A Seminar report on

BLUE BRAIN TECHNOLOGY

A Dissertation submitted to JNTU Hyderabad in partial fulfillment of the academic requirements for the award of the degree.

Bachelor of Technology

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CERTIFICATE

This is to certify that the Technical Seminar report entitled **"BLUE BRAIN TECHNOLOGY"** being submitted by K.Srikar (20H51A6613) in partial fulfillment for the award of **Bachelor of Technology in Computer Science and Engineering(AI&ML)** is a record of bonafide work carried out his/her under my guidance and supervision.

The results embodies in this seminar report have not been submitted to any other University or Institute for the award of any Degree.

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SIGNATURE

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ABSTRACT

It took us thousands of centuries to evolve from Unicellular Organism to this complex biological form. Our Brain and Intelligence were the center of all the evolution we've been through. Human brain is a pool of intelligence, which will be of no use after the death. But with the help of this new technology, it becomes possible human intelligence can virtually exist after the death of an individual. "BLUE BRAIN" is a technology, in which we upload the human brain recorded structure and signals in the Super Computer to make a simulation of how intelligence works. Uploaded human brain recorded structure in computer would work as Virtual Brain. Even after the death of an individual, his brain will be alive virtually. For this we are going to use Nanobots to record the structural neuron transmitting signals and also the response given by the brain on the stimuli of the body using the neurons. These neurons act as an interface between the brain and the body. We will upload all the recorded data of the brain functioning in the super computer with a huge amount of storage capacity and processing power. We will discuss the working of the Blue Brain Technology and would focus on its advantages, drawbacks and the way to utilize less memory and the brain based chip technology as well as its future expected applications.

CHAPTER 1

INTRODUCTION

The most precious making of god is “human brain” and the intellect of man is because of brain. Sequences delivered by the impulses are translated by brain which enables the person to retort. When the body is shattered after the demise of man the knowledge of a brain is lost. That knowledge might have been used for the progress of the human culture. What if we upload the contents of natural brain into a fabricated brain?

1.1 Blue brain

The world’s first ever “virtual brain” which means it adopts the functions of human brain. the idea behind blue brain is to know some aspects of human identification. None of them have ever unstated the intricacy of human brain, it is composite than any circuitry in the humankind. we can answer “yes” to the questions that crop up of asking “can we in fact create a human brain?”for the reason that anything produced by bloke has always followed the nature .it was a question for all when a machine like computer wasn’t designed. now if possible the idea of virtual brain will come true within 30 years or so, which will be able to scrutinize ourselves into the computers.

Fig-1:blue brain

1.2 Why we need virtual brain?

We are urbanized today because of our acumen .the instinctive eminence of intelligence cannot be created. Some people have this excellence, so that they can imagine up to such an extent where others can't even reach. The world is always in need of such brainpower and a clever brain. After death the intelligence is lost along with the body hence the elucidation to it is virtual brain. This helps in preserving the brain and intelligence even after the death. Teething troubles are often faced in remembering things such as person's names, the spellings of words, birth dates, appropriate grammar, history, evidences etc...In the tiring life everyone want to be hassle-free. Can't we exploit any contraption to assist for all these?, what if one lived as a program in a computer?. The response to all this is need of a virtual brain.

1.3 How it is possible?

Mainly, it is supportive to describe the crucial manners wherein a person may be uploaded into a computer. Raymond Kurzweil in his paper describes mutually enveloping and non-invasive techniques. The use of small robots or nanobots is the majority potential. these tiny robots are enough to travel right the way through our circulatory systems. They will be able to examine the activity and configuration of our central nervous system by travelling into the spine and brain. While we still dwell in our genetic form nanobots will be able to provide an interface that is as close as our mind with computers. These are meant to provide a entire readout of the connections between each neuron by cautiously scanning the structure of our brain and also trace the current circumstances of the brain. This could then prolong to function as us when information is entered into a computer. the requirement is a computer with bulky enough storage space and processing power. Does the sample and state of neuron connections in our brain all that makes up our self conscious beyond doubt..?there are two types of people one who believe human posses a soul whilst some very scientific people consider that quantum forces donate to our awareness. here it's necessary to think technically. we necessitate to only know the media and contents but not how the brain in fact works to transfer it to a computer. the tangible ambiguity of how we achieved perception in the first place, or how we maintain it, is a separate treatise. As this conception appears to be very tricky and complex we have to initially know how a human brain really functions

