office for Economic Cooperation and Development) [1]. In USA, the first 10 years of the Human Brain project has just finished and the major highlights of their activities were summarized in [2]. They are now starting the next decade of the project building upon their successes and failures. In Germany, their Federal Ministry of Education has started the initiative of creating a “National Network for Computational Neuroscience” with the primary aim of understanding cognitive functions through Computational Neuroscience. To carry out this activity, they have established 4 major Bernstein Centers for Computational Neuroscience (Berlin, Munich, Gottingen, Freiburg) collaborating and sharing data, computer models, theories and approaches [3].

In Japan, **NRV** (Neuroinformatics Research in Vision) is a pioneering neuroinformatics project we initiated in 1999 under the auspices of Strategic Promotion System for Brain Science of the Special Coordination Funds for Promoting Science and Technology at the Science and Technology Agency (now under the Ministry of Education, Culture, Sports, Science and Technology- MEXT) with the primary aim of building the foundation of neuroinformatics research in Japan. NRV’s top priority is the promotion of experimental, theoretical, and technical activity in vision research due to the wealth of researches related to vision science in Japan.

The first goal of the NRV project is the construction of mathematical models for each level of the visual system: single neuron; retinal neural circuit; and higher visual function. The second goal is the building of integrated resources for neuroinformatics, by utilizing information science technologies within the research support environment that we have named the '**Visiome Platform**'. The third goal is to develop new vision devices based on brain-derived information processing principles. Figure 1 shows the overall scheme of the NRV project [4]. There are 5 major groups carrying out specific activities as summarized below:

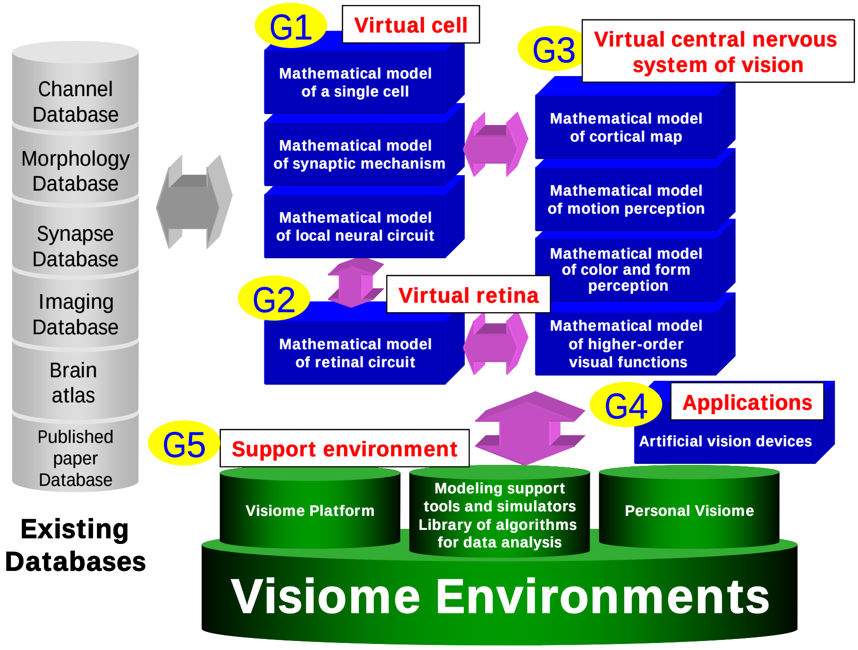

Figure 1. Visiome environment

- G1: Modeling a single neuron by mathematical reconstruction
- G2: Realization of virtual retina based on cell physiology
- G3: Study on the visual function by computational and systems' approach
- G4: Realization of artificial vision devices and utilization of silicon technology for recording and stimulation
- G5: Fundamental neuroinformatics research and development

2. Perspectives of the Japan Node from NRV Experience

Based on our NRV project experience, I believe that we can utilize and extend the basic scheme of the neuroinformatics platform to any other possible areas. Figure 2 shows a conceptual framework describing what shall constitute the major components of the Japan node. We have tentatively identified 10 major components, namely:

- Visiome Platform (VP)
- Cerebellar Development Transcriptome DataBase (CDT-DB)
- Cell Glia Platform
- Integrative Brain Project
- Insect Brain Platform

- Brain Imaging Platform
- Visiome for visual psychophysics
- BMI/BCI/Motor function/Robotics
- Clinical Medicine
- Neuroinformatics Technical Innovations

