Article │ Received 6 January 2025; Accepted 9 March 2025; Published 13 March 2025
https://doi.org/10.55092/pcs20250007

Construction of multi-functional modular brain inspired robotics industry-education integration laboratory

Danni Fu

Institute of Science and Technology for Brain-inspired Intelligence, Fudan University, Pudong New Area, Shanghai, China

*Correspondence author; E-mail: fudanni_@fudan.edu.cn.

Abstract: On the basis of continuous improvement of lab construction and management, a subsequent generation of embodied intelligent robots with professional knowledge and competencies will be constructed through interactive learning between the digital twin brain and the environment. In order to further standardise and strengthen the operation and management of the Multi-functional modular Brain Inspired Robotics Industry-education Integration Laboratory, the level of scientific research capacity, the construction of management systems and practicing national standards is an important way to realize the standardisation, scientification and refinement of laboratory management. Through on-site improvement, self-inspection, regular sampling, process monitoring, and best practices, *etc.* to effectively manage researchers, equipment and materials, research environment, and improve laboratory operation management capabilities.

Keywords: standardization; industry-education integration laboratory; laboratory management

1. Introduction

In order to thoroughly integrate mathematics, brain science, information science and other disciplines of comprehensive research university, to deeply promote the interdisciplinary research of cutting-edge disciplines such as intelligent science and technology, to gradually reveal the working principle of brain structure and function at the whole brain scale, to assist in the establishment of ultra-large-scale pulsed neuron network computational models and platforms, and to establish experimental and theoretical methods such as cross-scale neural system structure and function analysis, multi-modal data fusion, the assimilation of meso scale data, and high performance computing propelled by brain inspired computing. Lab safety management in institutions is an important guarantee for regular teaching and research activities [1]. Construction of multi-functional modular brain inspired robotics industry-education integration laboratory to enhance the brain inspired embodied intelligent cognitive ability, which is of great significance to the interdisciplinary integration development of mathematics, brain science and the original innovation of intelligent science and technology, to optimize and improve the soft and hard platform construction related to whole brain computing, and to enhance the data acquisition capability

and data platform computing capability of digital twin brain simulation experiment, through the robot as a body computing capability, and through the robot as a body computing capability, to form an understanding of the objective world through the robot as the body and the interaction with the environment, and the cultivation of young talents with exceptional comprehensive qualities who are adept in crossing disciplinary boundaries is fostered.

2. Methods

With the rapid development of our country's modernization and the continuous expansion of the scale of education in colleges and universities, local undergraduate institutions had increased their investment in laboratory construction and laboratory management [2]. Relying on the advantages and resources of existing disciplines, our institute takes discipline construction as the core, focuses on the improvement of platforms and support conditions, combines cross-field basic research with in-depth discipline intersection, and we will carry out the research of discipline intersection and integration of digital twin brain with a scale of 100 billion neurons, establish the theory and algorithms of brain inspired intelligence based on the platform of whole-brain simulation, analyses the mechanism of brain information processing, and promote the breakthroughs of primitive innovations and major researches to make a contribution to the "the First Fudan" and the first-rate universities and disciplines. To achieve the following construction tasks, firstly, promote cross-disciplinary integration by taking the research goal of whole-brain computing. Secondly, improve the software and hardware platform construction, and build a whole-brain computing platform based on mesoscopic scale data assimilation method. Thirdly, deepen academic exchanges and promote the cross-disciplinary ecology of brain inspired intelligence through external cooperation.

Multi-functional modular Brain Inspired Robotics Industry-education Integration Laboratory has been put into use, with an area of 120㎡, which can accommodate 40 faculties teaching and scientific research work in the field of robotics, shown in the figure 1, and is equipped with instruments shown in the figure 2 such as the humanoid robot iCub, the humanoid robot NAO, the quadrupedal robot Laikago Pro and so on.The industry-education integration experiments provide visual, auditory, tactile and other perceptual abilities for the twin brain to construct the corresponding robot form, learn intelligent behaviors to adapt to the environment, and validate the twin brain model's ability to interact with the real world. From the beginning of the establishment of the laboratory school must do a good job of laboratory management. However, it is found that the laboratory management work in higher vocational schools is not quite satisfactory, and the traditional way of coping with the problem is no longer able to co-ordinate the current problems, therefore, the school must make a good plan to optimize the laboratory management into practice [3].

Figure 1. Laboratory rendering.

Figure 2. Robotic devices promote research on embodied intelligence.