CHAPTER 2

HISTORY OF BLUE BRAIN

Year	Project progress
2005	In June, the EPFL and IBM sign an agreement to launch the Blue Brain project (BBP).
2006	In February, during the summer, the BBP team generates its first model of a cortical column, using a simplified neuron model.
2007	In January, Henry Markram presents the project to the Davos forum. November 26 marks the end of the first phase of the project, which announces the completion of an initial model of the rat cortical column.
2008	The BBP team tests the accuracy of its model-building, In June, an article in the HFSP Journal summarizes the on-going debate on the size and location of functional cortical columns.
2009	In June, the BBP's BlueGene/L supercomputer is replaced by a BlueGene/P, with double the number of processors . The new machine represents a major increase in BBP computing power
2010	The BBP drives the formation of a Consortium.
2011	In January, the European Commission informs the Human Brain Project consortium that it has been selected to perform a preparatory study. Work on the study begins in May. The project hires new engineers and scientist. The project publishes several high impact papers describing new methods to generate cell models and in silico studies of virtual brain tissue.
2012	In April, Human Brain Project Consortium concludes its preparatory study and publishes a public report. In October the HBP consortium submits its formal application to become a FET Flagship project. The Blue Brain team coordinates the preparation of the proposal. An important paper in PNAS describes BBP-developed methods. At the Neuroscience 2012 conference in New Orleans, the Blue Brain Project presents more than 20 posters, describing a first reconstruction of the rat cortical column.
2013	On January 28, the EU Commission announces that it has selected the Human Brain Project as one of its two FET Flagship projects. Work on the project begins in October 2013. The Blue Brain Project is officially granted the status of a Swiss National Research Infrastructure, funded by the ETH Board.
2014	The BBP computing team works to improve the efficiency and scope of BBP computing tools and supercomputing infrastructure. A series of publications describe the new tools. In June, the BBP replaces its previous supercomputer (the BlueGene/P) with a BlueGene/Q

	machine (Blue Brain 4) hosted at the Swiss National Computing Centre (CSCS) in Lugano. The new machine offers higher performance and expanded memory. In the same month, BBP, IBM Research and ETH Zürich announce a collaboration to develop a new hybrid memory strategy for supercomputers, matching the heavy memory requirements for reconstructions of large volumes of neural tissue (brain regions, whole brains). The BBP completes validated digital reconstructions of neural microcircuitry in the brain of young rats. Work begins on a major paper, presenting the reconstruction, and on online resources, making the results available to the broader community.
2015	Blue Brain reaches a major milestone with the publication of a first draft of the digital reconstruction of neocortical microcircuitry (Markram et al, 2015). The study confirmed the practicability of building and simulating a digital copy of a neighborhood of the brain.
2016	The Blue Brain Project releases the Blue Brain Python Optimization Library (BluePyOpt).
2017	The team uncovered a universe of multi-dimensional geometrical structures and spaces within the networks of the brain. This research, published in Frontiers in Computational Neuroscience. Blue Brain Project launches three-day conference to kick-start neuromodulation analysis – NM2
2018	Blue Brain Nexus: an open-source information graph for data-driven science. Blue Brain Nexus allows data-driven science through looking, desegregation and pursuit large-scale knowledge and models. Blue Brain Project deploys HPE mainframe computer for digital reconstruction and simulations of the class brain to advance the understanding of the brainIn July, Hewlett Packard Enterprise (HPE) announced that the EPFL Blue Brain Project had selected HPE to build a next-generation supercomputer for modeling and simulation of the mammalian brain. especially simulation-based analysis, analysis and image, to advance the understanding of the brain. Blue Brain Project releases first-ever digital 3D neuron atlas Like “going from hand-drawn maps to Google Earth,” the Blue neuron Atlas permits anyone to ascertain each region within the mouse brain, cell-by-cell – and freely transfer knowledge for new analyses and modelling. The first digital 3D atlas of every cell in the mouse brain, Released by EPFL’s Blue Brain Project and published in Frontiers in Neuroinformatics, the Blue Brain Cell Atlas integrates data from thousands of whole brain tissue stains into a comprehensive, interactive and dynamic on-line resource which will continuously be updated with new findings.

