iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: https://doi.org/10.22214/ijraset.2023.52654

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Review Paper on Blue Brain Technology

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Abstract: ***The human brain is the most important and complex part of our body. It controls our muscles and gives us the ability to think, create ideas, and act. The neurons present in the brain store the information of events that happened with us. We, humans, are said to be "intelligent" because of our brains. But when our body decays with time we tend to lose our memory and intelligence, so here comes the concept of the Blue Brain. It is a Virtual Brain that uses a supercomputer called "Blue Gene". It basically functions as a Human Brain. Its main function is to create a connection between the human brain and the artificial Brain. As the Life span of human beings is limited this invention is done to understand human feelings, knowledge, ideas, memories, dreams of a person, and that could be downloaded/extracted and can be used for different purposes. Neurological diseases can be cured by this technology.***

Keywords: Blue brain, artificial intelligence, supercomputer, blue gene, nanorobots, virtual machine, brain simulation, blue brain technology.

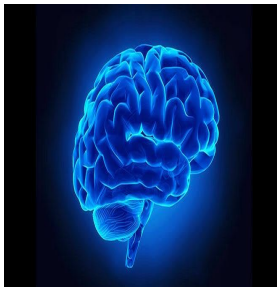
I. INTRODUCTION

Blue Brain is an artificial brain that can think, respond and store memory. Supercomputers with high processing power and storage capacity can create an interface between Human Brain and the virtual one. It is a Virtual Brain that uses a supercomputer developed by IBM which is called "Blue Gene". It runs a software named "NEURON". It acts as a Human Brain. Its main function is to understand the Human Brain, its feelings, knowledge, ideas, memories, dreams of a person that could be stored for different purposes. This information from the Human brain is extracted using "nanobots", small robots. They scan the structure of neurons in the Central Nervous System and Spine. Nanobots act as an interface between the human brain and Blue Brain. This is not happening today or tomorrow but surely in near future. Diseases such as Alzheimer's and Parkinson's could also be better analyzed and treated by using this technology.

II. BLUE BRAIN TECHNOLOGY

In July 2005, Blue Brain Project (BBP) - the first artificial brain was launched by International Business Machines (IBM) in collaboration with Brain Mind Institute (BMI). The Blue Brain project is headed by the founding director Henry Markram, who also heads the École Polytechnique Fédérale de Lausanne (EPFL), and co-directed by Felix Schürmann and Sean Hill. This was created for simulating mammalian brain functions in detail. Its aim was to gain a better understanding of biological intelligence and its connected processes using Blue Brain Technology.

Blue Brain is in the developing stage, within 30 years of time we could scan ourselves through this.



III. VIRTUAL BRAIN

We can say Virtual brain is an artificial brain, that but acts as a human brain. It can think like the brain, take decisions based on past experience, and respond as the natural brain can. This is made possible by using supercomputers with enormous storage capacity, processing power and interfaces between the human brain and this artificial brain. The information stored in the natural brain can be uploaded to the computer using this interface. As humans age and die their knowledge and intelligence become void. So to store these things forever Virtual Brain is used.

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A. *Need of Virtual Brain*

Today we are developed because of our intelligence. Intelligence is an inborn quality that can not be created. Some people have this quality so that they can think up to such an extent where others can not reach. Just as the scientists, physicists, mathematicians, etc. Humans are always in need of a high intelligence level of their brain. However, intelligence is lost with the body after death. The virtual brain can be the solution for this. The brain and the human intelligence will be alive even after death.

We often face difficulties in remembering things such as people's names, addresses, birthdays, and the spellings of words, important dates, and events. In a busy life like this, everyone wants to be relaxed. So why can't we use any machine to assist us with all these? Virtual brain may be the answer to it. What if we upload ourselves into the computer, we would have been simply aware of a computer, or what if we lived in a computer as a program?

B. *Blue Brain Objectives*

The main aim of the Blue Brain is to transfer the human brain into a machine. So that, we humans could think and take decisions without any effort. Today scientists are in research to invent an artificial brain that can respond, take decisions, think, and keep anything in memory for a longer period of time. Different actions and structures of our CNS i.e., the central nervous system can also be studied.

C. *Functioning of Natural Brain*

The ability of the human brain to feel, interpret, hear and see things in our surroundings is controlled by neurons that perform calculations similar to that of a computer. Yes, the nervous system is quite like magic because we can't see it, but it works through electric impulses through your body.

