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A Review Study on Virtual Brain

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Abstract— Scientists are now working on developing an artificial brain that is capable of thought, response, decision-making, and memory retention. The primary goal is to transfer the human brain onto a computer so that man can freely ponder and make decisions. The virtual brain will assume the role of the man after the death of the body. Therefore, even when a person passes away, we will still have access to their knowledge, intelligence, personalities, emotions, and memories, all of which can be utilized to advance human society
Keywords— About five key words in alphabetical order, separated by comma

I. INTRODUCTION

Human brain is the most valuable creation of God. The man is called intelligent because of the brain. The brain translates the information delivered by the impulses, which then enables the person to react. But we loss the knowledge of a brain when the body is destroyed after the death of man. That knowledge might have been used for the development of the human society. What happen if we create a brain and up load the contents of natural brain into it?

The project was founded in May 2005 by Henry Markram at the EPFL (Ecole Polytechnique Federale De Lausanne) in Lausanne, Switzerland. Goals of the project are to gain a complete understanding of the brain and to enable better and faster development of brain disease treatments. The research involves studying slices of living brain tissue using microscopes and patch clamp electrodes. Data is collected about all the many different neuron types. This data is used to build biologically realistic models of neurons and networks of neurons in the cerebral cortex. The simulations are carried out on a Blue Gene supercomputer built by IBM, hence the name "Blue Brain". The simulation software is based on Michael Hines's NEURON, together with other custom-built components.

II. WHAT IS VIRTUAL BRAIN

Artificial the name of the world’s first virtual brain. That means a machine that can function as human brain. Today scientists are in research to create an artificial brain that can think, response, take decision, and keep anything in memory. The main aim is to upload human brain into machine. So that man can think, take decision without any effort. After the death of the body, the virtual brain will act as the man .So, even after the death of a person we will not lose the knowledge, intelligence, personalities, feelings and memories of that man that can be used for the development of the human society. No one has ever understood the complexity of human brain. It iscomplex than any circuitry in the world. So, question may arise “Is it really possible to create a human brain?” The answer is “Yes”. Because whatever man has created today always he has followed the nature. When man does not have a device called computer, it was a big question for all. Technology is growing faster than everything. IBM is now in research to create a virtual brain, called “Blue brain”. If possible, this would be the first virtual brain of the world. With in 30 years, we will be able to scan ourselves into the computers. Is this the beginning of eternal life?

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III. WHY WE NEED VIRTUAL BRAIN?

Why we need Virtual Brain? Today we are developed because of our intelligence. Intelligence is the inborn quality that can not be created. Some people have this quality, so that they can think up to such an extent where other can not reach. Human society is always need of such intelligence and such an intelligent brain to have with. But the intelligence is lost along with the body after the death. The virtual brain is a solution to it. The brain and intelligence will alive even after the death. We often face difficulties in remembering things such as people's names, their birthdays, and the spellings of words, proper grammar, important dates, history, facts etc... In the busy life every one wants to be relaxed. Can't we use any machine to assist for all these? Virtual brain may be the solution to it. What if we upload ourselves into computer, we were simply aware of a computer, or maybe, what if we lived in a computer as a program?

IV. GOALS AND OBJECTIVE

The Blue Brain Project is the first comprehensive attempt to reverse-engineer the mammalian brain, in order to understand brain function and dysfunction through detailed simulations. The mission in undertaking The Blue Brain Project is to gather all existing knowledge of the brain, accelerate the global research effort of reverse engineering the structure and function of the components of the brain, and to build Complete theoretical framework that can orchestrate the reconstruction of the brain of mammals and man from the genetic to the whole brain levels, into computer models for simulation, visualization and automatic knowledge archiving by 2015.