Table-1:Progress till date

CHAPTER 3

HUMAN BRAIN AND VIRTUAL BRAIN

3.1 Functions of Natural Brain:

Before getting to know about the building and functions of Blue Brain, it is important to grasp information regarding the working of human brain. The human ability to observe, clarify and respond is controlled by nervous system. The nervous system is quite magical one which works through electric impulses from human brain.

The following are the steps of working of natural brain.

1) Input: The action of obtaining information from the atmosphere through sensory cell [Neuron] is named as Sensory input (i.e.) when the human eye sees something (or) the hands touches something, the sensory cell sends associate information to the brain.

2) Interpretation/Integration: Understanding the acquired input with the help of brain is called Interpretation. During this process, billions of neurons work along to recognize the environment.

3) Output: As soon as the things get interpreted, the brain sends message to effector cells, muscle or glands via neurons which respond to the environment.

4) Processing: The decision making [processing] is completed by arithmetic and logical calculations in neural circuitry. The beyond experience stored and present inputs acquired are used to make decision.

5) Memory: With the help of certain neurons in the brain, we can remember things.

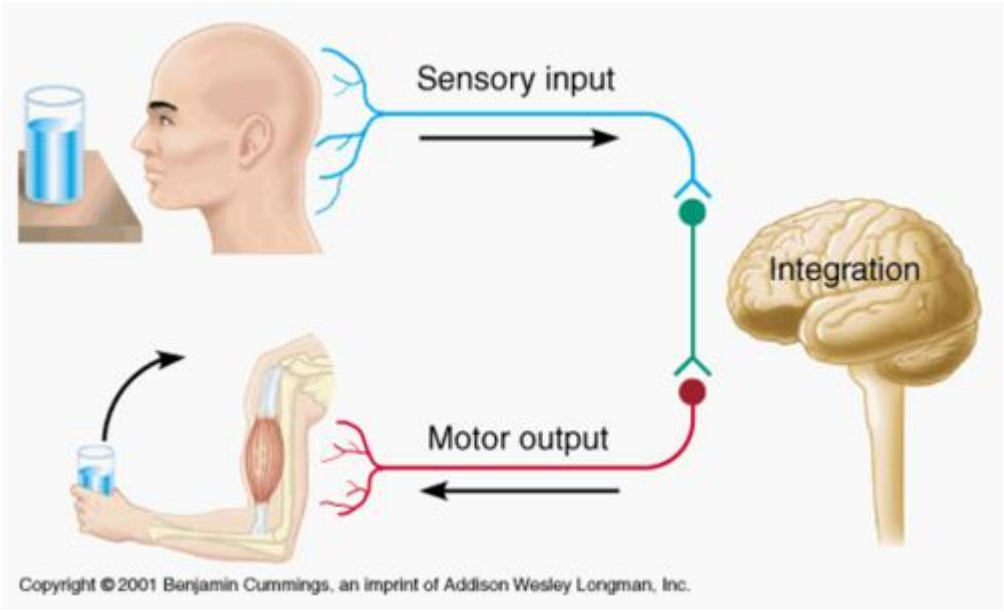

Fig-2:working of human brain

3.2. Functions of Simulated Brain:

The following are the steps of working of simulated brain

1) Input: The scientists have created artificial neurons with silicon chips within the similar manner as of actual neurons. These artificial neurons will receive input from secondary cells and also the electrical impulses from secondary cells are sent to supercomputers via artificial neurons for interpretation.

