

Optimized Cognitive Technology in Cerebral Traits of Blue Brain

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ABSTRACT

Implementing Blue Brain focuses on digital reconstruction of the brain by reverse engineering mammalian brain which mostly to upload human brain into machine. Blue Brain which works like a normal human brain with some special features this helps one to think and take decision as human brain does. by this feature of implanting human brain into machine will be more generic and useful for super brains. Thus, human brain will survive even after death and the knowledge, intelligence and feelings can be used for development of the society.

Keywords : Mammalian Brain, Blue Brain, Digital Reconstruction, Reverse Engineering.

I. INTRODUCTION

The blue brain technology aims to create a virtual brain similar to human brain. The blue brain is created at cellular level which can function and operate as a human brain the objective of this project is to develop and acquire knowledge of the brain and also enable quick treatment for brain disease. The data is collected about different neuron types. Today an artificial will be capable of not only thinking and responding but also in taking decision and keep things on mind. it is said that the brain is being made fully capable of substituting the natural brain after brain death or after brain injury. This new technology has made great improvement in supercomputing.

II. RELATED WORK

1. **Raymond Kurzweil** recently provided an interesting paper on this topic. In it, he describes both invasive and non-invasive techniques. The most promising is the use of very small robots, or nanobots. These robots will be small enough to travel throughout our circulatory systems. Traveling into the spine and brain, they will be able to monitor the activity and structure

of our central nervous system. They will be able to provide an interface with computers that is as close as our mind can be while we still reside in our biological form. Nanobots could also carefully scan the structure of our brain, providing a complete readout of the connections between each neuron. They would also record the current state of the brain. This information, when entered into a computer, could then continue to function like us. All that is required is a computer with large enough storage space and processing power. [1]

2. **Ms. Akanksha V. Patil and her team** proposed that today scientists are in research to create an artificial brain that can think, respond, 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, which can be used for the development of the human society. 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. IBM, in partnership with scientists at Switzerland's Ecole Polytechnique Federale de Lausanne's (EPFL) Brain and Mind Institute will begin simulating the brain's biological systems and output the data as a working 3- dimensional model that will recreate the high-speed electro-chemical interactions that take place within the brain's interior. These include cognitive functions such as language, learning, perception and memory in addition to brain malfunction such as psychiatric disorders like depression and autism. From there, the modeling will expand to other regions of the brain and, if successful, shed light on the relationships between genetic, molecular and cognitive functions of the brain.^[2]

3. Blue Brain

A blue brain which is moulded with software and hardware has the ability to think, react, take decision and also store knowledge and it is similar that of a human brain. Blue brain is for the simulation of mammalian brain. where, simulation is a production of computer model for something that brain can perform. It is used to stimulation of the mammalian brain and to identify the fundamental principles of brain structure and function in health & disease. This research also includes examine the slices of living brain tissue using the microscopes and patch clamp electrodes. Data has collected from all the different types of neurons and its data is used to build the biologically realistic models of neurons and networks of neurons in the cerebral cortex. This stimulation was carried out on a Blue Gene supercomputers built by IBM, hence it is called "Blue Brain" and its software based on Michael Hines's Neuron and together with some other custom built components. The main of this project is to gain the complete understanding of the brain and to ensure the better and faster development of brain disease treatments. This project has its own biological importance and applications.

Possibilities to create human brain:

The content, data and information can be stored on a super computer with no difficulty, since it has large storage capacity and processing power. This methodology is used for creating a virtual brain similar to that of a human brain.

It can be implemented through computer processing power where nanobots and brain chip is used for this technique.

why Blue Brain?

- Human brain does lot of work and instructs to perform actions. Thus, to construct a blue brain will be more serviceable in keeping the intelligence, knowledge and skill of any person forever
- Effortless recollection of things.

Need of Blue Brain

Today we have developed lots and lots of artificial robots because of our intelligence. Intelligence is our inborn quality which can't be created but we can stored for future use or reference. Human society is need for such a intelligence for future generation. But after the death all our human intelligence is destroy but virtual brain has solution to store all our intelligence and it is alive after the death. In reality, we often have the difficulties of remembering all programs in our day-to-day life, birthdays, important dates and all those stuffs. But virtual brain has a solution to it because when we upload ourselves to the virtual brain it creates the awareness about our stuffs in our day-today life and some important memories, intelligence of great person can be stored for the future use.

