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Blue Brain: Using Blue Gene Supercomputers

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Abstract: **-- Human brain is the most valuable creation of God. The man is intelligent because of the brain. "Blue brain" is the name of the world's first virtual brain. That means a machine 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.**

Keywords: **-- Nanobots, Neurons, Sensory System**

I. INTRODUCTION

Blue brain is the name of the world's first virtual brain. That means a machine that can function as human brain. Computer simulations in neuroscience hold the promise of dramatically enhancing the scientific method by providing a means to test hypotheses using predictive models of complex biological processes where experiments are not feasible. Of course, simulations are only as good as the quality of the data and the accuracy of the mathematical abstraction of the biological processes. The first phase of the Blue Brain Project therefore started after 15 years of systematically dissecting the micro-anatomical, genetic and electrical properties of the elementary unit of the neocortex a single neocortical column, which is a little larger than the head of a pin. 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 is complex 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. But today it is possible due to the technology. Technology is growing faster than everything. IBM is now in research to create a virtual brain. It is called Blue brain. If possible, this would be the first virtual brain of the world.

II. WHAT IS BLUE BRAIN?

The IBM is now developing a virtual brain known as the Blue brain. It would be the world's first virtual brain. Within 30 years, we will be able to scan ourselves into the computers. We can say it as Virtual Brain i.e. an artificial brain, which is not actually a natural brain, but can act as a brain. It can think like brain, take decisions based on the past experience, and respond as a natural brain. It is possible by using a super computer, with a huge amount of storage capacity, processing power and an interface between the human brain and artificial one. Through this interface the data stored in the natural brain can be up loaded into the computer. So the brain and the knowledge, intelligence of anyone can be kept and used for ever, even after the death of the person.

III. VIRTUAL BRAIN AND ITS NEED

We can say Virtual brain is an artificial brain, which does not actually the natural brain, but can act as the brain. It can think like brain, take decisions based on the past experience, and response as the natural brain can. It is possible by using a super computer, with a huge amount of storage capacity, processing power and an interface between the human brain and this artificial one. Through this interface the data stored in the natural brain can be up loaded into the computer. So the brain and the knowledge, intelligence of anyone can be kept and used for ever, even after the death of the person. Today we are developed because of our intelligence. Intelligence is the inborn quality that cannot be created. Some people have this quality, so that they can think

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up to such an extent where other cannot reach. Human society is always needed 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, and etcetera. In the busy life every one wants to be relaxed. Cannot 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. HOW IT WORKS

First, it is helpful to describe the basic manners in which a person may be uploaded into a computer. 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. Nanobotes 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 as us. All that is required is a computer with large enough storage space and processing power. Is the pattern and state of neuron connections in our brain truly all that makes up our conscious selves? Many people believe firmly those we possess a soul, while some very technical people believe that quantum forces contribute to our awareness. But we have to now think technically. Note, however, that we need not know how the brain actually functions, to transfer it to a computer. We need only know the media and contents. The actual mystery of how we achieved consciousness in the first place, or how we maintain it, is a separate discussion.
Really this concept appears to be very difficult and complex to us. For this we have to first know how the human brain actually works.

V. FUNCTIONING OF HUMAN BRAINS

The human ability to feel, interpret and even see is controlled, in computer like calculations, by the magical nervous system. Yes, the nervous system is quite like magic because we can't see it, but its working through electric impulses through your body.

One of the world's most "intricately organized" electron mechanisms is the nervous system. Not even engineers have come close to making circuit boards and computers as delicate and precise as the nervous system. To understand this system, one has to know the three simple functions that it puts into action: sensory input, integration, motor output.

1) Sensory input: When our eyes see something or our hands touch a warm surface, the sensory cells, also known as Neurons, send a message straight to your 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 your senses.

2) Integration: Integration is best known as the interpretation of things we have felt, tasted, and touched with our sensory cells, also known as neurons, into responses that the body recognizes. This process is all accomplished in the brain where many, many neurons work together to understand the environment.