V. ARCHITECTURE

Architecture of Blue Gene Blue Gene/L is built using system-on-a-chip technology in which all functions of a node (except for main memory) are integrated onto a single application-specific integrated circuit (ASIC). This ASIC includes 2 PowerPC 440 cores running at 700 MHz. Associated with each core is a 64-bit "double" floating point unit (FPU) that can operate in single instruction, multiple data (SIMD) mode. Each (single) FPU can execute up to 2 "multiply-adds" per cycle, which means that the peak performance of the chip is 8 floating point operations per cycle (4 under normal conditions, with no use of SIMD mode). This leads to a peak performance of 5.6 billion floating point operations per second (gigaFLOPS or GFLOPS) per chip or node, or 2.8 GFLOPS in non- SIMD mode. The two CPUs (central processing units) can be used in "co- processor" mode (resulting in one CPU and 512 MB RAM (random access memory) for computation, the other CPU being used for processing the I/O (input/output) of the main CPU) or in "virtual node" mode (in which both CPU swith 256 MB each are used for computation). So, the aggregate performance of a processor card in virtual node mode is : 2 x node = 2 x 2.8 GFLOPS = 5.6 GFLOPS, and its peak performance (optimal use of double FPU) is: 2 x

5.6 GFLOPS = 11.2 GFLOPS. A rack (1,024 nodes = 2,048

CPUs) therefore has 2.8 teraFLOPS or TFLOPS, and a peak of 5.6 TFLOPS. The Blue Brain Projects Blue Gene is a 4- rack system that has 4,096 nodes, equal to 8,192 CPUs, with a peak performance of 22.4 TFLOPS. A 64rack machine should provide 180 TFLOPS, or 360 TFLOPS at peak performance.

Fig.1. Hierarchy of Blue Gene processing units

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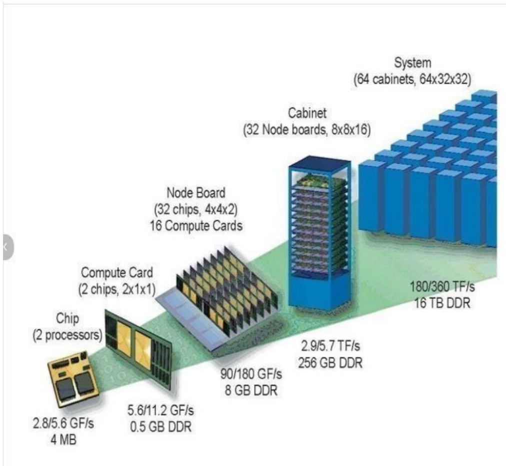

VI. METHODOLOGY

The methodology adopted for this study on the Blue Brain **Project** involves a combination of qualitative research, literature review, and analysis of existing computational neuroscience frameworks. The primary objective is to understand the goals, architecture, tools, and challenges associated with the Blue Brain Project, which aims to create a digital reconstruction of the human brain.

1. Literature Review

- Extensive review of scientific papers, official Blue Brain Project documentation, and publications by École Polytechnique Fédérale de Lausanne (EPFL).
- Analysis of journal articles, technical reports, and white papers related to brain simulation, neural modeling, and high-performance computing in neuroscience.

2. Data Collection

- Secondary data collected from online databases such as IEEE Xplore, ScienceDirect, PubMed, and SpringerLink.
- Collection of data on the technologies used, including NEURON simulation environment, Blue Gene supercomputers, and data modeling tools.

3. Technology Evaluation

- Examination of the software and hardware architecture employed in the project.
- Overview of simulation models used (e.g., multi-compartmental neuron models) and techniques like reverse engineering of the brain.

4. Comparative Analysis

- Comparison with other brain simulation initiatives (e.g., Human Brain Project, OpenWorm, and the Allen Brain Atlas) to identify unique aspects of the Blue Brain Project.
- Evaluation of limitations and ethical considerations in brain simulation.

5. Conceptual Modeling

- Development of simplified conceptual models to illustrate how real neurons and synaptic activities are emulated digitally.
- Understanding of how data from rat brain simulations is extrapolated to human brain modeling.

6. Tools Used

- Use of diagramming tools (like Lucidchart, Draw.io) to represent the architecture.

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- Analysis tools like MATLAB or Python (if simulations or data processing is included in the study).