Laboratory safety is facing many problems, such as wide coverage, unscientific management system, unsound responsibility system, insufficient implementation of safety system, insufficient safety investment, and so on [4]. The construction and practice of a safety management system in university laboratories, including the establishment of regulations and rules, personnel training and awareness education, safety facilities and equipment, and emergency management. It also includes analysis and summaries of practical case studies to provide valuable references and guidance [5]. Chinese National Standardization Administration Committee platform released “Good Practice for Scientific Research Laboratory”(GB/T27425-2020) standard [6], which has been implemented since June 2021, including management requirements and technical requirements, which are related to the operation of scientific research laboratories, operating conditions, as well as research activities. It is a set of normative system for the planning, implementation, inspection, recording, archiving and reporting of research activities in research laboratories. In addition, there are relevant provisions such as the “Measures for the Administration of National Experimental Teaching Demonstration Centers” [7]. To analyze the construction and operation status of laboratories, so as to provide the reference for the standardized detection and management. For example, the management system has played an important role in the standardized management of schistosomiasis laboratories [8]. The laboratory standardization management aims to achieve "rules, neatness, standardization, unity, and safety," and gradually establish laboratory regulations and management systems. The specific standardization content is summarized in the table 1, which can be adjusted according to the specific laboratory environment.

3. Results

Table 1. Specific normative content.

Normative aspect	Normative content	Specific content
Personnel responsibility	Definition of authority and responsibility	Specify personnel: the head of research laboratory, the safety officer, researchers, archivists and other part-time support managers. Responsible person for each area.
	Dress code	Required dress code: Uniform dress code. According to the general cleanliness, anti-static requirements, each person should be equipped with at least 2 sets of lab coats and shoes,clean and tidy.Replace anti-static clothing that does not have protective functions in time.Prevent non-standard behaviors that may cause

		anti-static failure, such as stepping on the back of anti-static shoes, not putting long hair in anti-static hats, and arms protruding from anti-static suits.
	Document management	Document management: research project management, lab documents (systems, plans, equipment instruction manuals, components and materials test reports/certificates of conformity, experimental outline record reports, *etc.*) need to be equipped with filing cabinets and classified files, the documents are managed by a person, and are properly categorised, registered, and borrowed.
	Personnel training	Training programme: annual training for lab personnel in lab operations, equipment operation, safety, environmental protection, fire prevention, emergency response, *etc.*
Research facilities and environment	Access control	Entry and exit authority control: logistics door, pedestrian door, normally closed door, fire door, *etc.* Video surveillance devices and access control devices should be installed at the necessary entrance of lab.
	Route	Specific routes: available visiting route, logistic route, pedestrian route.
	Basic environmental cleanliness	Post “Tidy Up and Clean Up Programme”. Inspect: no clutter, no water, no ash, no smoke, rubbish cleaned up timely. Check the alignment: alignment of more lines have a special alignment groove to ensure neat, orderly, and laying aisle cable should be a special protective cover or alignment groove.And the ground should meet the requirements of the experiment.
	safety requirement	Safety instructions: Safety instruction manuals and safety information signs should be equipped and complied with. Emergency evacuation and light: Safety exits and evacuation routes should be clearly marked and kept open. Prohibit the occupation, locking and blocking, and set up emergency light. Door opening direction: The doors of the labs prone to fire, explosion, lack of oxygen, extremely low temperature and other dangerous chemicals should be opened in the direction of evacuation, and should be equipped with monitoring alarms and automatic fire extinguishing systems. Fire broadcast system: Open flames are strictly prohibited in the labs. And should have a fire broadcasting system that is operational. Safety facilities: Fire-fighting equipment (e.g. fire extinguishers, fire hydrants, fire doors, fire gates, *etc.*), smoke detectors, monitoring systems, emergency sprinklers, eyewash devices, hazardous gas detectors, ventilation systems, protective shields, guard isolation, and other safety facilities. Must be configured

according to potential risk factors. And regular inspection to ensure that can be used normally. It is str ictly prohibited to cover up fire fighting equipment and facilities.

Professional Power Distribution: Temporary high power electricity consumption in the lab must be taken by professional power distribution personnel by laying lines.

Power distribution box safety: Electrical interconnection between the door and the body. Insulation protection cover should be set on the exposed metal parts.

In fire and explosion hazardous places, power supply and distribution equipment with appropriate protection should be used.

Line switches: All switches, sockets, *etc.* in the laboratory power line and line system should be kept in good working condition.

Do not overload: Lab electricity should meet the needs of various electrical appliances, and should not be overloaded.

Check: The grounding resistance value should be determined according to the specific requirements of the experimental instrument and equipment. When there is no special requirement, it should not be greater than 4Ω.

Zero-potential bonding measures: Lab protective grounding should adopt zero-potential bonding measures.