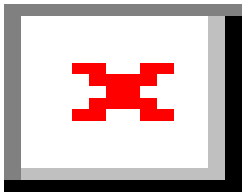
One of the world's most "intricately organized or complex" electron mechanisms is the nervous system. To understand this system, we must know the three simple functions that drives it: sensory input, integration, motor output.

1) *Sensory input:* When we touch a warm or cold surface or hear some noise, the sensory cells, i.e Neurons, send a signal (message) to the brain. This action of getting information from your surrounding environment is called sensory input because we are putting things in your brain by way of our senses.
2) *Integration:* It is the interpretation of things that we feel, touch, hears, or taste with sensory cells. This process is accomplished by many neurons working together in the brain.
3) *Motor Output:* Through the above processes, our brain has interpreted all the actions like tasting, touching, or any other sense. Then the brain sends the signal through the neurons to muscle cells, which perform the action which is the consequence of the input in the environment.

IV. WORKING OF BRAIN

A. *Visualization of Neurons*

RTNeuron is generally used for the process of visualization of neural simulations. It is a scalable rendering tool for the visualization. This RTNeuron package is written in C++ and OpenGL programming language. It makes use of ad-hoc software specially designed for the purpose of neural simulation. It cannot be used for other simulations. Hodgekin-Huxley simulations are given as input in neuron and also the output is created as 3D. For visualizing the results, a Silicon Graphics Inc [SGI] of 300GB shared memory is used. As the visualizations are multi-scale i.e single neuron or cortical columns, the animations could be paused, zoomed and thus the researchers could interact with the model.



B. Brain Simulation

Now we have known about this technology, it's time to implement natural things using artificial things.

1) Human Brain

a) Input

In the nervous system in our body, the neurons are responsible for the message passing. This information is obtained from the atmosphere. The body receives the input from the sensory cells whenever a person touches, tastes or sees something.

b) Interpretation

The input received by the brain in the form of electrical impulse from the neurons needs to be processed. Understanding of this information is done through interpretation to gain knowledge about the environment. Billions of neurons work together to carry out this task efficiently.

c) Output

As soon as the brain interprets the input state, the brain sends the electrical impulses to the effector cells, muscles or glands via neurons that respond to the environment. The sensory cells of which part of our body is going to receive depend upon the state of the neurons in the brain at that time.

d) Memory

The neurons help in remembering the past things when required by interpreting the states of our brain.

e) Processing

Logical and arithmetic calculations are done in our neural circuitry when we think of certain things or make decisions. The current input received is used for making decisions and the past experiences are stored and the states of certain neurons are changed to give the output.

2) Simulated Brain

a) Input

In a similar approach, the synthetic system may be created. The scientists have already created artificial neurons by substituting them with silicon chips. it's additionally been tested that these neurons will receive the input from the secondary cells. So, the electrical impulses from the secondary cells is received through these artificial neurons and sent to a mainframe or the supercomputer for interpretation.

b) Interpretation

The interpretation of the electrical impulses received by the synthetic somatic cell is done by the collection of registers. Different values in these registers represents different states of the brain.

c) Output

Similarly supported the states of the register the output signals are given to sensory cells which are present within the artificial neuron.

d) Memory

To store the records permanently we use secondary memory for storage(hardware). The sets of registers will be stored permanently with and the information that is present in it could be retrieved and used when it is needed.

e) Processing

In similar way, the processing can be done by the computer by using some stored information and by the inputs received. Similar to our human brain, the artificial brain will perform some arithematic and logical operations by using the concept of artificial intelligence

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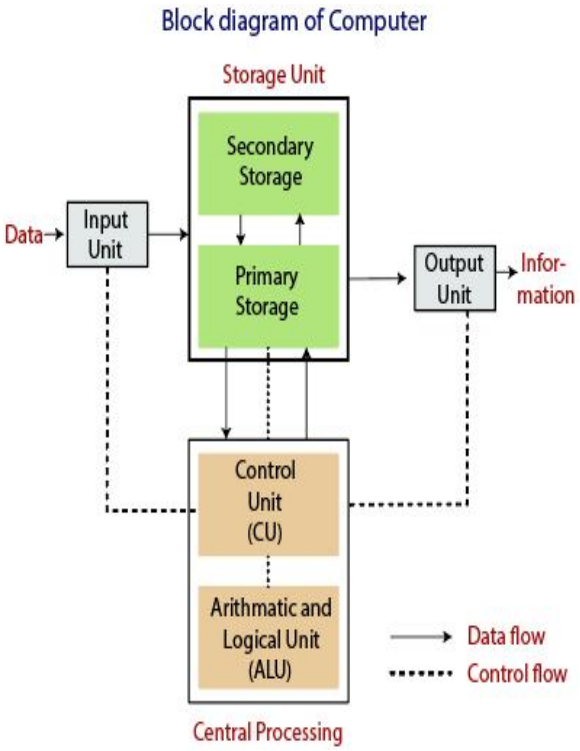