2) Interpretation: The electric impulses that are obtained from synthetic neurons are interpreted by the way of set of register. The various values in the register represent different states of the brain.

3) Output: After being interpreted, the output signals are given to sensory cells present within the artificial neuron.

4) Memory: It is possible to store the records permanently with the help of secondary memory [Hardware]. By this way, the sets of register will be stored permanently and the information in it could be retrieved and used when it is needed.

5) Processing: The processing is done by computer by some stored information and by the inputs received. Artificial brain will perform some arithmetic and logical calculations as performed by our human brain using the concept of artificial intelligence.

3.3 Comparison between Natural Brain and Simulated Brain

Parameters	Natural Brain	Simulated Brain
INPUT	Through Sensory cell/Neurons.	Through Silicon chip of artificial neuron.
INTERPRETATION	By states of neurons.	By means of set of bits in register.
PROCESSING	Arithmetic and logical calculation in neural circuitry.	Arithmetic and logical calculation using the concept of artificial intelligence.
OUTPUT	Through Sensory cell/Neurons.	Through Silicon chip of artificial neuron
MEMORY	Permanent state of neuron	Secondary memory [hardware].

Table-2:Natural brain v/s simulated brain

CHAPTER 4

NEURON & WORKING OF BLUE BRAIN

4.1 NEURON

The package which includes initial software for neural simulation is NEURON. this was designed by Michael Hines and John Moore in 1990 which is written in C, C++, and Fortran. current version is 7.2, it is open source software and of no cost. The collaboration to port the package to the extremely parallel Blue Gene Supercomputer. the ultimate goal is to be able to recognize and replicate human perception. Pairing the brain simulations to living avatars in a virtual environment and finally to robots interacting with the real world.

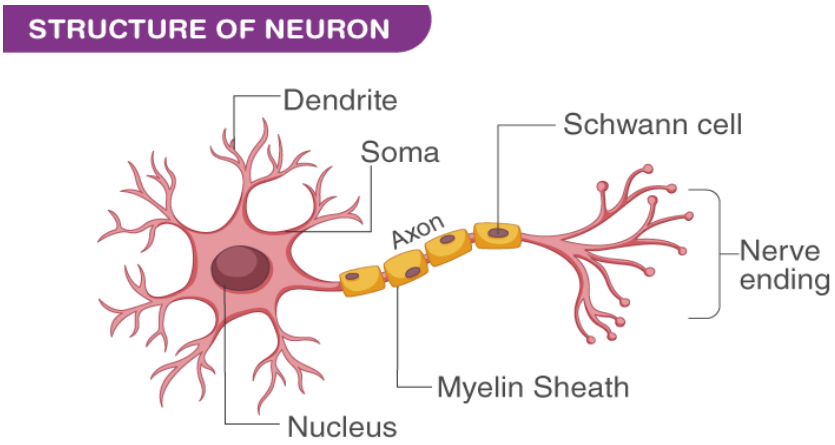

Fig-3:Biological neuron

4.2 WORKFLOW OF NEURON

The simulation method involves creating virtual cells with the help of algorithms that were established to define real neurons. The algorithms and parameters are accustomed for the species, age and illness stage of the animal being simulated. There are around a billion of proteins in one cell, every individual protein is examined. initially a skeleton is formed from all different kinds of produced neurons, according to the rules the cells are connected together that have been found experimentally. Finally the neurons are functionalized and simulation gets to life. The emergent behaviour patterns are viewed with visualization software. the cortical column is the basic unit of cerebral cortex. The mapping is done by each column to single function. Example, the rat cortical column has about 10,000 neurons and size is about pinhead. the latest simulations has enclosed about 100 columns,1 million neurons and 1 billion synapses. A rat has in total 100,000 columns one column is dedicated to each whisker .humans have nearly 2 million, for multi scale simulation the techniques are being developed. Whereby active parts of the brain are simulated in great detail while quiescent parts are not so detailed. These observations are produced by the simulations

that are seen in existing neurons. The strategy is to form a widespread simulation tool, that provides easy methods to build circuits. the brain simulations are paired of virtual system as well as real world. The vital aspect is to create and understand human consciousness.