Anti-static measures: The anti-static lab should post an anti-static area sign in a prominent position. Equip with corresponding anti-static detection and elimination facilities as needed. Anti-static equipment and protective equipment shall be tested and qualified, and within the valid period.

Electrostatic grounding: chemical storage cabinets should be electrostatic grounding. There should be a certain distance between the explosion-proof cabinets to facilitate ventilation through the ventilation holes.

Equipped with emergency protective equipment: The use of strong acid, strong alkali and other chemical hazards of the lab, should be set up near the emergency eyewash and emergency sprinkler. Anti-static/corrosion resistant gloves, protective clothing, dust masks and other emergency protective equipment.

Safety spacing and protection: the perimeter of the experimental equipment should be set up with safety spacing and protective measures to ensure that the normal activities of personnel are not harmed by fixed objects, moving objects and possible flying objects.

Check: Movable laboratory benches (racks) should be equipped with brakes.

Research equipment and materials	Standardized placement	Standardized placement: Auxiliary equipment and tools are placed on shelves, tool cabinets, *etc.* and marked. Research products, equipment, jigs and tools in the lab are partitioned and positioned.
	Instrumentation management documentation	Check: SOP, usage record, maintenance record, weekly inspection record book, asset label, repair record.
	Measurement instruments	Submit the inspection on time and issue the metering report, and use it within the metering period.
	Special equipment	Special equipment registration certificate, safety operation procedures, safety signs, regular inspection records, and used during the inspection period.
	Raw materials, components and reagents	Inventory receiving, registration, and recovery.
	Gas cylinder, gas line	Ensure gas cylinders are fixed and used, and anti-slip devices are equipped. And keep the safety protection measures of the gas cylinder cabinet in a normal working state. Special gas cylinder cabinets with functions of temperature and humidity detection, gas concentration detection, ventilation, *etc.* can be set up to avoid the influence of heat sources and direct sunlight. Safety signs corresponding to the hazardous characteristics of gases should be set up.

4. Conclusion

After the continuous implementation of the above normative elements, through enhancements in laboratory construction and management, the establishment of a whole-brain computing platform based on mesoscopic scale data assimilation method, and creating a new space for talent cultivation such as a multifunctional modular brain inspired robotics industry-education integration lab. A corresponding robot form will be furnished for the twin brain, providing visual, auditory and tactile perception capabilities, learning adaptive intelligent behavior, verifying the interaction ability of the twin brain model with the real-world context, and foster the cultivation of high-level professionals for the intelligent robot industry.

Acknowledgment

Funding: This work was funded by the Fudan University with grant number IDH2306032.

Conflicts of interests

The author declares no conflicts of interest.

References

[1] Zhou Y, Li J. Hidden Dangers and Countermeasures of Laboratory Safety Management in Colleges and Universities in China. *In Proceedings of the 2019 International Conference on Pedagogy, Communication and Sociology*, Ningbo, China, May 25–26, 2019, pp. 137–140.

[2] Xin S. Analysis of the Current Status and Countermeasures of Chemical Laboratory Safety Management in Local Colleges and Universities. *Int. J. New Dev. Educ*. 2023,5(18): 125–130.

[3] Jing W. Research on the Problems and Improvement Countermeasures of Laboratory Management in Higher Vocational Colleges and Universities. *Adv. Vocat. Tech. Educ.* 2023,5(8): 69–74.

[4] Li X. Exploration and Research on the Management of Laboratory Safety in Colleges and Universities under the New Situation. *In Proceedings of the 2020 8th International Education, Economics, Social Science, Arts, Sports and Management Engineering Conference*, Chengdu, China, September 30–31, 2020, pp. 118–121.

[5] Yu H, Xie X, Zhang H. Construction and Practice of Safety Management System in University Laboratories. *Adult High. Educ.* 2023,5(19): 97–104.

[6] National Standard Information Public Service Platform. 2020. Good Practices for Research Laboratories (In Chinese). Available: https://std.samr.gov.cn//gb/search/gbDetailed?id=B4C25880C44E1CB3E05397BE0A0A92D0 (Accessed on 19 November 2024).

[7] Ministry of Education of the People's Republic of China. 2016. Notice of the General Office of the Ministry of Education on Issuing the Measures for the Administration of National Experimental Teaching Demonstration Centers (In Chinese). Available: http://www.moe.gov.cn/srcsite/A08/s7945/s7946/201612/t20161227_293114.html (accessed on 10 December 2024).

[8] Zheng Z, Qin J, Chen L, Zhu H, Tang L, *et al.* Construction and operation status of management system of laboratories of schistosomiasis control institutions in Hubei Province. *Zhongguo Xue Xi Chong Bing Fang Zhi Za Zhi*, 2016, 28(5): 519–522.