Parameters	Natural Brain	Simulated Brain
Input	Through Sensory Cells/ Neurons	Through Silicon chip of artificial neuron.
Interpretation	By using states of Neuron	By using set of bits in register.
Output	Through Sensory cells/ Neurons	Though Silicon chip of artificial neuron.
Memory	Permanent state of neuron	Secondary Memory [hardware].
Processing	In neural circuitry, arithmetic and logical operations are done.	Using the concept of Artificial intelligence, arithmetic and logical operations are done.

C. Uploading of Human Brain

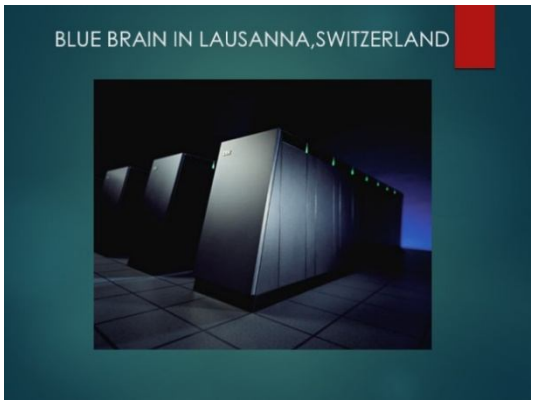
The uploading of information is possible by using small robots known as Nanobots. These robots are so small that they can travel through the circulatory system along with the spine and brain. Their job is to monitor and analyze the structure of our central nervous system.

They provide an interface with the computers which is as close to our mind as resides in our biological form.

Nanobots could also scan the structure of our brain, providing a complete readout of the connections. When this information is entered into a computer we could store our memories, dreams, thoughts in the computer.

D. Hardware Used

"Blue Gene", engineered by IBM , installed on the EPEL campus in Lausanne, Switzerland and was managed by CADMOS had utilized following primary hardwares.



1) 8,096 CPUs at 700 MHz
2) 256MB to 512MB memory per processor to simulate billions of neurons.
3) 100 kilowatts power consumption.
4) A program that converts the electrical impulses from brain into an input signal to be used by the supercomputer an vice versa.
5) Processor with very high processing power.
6) 22.8 TFLOPS peak processing speed.
7) 16 TB of memory is required as there are billions and billions of neurons.
8) Powerful Nanobots to act as interface medium between the natural brain and supercomputer.
9) Linux and C++ software

The “Blue Brain” and Human Consciousness

"Blue Brain" offers a great understanding of human consciousness.

It’s an actual ‘computer brain’ that may eventually have the ability to think for itself.

When the Blue Brain was fed with the electrical impulses for the first time, it produced strange patterns with lightning-like flashes produced by ‘cells’ that the scientist recognized from living and animal processes. This all happened entirely on its own.

Flash Activity

Blue Brain started producing flashes of activity that scientists recognized from measurements of natural brain behavior -- on its very first day. "It happened entirely on its own“.

V. BENEFITS, APPLICATIONS AND DRAWBACKS

A. *Positive Effects*

1) Remembering things become effortless.
2) Self decisions can be made by the computer using past experiences.
3) A person’s intelligence can be stored an utilized for future inventions.
4) The activity of different animals can be understood. That means by interpretation of the electric impulses from the brain of the animals, their thinking can be understood easily.
5) With the help of nerve simulation, a person with hearing disorder or pralysis can communicate.
6) It is also helpful for many psycological diseases.

B. *Negative Impacts*

1) Since the Blue Brain project is based on Computer Technology, therefore it is prone to virus attacks and hacking.
2) There may be a possibility of human cloning.
3) The procedure of regaining the memory back is expensive.
4) Huge amount of electric power is required to run the machine.
5) Technical Knowledge can be used against us.
6) Humans will become more dependent on the computer.
7) If the neural schema of a person is hacked then it can be used against the same person.
8) It may lead to many dangerous consequences like war against the humans and machines.