4.3 STEPS TO BUILD THE BLUE BRAIN

It includes three steps.They are

1. Data collection
2. Data simulation
3. visualization

4.3.1 DATA COLLECTION

During this process small brain tissue is collected, the shape and electrical behaviour of the individual neuron is fetched with the help of microscope or patch clamping method. on the basis of their form, electrical and physiological behaviour the neurons are collected which are present within the cerebral cortex. these interpretations are translated into algorithms illustrating the neuron's process, purpose and their positioning methods. this compilation of data will provide information to the researchers to create a 3D replica of neuron to study it completely

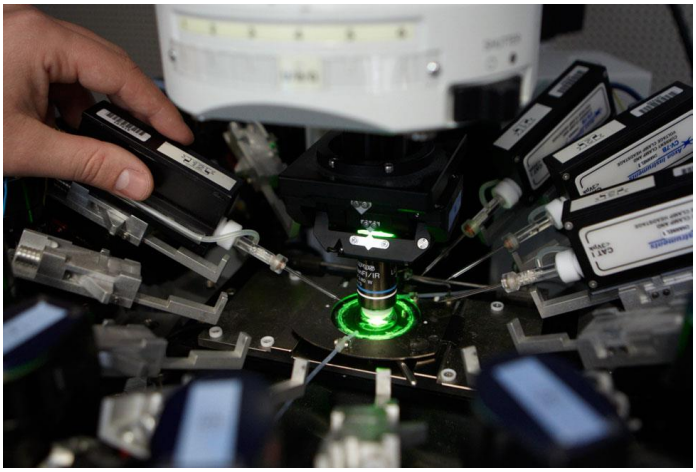

Fig-4:patch clamp

The above figure shows the patch clamp technique worn to gather the data of the neurons from a particular cell. This method is also used to collect information such as no of neurons, no of synapses and connection between neurons and the synapses. This is used to study neuron and synapses to create a 3Dmodel of neuron.

4.3.2 DATA SIMULATION

The main aim of data simulation is to create virtual cell using various algorithms that will describe and define the real neurons. the human is been simulated depending upon the age, species, disease stage on the basis of which the algorithms are adapted.

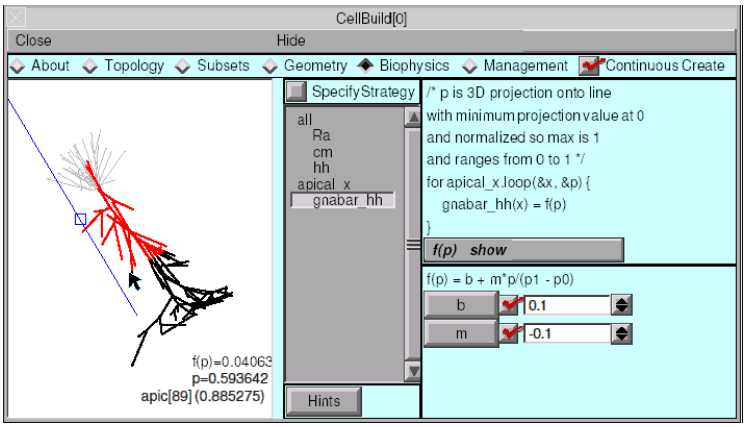

Fig-5: Neuron Cell Builder

"Blue brain project-software development kit" is a set of API, a C++ library wrapped up in python and java. This allows researchers to check virtual cell sample, use and simulate. "NEURON" is the primary software used for the neural simulations.

4.3.3 VISUALIZATION

In this section a 3D model of neurons is fashioned such that this can be used by the researchers to cram the structure and operation of neuron. the software used here is "RT NEURON", which is helpful to learn the operation of neurons and synapses.