III. HISTORY OF BLUE BRAIN

The aim of the project, founded in May 2005 by the Brain and Mind Institute of the École Polytechnique Fédérale de Lausanne (Switzerland) is to study the brain's architectural and functional principles. The project is headed by the Institute's director, Henry Markram. Using a Blue Gene supercomputer running Michael Hines's NEURON software, the simulation does not consist simply of an artificial neural network but involves a biologically realistic model of neurons. It is hoped that it will eventually shed light on the nature of consciousness. There are a number of sub-projects, including the Cajal Blue Brain, coordinated by the supercomputing and Visualization Centre of Madrid (CeSViMa), and others run by universities and independent laboratories.

IV. FUNCTIONING OF BLUE BRAIN

There are three main steps to build virtual brain, i) Data acquisition, ii) Simulation, iii) Visualization of results.

INPUT: Data Acquisition

Individual slices of brain are taken and it is placed under the microscope and measures the shape and electrical activity of individual neurons and different types of neurons and its behaviors are studied and catalogued. The neurons are typed by its shape morphology, electrophysiological behavior location with the cortex, and their population density. These observations are then translated into mathematical algorithms, forms, function and positioning of neurons. These algorithms are then used to generate the biologically realistic virtual neurons. The electron physiological behaviors of neurons are studied using a 12 patch clamp instrument. This tool has been developed for the blue brain project. It enables the twelve living neurons to be concurrently patched and their electrical activity recorded. Carbon nanotubes coated electrodes can be used to improve recording.

Sound and image are two inputs given here which is received through the sensory cell.

Simulation

For neural simulation, the primary software used by the BBP is a package called NEURON and it was developed in starting 1990s by Michael Hines at Yale University and John Moore at Duke University. This software continues to be under active development and its current active version at 7.2. It is free and open source software. In 2012 stimulations nearly 10,000 neurons run at approximately 300x slower than real time. The stimulation time-step for the numerical integration is 0.025 ms and the time step for the output could be 0.1ms.

This algorithms are used to syntheses the virtual cells and they are found to describe the real neurons. The algorithms and parametres are varied by their age, species, and stages of the animal being affected by the disease and each & every single proteins are stimulated. First a network skeleton is built from all the different kinds of synthesised neurons. Then the cells are connected together according to the rules that have been found experimentally. Finally the neurons are functionalised and the simulation brought to life. The patterns of emergent behaviour are viewed with visualisation software. The input received is interpreted by the brain and defining states of neurons in the brain. This simulation has two major aspects Simulation speed & Simulation overflows Simulation speed.

Simulations of the one cortical column tihat runs about two hundreds times slower than the real time. It almost takes about 5 minutes to complete the one second of simulated time and it desplays as a uneven line scaling. The simulatin time-step vary at 0.025ms for numerical calculation and 0.1ms for writing the output to the disk.

Simulation overflow

The main work of this step is to make virtual cells using the algorithm and it is written into the define real neurons. It will be based on the characteristics as mentioned above. In the single cell, there are hundreds of million proteins and each of single protein is simulated. At first network of the body is built using the different kinds of synthesized neurons. And the cells are connected as per the rules. Finally, Neurons starts to function and the simulation is achieved. The different behaviour of the neurons is visualized using the visualization software. Each and every two weeks a column model is run. Column mentioned here is the cortical column and it is mapped into a single function. The results are seen in the living neurons.

Simulation of neurons will be based on the Shallow neural network. Shallow neural network, where it has only one hidden layer which is opposite to deep neural network where it has many multiple layers. Shallow neural network, allows one layer and makes to understand the thing correctly.

Restricted neural network in deep learning, a stochastic neural network which consists of one layer of visible units and another layer of hidden units and finally the bias unit. In bias unit where the state could be always on and it is a way of adjusting the different inherent of different task. Restricted neural network, it allows only minimum number of network to connect.