3) Motor Output: Once our brain has interpreted all that we have learned, either by touching, tasting, or using any other sense, then our brain sends a message through neurons to effecter cells, muscle or gland cells, which actually work to perform our requests and act upon our environment. The word motor output is easily remembered if one should think that our putting something out into the environment through the use of a motor, like a muscle which does the work for our body.

VI. BRAIN SIMULATION

Now the question is how to implement this entire natural thing by using artificial things. Here is a comparative discussion.

1. Input

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In a similar way the artificial nervous system can be created. The scientist has already created artificial neurons by replacing them with the silicon chip. It has also been tested that these neurons can receive the input from the sensory cells .So, the electric impulses from the sensory cells can be received through these artificial neurons and send to a super computer for the interpretation.

2. Interpretation

The interpretation of the electric impulses received by the artificial neuron can be done by means of a set of register. The different values in these register will represent different states of the brain.

3. Output

Similarly based on the states of the register the output signal can be given to the artificial neurons in the body which will be received by the sensory cell.

4. Memory

It is not impossible to store the data permanently by using the secondary memory .In the similar way the required states of the registers can be stored permanently. And when required these information can be retrieved and used.

5. Processing

In a similar way the decision making can be done by the computer by using some stored states and the received input and by performing some arithmetic and logical calculations. Now there is no question how the virtual brain will work but the question is how the human brain will be uploaded into it. This is also possible because of fast growing technology.

VII. STEPS TO BUILDING A BLUE BRAIN

1. Data collection
2. Data simulation
3. Visualization

1. Data collection: Data acquisition involves taking brain slices, placing them under a microscope, and measuring the shape and electrical activity of individual neurons. This is how the different types of neuron are studied and catalogued. The neurons are typed by morphology i.e. their shape, electrophysiological behaviour, location within the cortex, and their population density. These observations are translated into mathematical algorithms which describe the form, function, and positioning of neurons. The algorithms are then used to generate biologically-realistic virtual neurons ready for simulation.

The electrophysiological behaviour of neurons is studied using a 12 patch clamp instrument (Fig1 & Fig2). This tool was developed for the Blue Brain Project and it forms a foundation of the research. It enables twelve living neurons to be concurrently patched and their electrical activity recorded. The Nomarski microscope enhances the contrast of the unstained samples of living neural tissue. Carbon nanotube-coated electrodes can be used to improve recording

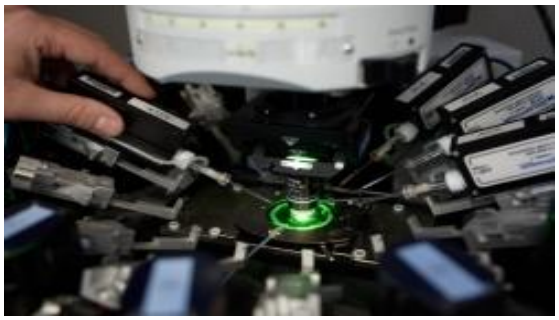

Fig1. The 12 patch-clamp, close-up view

Fig2. 12 patch-clamp at the Blue Brain lab

2. Data simulation: It concerns with two major aspects:
a. Simulation speed
b. Simulation workflow

***Simulation speed*:** Simulations of one cortical column (more than 10,100 neurons) run about two hundred times slower than real time. It takes about five minutes to complete one second of stimulated time. The simulations display unevenly line scaling. Presently the major seek is biological soundness rather than presentation. After understanding biologically significant factors for a given effect it might be feasible to

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crop constituents that don't subsidize in order to advance performance.

***Simulation overflow*:** Making virtual cells using the algorithms, written to define and describe real neurons, is the major seek of this step. Algorithms and constraints are adapted according to the age, species, and disease stage of the animal being simulated. Each one of the protein is simulated. Note: there are hundreds of millions of proteins in one cell. a. First a network skeleton is built from all the different kinds of synthesized neurons. b. After this, the cells are joined according to the experimentally found rules. c. Finally the neurons are functionalized and the simulation brought to life. The blueprints of emerging behavior are watched with visualization software.