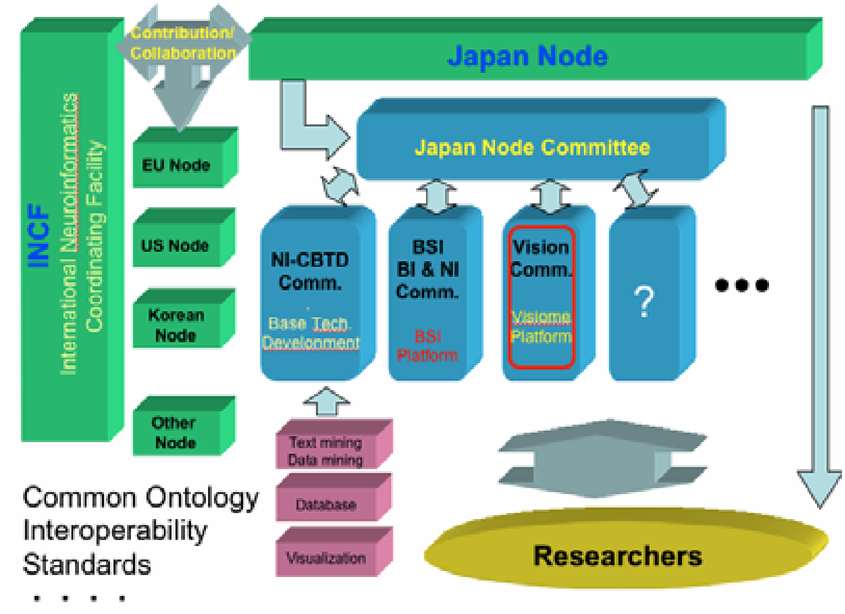

Figure 2. Conceptual scheme of the Japan node

VP is now operating (http://platform.visiome.org/) while CDT-DB will open to the public on February 2005. Cell Glia Platform will be implemented by the National Project for Cell Glia Interactions. They will extend the activities started by G1 under the NRV project. The Integrative Brain Project will start on 2005 while the preliminary implementation for Insect Brain Platform has already started this year. For the Brain Imaging Platform, the details will be presented by Prof. Suzuki during the late afternoon session of the workshop. The implementation detail for the other components is still subject to further discussions with several of them to be discussed in the workshop.

The opening of VP to the public last May 2004 is one of the major highlights of the NRV project which ended last March 2004 [5]. The platform is basically designed as a research resource archive that can be accessed from the Internet and provides published references, articles with reusable programs/scripts of mathematical models, experimental data, analytical tools, and many other resources. The platform allows researchers to find out how the submitted models work or compare their own results with other experimental data. It also allows users to improve existing models by making it easier for users to integrate their new hypothesis into the existing model. Moreover, users can export/import their own models, data, and tools to the database to be shared with other users and colleagues.

Aside from having an extensive collection of indexed database of literature references, codes or models used by the paper and registered in VP are easily accessible in the tree structure index. In general, VP helps researchers in their quest to understand the visual system from the perspective of visual functions and assist in the construction of models based upon their own hypotheses.

Figure 3. The top page of the VP

Currently, there are 8 major types of contents in VP, namely: binder, reference, book, model, url, data, tool, stimulus. As of November 2004, VP contains a total of roughly 3000 registered items. From the start of its operation, there is an increasing trend of content access and download of its resources as shown in the figure below. More details of VP features will be presented in the late afternoon session of the workshop.

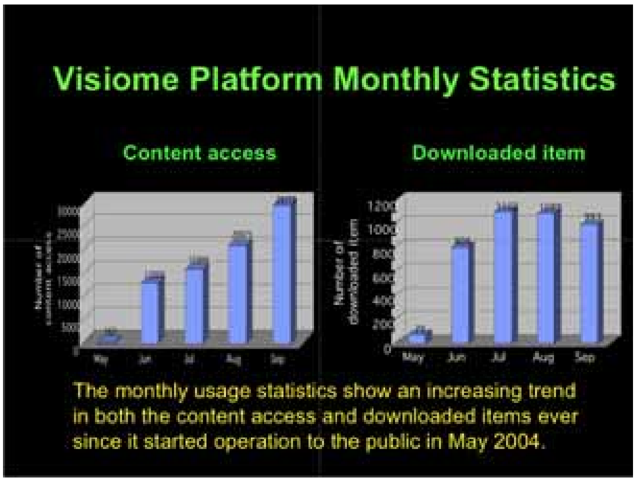

Figure 4: VP monthly usage statistics

Our experience in the VP implementation led us to believe that the development of the Japan node infrastructure requires proper coordination at different organizational levels to ensure standardization of rules for sharing, coherent tools to avoid redundancy and waste of resources, and appropriate guidelines to spell-out specific target and action plan. One important action plan that can be considered important is the development of core technologies that will serve as the bases of development to ease standardization and integration of data and other resources. Although each platform addresses different areas and specializations, the underlying technology for basic functions such as data storage, retrieval, searching, visualization, statistical analysis, modeling/simulation and other forms of information extraction will be similar.

Aside from the basic features such as indexing of research resources, each platform will be more useful if it can provide peer-reviewed sections where authors can directly publish reports on new data. This will pave way for the standardization of datasets that makes testing of new models straightforward.

More importantly, the future of the Japan node lies on the active involvement of its members as well as in the participation of the research communities since the data they provide form the lifeblood of the system. There must be an active promotion of the importance of data sharing and appropriate reward mechanism to encourage researchers to participate in this endeavor. Relevant government and non-government agencies, journal publication firms, education and research institutes must be tapped to participate in this project because their influence will enhance the quality of contribution and support to the project's funding, research, and development.

3. Conclusions

This workshop provides us a great opportunity to learn from the experiences of other groups who have conducted similar activities to achieve the goal mandated by the INCF Committee. Based on our experience in the development and operation of VP, we identified some areas where we need to work on for the initial phase in the establishment of Japan node:

- Identify major fields of neuroscience to become development platforms
- Identify potential organizations to work as partners in the building process
- Identify ways to make the development and operation sustainable
- Development of standard for common ontology, data interchange, interoperability, etc.

Surely, the road ahead will not be easy but if we pull together our resources, the burden of understanding the brain will no longer rest on one country or organization. The fulfillment of knowing that “YOU ARE NOT ALONE” in this endeavor is a reassuring way for the society to continue its quest for the understanding of the biological brain and in the creation of the virtual brain.

Acknowledgements

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