OUTPUT : Visulation Results

RTneurons is the application used by the BBP for visualisation of neural simulation. RTNeurons is an ad-hoc software were designed particularly for neural simulation. Finally the neurons are functionalised and the simulation brought to life. The patterns of emergent behaviour are viewed with visualisation software. The input received is interpreted by the brain and defining states of neurons in the brain. The

RTNeurons takes the output from the Hodgkin-Huxley simulations in Neurons and renders them in 3d format. This 3d animation can be stopped, zoomed which helps the researchers for the better interaction with the model. The output of the blue brain that is processed in the silicon chip. Signal is given to the artificial neurons in the body which will be received by the sensory cell. And also receive electric impulses to perform any action.

MEMORY:

The concept of the blue brain technology, it requires massive storage capacity for digital system other than main memory and secondary memory. Where Blue Brain storage space is nothing but the brain uploading. Brain uploading means that collecting the information from the memory using the machine learning algorithm which works on real time. Data collected from the Machine learning algorithm which will be grouped into separate storage folders or registers depending on different types of data. This variation on data based on the input identified. Binary values i.e. 1 and 0 are the only values that are given as the input for the variations of the data. This also includes the technique of Natural Language Processing(NLP) which makes the project livelier and user friendly and therefore all the users will be comfortable while they interact on their region language. The required states of registers can be stored permanently as it is possible to store data using the secondary memory and the data 's can be further acknowledged and used later. Working of storage space is mentioned in flowchart:

PROCESSING : With stored details decisions are made. Processing can be done by logical and arithmetic calculations.

Uploading Human Brain:

- Small robots called nanobots are used for uploading contents into the human brain
- These Nanobots travel throughout the circulatory system.

- Activities and the structure of the central nervous system is monitored by the nanorobots which travel into the spine and brain.
- They provide an interface with computer which are into the biological form
- Thus, contents in the brain will be uploaded into the computer.
- A well designed nanobot that should efficiently act as a communicating agent between natural brain and computer
- High processing power processor
- Vast network
- To convert electric impulses to input signal which is to be received by the computer and to be send by the computer
- Large storage capacity.

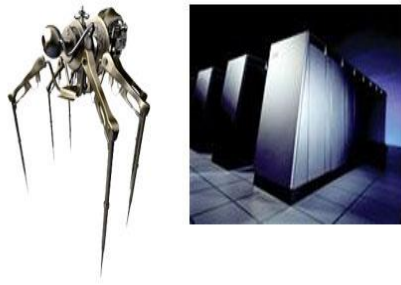


Figure 1. Nanobots and Supercomputer

Hardware and software requirement:

This primary machine uses “Blue Gene” supercomputer as the hardware component built by the IBM. The computer is used by a number of different research groups, not exclusively by the Blue Brain Project. In mid-2012 the BBP was consuming about 20% of the compute time.

Blue Gene/P technical specifications:

1. 4,098 quad-core of nodes.
2. Every core is a PowerPC of 4.5, 8.5 GHz
3. It consists of more than 6×10^{13} flops
4. 16 terabytes memory
5. 1 Peta Byte of disk space.
6. Operating system used is Linux SuSE SLES 10

Silicon Graphics: A 32-processor Silicon Graphics Inc. (SGI) system with 300 Gb of shared memory is used for visualisation of results.

- super computer

This method of implanting nanobots in human brain will be more successful for human with super brains i.e., scientists. This is like using their intelligence after brain death or brain injury.

JuQUEEN.

JuQueen ia an IBM Blue Gene/Q supercomputer that has been installed at the Julich Research centre at Germany in May 2012. It performs at 1.6peta flops and has been ranked as the world’s 8th fastest supercomputer in June2012. That this machine is used for BBP simulations in 2013 for human brain project. In 2012, this supercomputer has been expanded with the additional racks. It also be used for the research initiative. The main aim of this JuQueen is that to develop three dimensional realistic model of human brain.

Deep

Dynamical Exascale Entry Platform, it is an exascale supercomputer has been built by the Julinch research centre in Germany. It is an prototype supercomputer that will perform about 100petaflops, aimed to built at the end of 2014. But in the future they were decided to provide 1 exaflops of performance for the complete function of the human brain in 2020. The DEEP prototype will be built using the intel MIC processors, which contains over 50 cores fabricated with a 22nm process. These prossores were codenamed as knights corner.