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C. Applications

1) It would help in getting a better understanding of conscious and sub-conscious mind.
2) Data around hundreds of years can be collected, stored and tested.
3) Neural code can be cracked.
4) It could be a leading drug discovery too for phycological and brain disorders.

VI. CONCLUSION

Hence, we can say that with some improvement in today's technology, the Blue Brain can be implemented in the future, and transferring ourselves into computer would be possible. The intelligence of the human brain will be stored even after the death for the betterment of society. We can make decisions without the actual presence of a person. But it is also true that we will depend on the computer. It will bring both positive and negative effects to human society. Very soon this technology will be highly accepted whole over the world.

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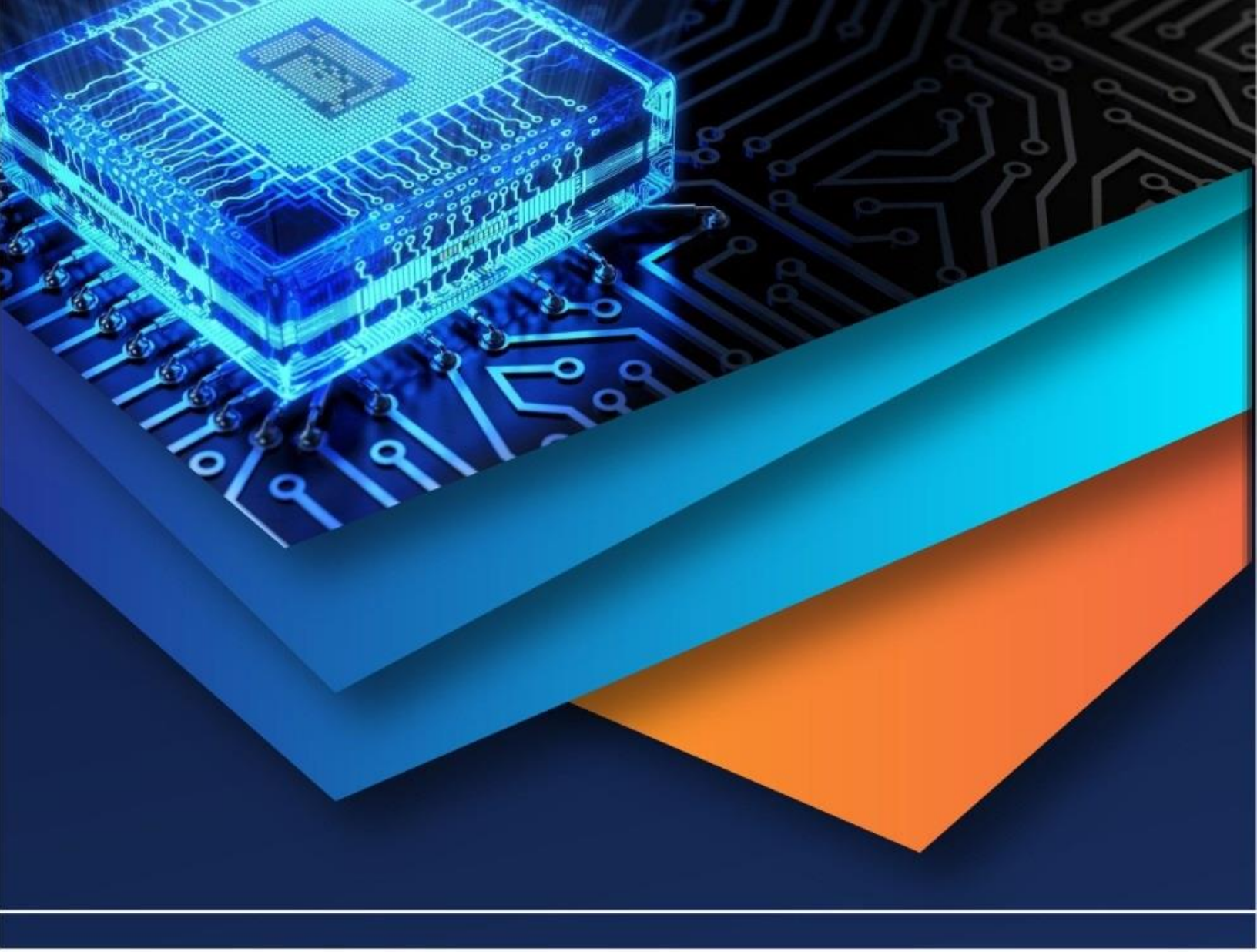

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