VII. NATURAL BRAIN AND STIMULATED BRAIN

A. Functions of the Natural Brain

Before exploring the structure and functionality of the Blue Brain, it's important to understand how the **human brain** works. The brain, as part of the nervous system, is responsible for perception, reasoning, and responses. It operates through **electrical impulses** transmitted by **neurons**, enabling complex interactions with the environment. The following are the primary stages involved in the brain's functioning:

1. **Input**:
   Sensory input refers to the process of receiving information from the environment through **sensory neurons**. For instance, when the eyes see an object or the skin feels something, these neurons send signals to the brain for further processing.
2. **Interpretation/Integration**:
   This stage involves understanding and interpreting the incoming signals. **Billions of neurons** work together to make sense of the environment and associate meaning with the sensory input.
3. **Output**:
   Once the input is processed, the brain sends **electrical signals** to **effector cells**, such as muscles or glands, prompting them to react appropriately.
4. **Processing**:
   The brain performs **logical and arithmetic operations** using neural circuits. It combines **past experiences** stored in memory with new input to make decisions.
5. **Memory**:
   Specific neurons are involved in **storing information**, allowing us to remember past events, learn new information, and recall knowledge when needed.

B. Functions of the Simulated Brain

In the Blue Brain Project, scientists aim to replicate the structure and functionality of the human brain using digital technology. The **simulated brain** follows a process similar to the biological brain, with each step digitally engineered using **supercomputers and artificial neurons**. Here's how it works:

1. **Input**:
   Artificial neurons, made using **silicon chips**, are designed to mimic real neurons. These synthetic neurons receive inputs from other artificial cells or sensors and transmit electrical signals to a **supercomputer** for processing.
2. **Interpretation**:
   The electrical impulses from the artificial neurons are analyzed using a set of **registers**. Each register holds values that represent different **states or conditions of the brain**.
3. **Output**:
   After processing, the interpreted signals are sent to artificial sensory cells or other output systems, enabling the simulated brain to interact with its environment.
4. **Memory**:
   Information is stored permanently using **secondary memory (hardware)**. This allows the simulated brain to **retain and retrieve data**, similar to how human memory functions.
5. **Processing**:
   Just like the natural brain, the simulated brain uses stored information and current input to make decisions. **Artificial intelligence (AI)** is employed to carry out logical and arithmetic operations that resemble human thought processes.

VIII. FUTURE PROSPECTS

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This Blue Brain project is an inevitable phase triggered in Neuroscience. It will permit us to take the principles of our intelligence and an entire model of cellular level brain will be generated in the next century. There may be no essential obstacle in modeling the brain and it is likely that in the near future there will be detailed models of the mammalian brain, including the human brain. Blue Brain is a project where voice/speech is provided as input/output [1]. We can also hope to learn about functions and dysfunctions of the brain from the precise models. Detailed models will be used to arrange all the knowledge of the brain and it lets quick diagnosis of brain dysfunctions and their treatment. After the release of Blue Brain technology, there can be advancement in the field of Artificial Intelligence, Psychology and Inter- Communication between species. By deeper research of brain structure and function, it will offer a rapid effect on new findings on pre-existing knowledge.

Fig 2. Evolution of Human Brain

IX. CONCLUSION

In conclusion, we will eventually be able to transform into computers. The majority of objections to this result appear to be simple to overcome. They either lack sophistication or just need more time for technology to advance. As we observe the marriage of biological and digital technology, the only significant concerns raised are also defeated. Although there is a long way to go, researchers have already benefited greatly from their

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model. One million neurons, one billion synapses, and up to 100 cortical columns can all be simulated simultaneously using the Blue Gene supercomputers. The project is expected to be finished by 2023, despite the fact that it is a rather complicated undertaking.

X. REFERENCES

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Cell, 163(2), 456–492.
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The Blue Brain Project: building the neocortical column.
BMC Neuroscience, 8(Suppl 2), P109.
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BMC Neuroscience, 8(Suppl 2), P110.
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Recent Developments and Insights

4. Ecker, A., et al. (2024).
Assemblies, synapse clustering and network topology interact with plasticity to explain structure-function relationships of the cortical connectome.
eLife.
This study explores how structural features of the cortical network relate to its functional properties, emphasizing the role of synaptic organization and plasticity.

5. Pokorny, C., et al. (2024).
A connectome manipulation framework for the systematic and reproducible study of structure–function relationships through simulations.
Network Neuroscience.
This publication introduces a framework for manipulating brain connectomes to systematically study how structural changes affect brain function.

Additional Resources

- Blue Brain Project Wikipedia Page
Provides an overview of the project's history, objectives, and achievements.

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- EPFL Press Resources
  Offers access to press releases, news articles, and other materials related to the Blue Brain Project.