V. METHODOLOGY

The artificial nervous system will be created. So the scientist have created the artificial neurons by replacing them on the silicon chip. It has been checked that the neurons receives the signal as input from the sensory cells. So the electric impulses from the sensory cells can be received through the artificial neurons. The interpretation of electric impulse received by the artificial neurons and it is stored in the register. The different values represents the different states of the brain. The sensory cell receives the output signal from the artificial neurons based on the states of the register. Same way decision making can also be done by the computer by using the register stored states and based on the input received it perform arithmetic and logical calculation. It isn't impossible to store the data permanently Therefore all the data can be stored permanently and it can be retrieved for the future reference. This project aims to create a computer simulation and it was implemented in rat. A super computer is used based on IBM's Blue gene to simulate the behaviour of neurons based on synaptic connectivity.^[2]

VI. BRAIN CHIP

Blue brain can also be implemented by using brain chip. That is brain implanting often refers through neural implants. This can directly connect to the biological subject brain and this can be placed on the surface of the brain or attached to the brain's cortex.

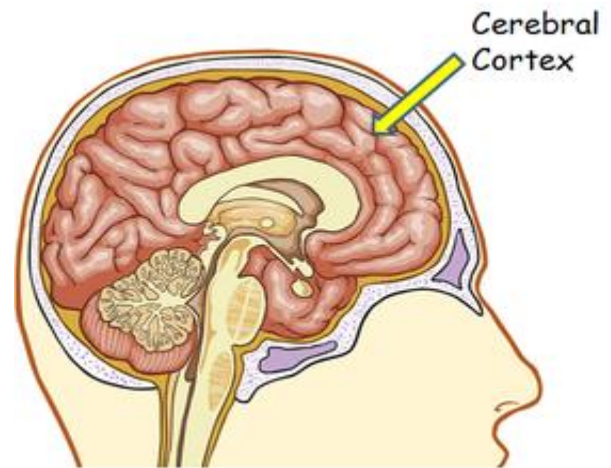


Figure 2. Implementing brain chip in cerebral cortex

The brain chip after implanting stays normal and once the brain is dead or injured it starts functioning when the nerves become weak and nerve ending of the brain touches the brain the chip starts functioning. Brain chip is made up of silicon chip. The chip contains digital neurons. The chip has low power processing unit and synapse to establish connection between neurons. The neurons and synapses are organised in cross bar arrays and are supported by a communication infrastructure for neurons to exchange data in real time.

VII. FUTURE WORKS

As mentioned earlier this blue brain technology is implemented only in rat brain. Blue Brain future technology is a focusing on storage where voice/speech recognition and visual data as input. Visual data includes videos, pictures or even a real time action. Using the same decomposition of algorithm, we can split this larger bits into smaller bits which results in the large amount of data storage. This can also be implement in human brain. Where nanobots can be placed in cerebral vein and brain chip can be placed in cerebral veins.

VIII. ADVANTAGES

- Human intelligence and visual aspect of knowledge can be stored most permanently by the virtual brain even after the brain death
- Decision making mandatory for a device containing blue brain
- It can perform all other major functions like any other machine can do.
- Allowing the deaf to hear via direct nerve simulation, and also be helpful for many psychological diseases. By downloading the contents of the brain that was uploaded into the computer, the man can get rid of from the madness

IX. DISADVANTAGES

- The human being become more dependent on machines.
- Restoring memory back into the super computer will be expensive.
- Computer viruses will pose an increasingly critical treat.
- Futher, there can be new dangers that the new technology can be opened. It will be suscepitble for the new forms of harm.

X. APPLICATION

Gathering and testing 100 years of data, cracking the neural code, understanding neocortical information processing, a novel tool for drug discovery for brain disorder, a global facility, a foundation for whole train simulation, a foundation for molecular modelling of brain function.^[1]

XI. CONCLUSION

Thus, by this research one can understand the complete study of blue brain where this method helps us in development of human society the case of brain

death. They are simple minded and require more time for technology to improve and develop.

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