BBP-SDK

The Blue Brain Project - Software Development Kit, a set of Application Programming Interfaces allows the researchers to use and audit prototypes and simulations. The Blue Brain Project-SDK is a C++ library wrapped in Java and Python. The primary software used by this for neural simulations is NEURON. Michael Hines of Yale University and John Moore at Duke University developed this in the starting of the 1990s. It uses C, C++, and FORTRAN. It is freely available open source software. The website makes everything available including the code and the binary data freely. Michael Hines in cooperation with BBP team in 2005 ported the package into the massive and parallel Blue Gene.

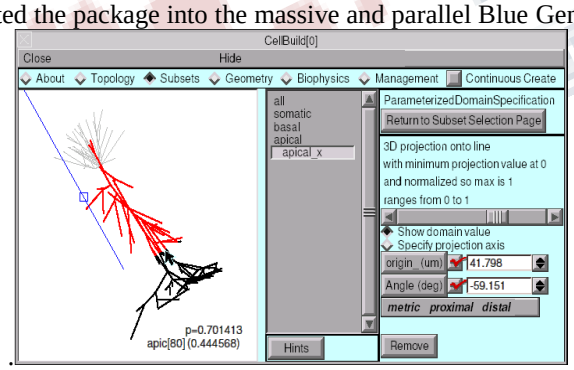

Fig3. NEURON cell binder window

3. Visualization of results:

RT Neuron

RT Neuron is the main application that Blue Brain Project uses for visualization of neural simulations. The BBP team developed this software internally. It is coded using C++ and OpenGL. RT Neuron is an ad-hoc software written specifically for neural simulations, i.e. it can't generalized to other kinds of simulation. RT Neuron takes the output from Hodgkin-Huxley simulations as input in NEURON and delivers them in 3D. This allows the programmers and researchers to view as activation potentials propagate through or between neurons. The animations can be paused, stopped, started and zoomed, hence allowing the researchers to interact with the model. The visualizations are multi-scale (they can render individual neurons or a whole cortical column).

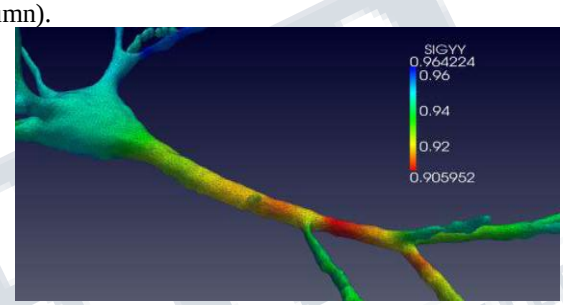

Fig4: Visualisation of neuron

VIII.COMPUTER HARDWARE/ SUPERCOMPUTERS

1. Blue Gene/L Super computer (initially till 2009)
2. Blue Gene/P Super computer (till 2011)

Blue Gene/P specifications:

- More than 4,000 quad-core nodes
- Each core is a PowerPC of 4.5, 8.5 GHz
- It consists of more than 6*1013flops, more than 15 terabytes memory
- 1 PetaByte of disk space and parallel file system
- Operating system: Linux SuSE SLES 10

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Fig5. Blue Gene/P's processing system outer view

3. *Juqueen (Blue Gene/Q) Super Computer*

Fig 6. Juqueen

It currently performs at more than 1.7 Petaflops. It was in 8th rank in the world in June 2012 in terms of speed. It was upgraded with more racks in October 2012.

IX. HARDWARE & SOFTWARE REQUIREMENTS

1. A super computer.
2. Memory with a very large storing capacity.
3. Processor with a very high processing power.
4. A very wide network.
5. A program to convert the electric impulses from the brain to input signal, which is to be received by the computer, and vice versa.
6. Very powerful Nanobots to act as the interface between the natural brain and the computer

X. UPLOADING HUMAN BRAIN

The uploading is possible by the use of small robots known as the Nanobots .These robots are small enough to travel throughout our circulatory system. 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. This information, when entered into a computer, could then continue to function as us. Thus the data stored in the entire brain will be uploaded into the computer. Merits and demerits With the blue brain project the things can be remembered without any effort, decisions can be made without the presence of a person. Even after the death of a man his intelligence can be used. 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. It would allow the deaf to hear via direct nerve stimulation, and also be helpful for many psychological diseases. Due to blue brain system human beings will become dependent on the computer systems. Technical knowledge may be misused by hackers; Computer viruses will pose an increasingly critical threat. The real threat, however, is the fear that people will have of new technologies. That fear may culminate in a large resistance. Clear evidence of this type of fear is found today with respect to human cloning. What can we learn from Blue Brain? Detailed, biologically accurate brain simulations offer the opportunity to answer some fundamental questions about the brain that cannot be addressed with any current experimental or theoretical approaches. Understanding complexity At present, detailed, accurate brain simulations are the only approach that could allow us to explain why the brain needs to use many different ion channels, neurons and synapses, a spectrum of receptors, and complex dendritic and axonal arborisation's. Applications: 1. Gathering and Testing 100 Years of Data. 2. Cracking the Neural Code 3. Understanding Neocortical Information Processing 4. A Novel Tool for Drug Discovery for Brain Disorders 5. A Global Facility 6. A Foundation for Whole Brain Simulations 7. A Foundation for Molecular Modeling of Brain Function

XI. ADVANTAGES& DISADVANTAGES

Advantages

1. We can remember things without any effort.
2. Decision can be made without the presence of a person.
3. Even after the death of a man his intelligence can be used.
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. It would allow the deaf to hear via direct nerve stimulation, and also be helpful for many psychological diseases. By down loading the contents of the brain that was uploaded into the computer, the man can get rid from the mad ness.

Disadvantages

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Further, there are many new dangers these technologies will open. We will be susceptible to new forms of harm.
1. We become dependent upon the computer systems.
2. Others may use technical knowledge against us.
3. Computer viruses will pose an increasingly critical threat.
4. The real threat, however, is the fear that people will have of new technologies. That fear may culminate in a large resistance. Clear evidence of this type of fear is found today with respect to human cloning.

XII. CURRENT RESEARCH WORK

1) 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)Researchers at Microsoft's Media Presence Lab are developing a "virtual brain," a PC-based database that holds a record of an individual's complete life experience. Called **MyLifeBits,** the project aims to make this database of human memories searchable in the manner of a conventional search engine. "By 2047, almost all information will be in cyberspace including all knowledge and creative works, said one of the project's leaders, Gordon Bell.

3)According to the **new scientist** Magazine report Rodrigo Laje and Gabriel Mindlin of the University of Buenos Aires in Argentina have devised a computer model of a region of the brain called the RA nucleus which controls muscles in the lungs and vocal folds. The model brain can accurately echo the song of a South American sparrow. The bird sing by forcing air from their lungs past folds of tissue in the voice box. The electric impulses from the brain that force the lungs had been recorded and when the equivalent impulses were passed to the computer model of the lungs of the bird it begins to sing like the bird.

Mr. Mindlin told the weekly science magazine he was surprised that simple instructions from the brain change a constant signal into a complex series of bursts to produce the intricacies of birdsong. He plans to add more brain power to his model which might reveal how birds improve their songs and learn them from other birds. He hopes it might one day be possible to use similar models to map the neural [brain] circuitry of animals without distressing lab experiments – just by recording their calls and movements, the magazine said.

XIII. CONCLUSIONS

In conclusion, we will be able to transfer ourselves into computers at some point. Will consciousness emerge? We really do not know. If consciousness arises because of some critical mass of interactions, then it may be possible. But we really do not understand what consciousness actually is, so it is difficult to say. Most arguments against this outcome are seemingly easy to circumvent. They are either simple minded, or simply require further time for technology to increase. The only serious threats raised are also overcome as we note the combination of biological and digital technologies.

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