RT Neuron

RTNeuron is the crucial application used by the blue brain project for visualization of neural simulations. it is written in C++ and openGL. it is an ad-hoc software which is not common to other types of simulations. The output from Hodgkin-Huxley simulations in neuron is fetched by RTNeuron and deliver them in 3D.by this the researchers are allowed to watch the activation potential propagation through a neuron and among neurons. This also lets the researchers to interact with the model by altering the animations in terms of stopping starting and zooming. the visualization can render individual neurons or even a complete cortical column

Fig-6:RT Neuron

4.4 HOW TO UPLOAD IN HUMAN BRAIN

The uploading is possible by use of small robots known as the Nanobots. These robots are the small enough to travel throughout our circulatory system. Travelling into the spine and brain, they will be able to activity and structure of our central nervous system. They will be able to provide and interface with computers that are as close as our mind can be while we still reside in our biological from. Nanobots can also carefully scan the structure of our brain and providing a complete readout of the connections. The information, when entered- into a computer, could then continue to function as us. Thus, the data can stored in the entire brain that will be uploaded into the computer Merits and demerits with the blue brain project the things can be remembered without any effort and decisions can be made without the presence of the person. Even after the death of the 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 to easily. It would allow the deaf to hear via direct nerve stimulation, an also be helpful for many phycological diseases. Due to the blue brain system, the 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.

Nanobots

Nanobots are small robots that are capable of travelling through our circulatory system into our spine and brain. They monitor the activity of the Central nervous system. They will be able to provide an interface with computers .Nanobots will scan the structure of the brain, providing a complete readout of the connections between each neuron and it would also record the current state of the brain. This information after entering into the computer could be able to function like our brain. A computer with large storage space and processing power is required.

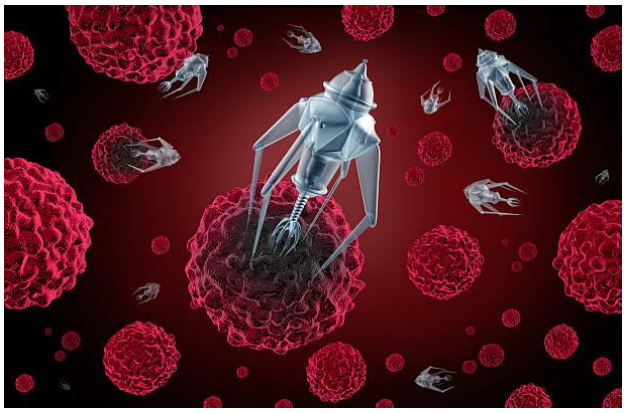

Fig-7:Nanobots

CHAPTER 5

COMPUTER HARDWARE & REQUIREMENTS

5.1 COMPUTER HARDWARE

5.1.1 BLUE GENE

Blue gene is the primary hardware used in the Blue Brain Project built by IBM. On June 2005 IBM agreed to supply the blue gene super computer to EPFL. It is installed in EPFL at Lausanne and managed by CADMOS (Centre for Advanced Modeling Science).

This super computer is used by number of research group for computing and brain simulation. The brain simulation is done one day per week and the rest of the day the data is gathered and cells are studied so that new things could be found out that would help in their research and also in analyzing all the data gathered.

fig-8:Blue Gene

5.1.2 SILICON GRAPHICS

Silicon Graphics Inc. (SGI) 32 bit-processor with 300 Gb of shared memory is used in visualization of results. It helps in studying the working of the neurons. It is also used in storing the state so that it could be used to remember things. It acts as an artificial neuron in the blue brain technology.

5.1.3 BRAIN CHIP

Mathew Nagle designed a brain chip that provided the balance among safety, durability and functionality. The chip was small enough that it doesn't hinder the normal brain function. Using integrated CMOS circuitry [an array of recording electrodes]; Nagle's chip recorded the brain signals. He improved the reliability of the recorded data using multiple electrodes.

5.2 HARDWARE AND SOFTWARE REQUIRMENT

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

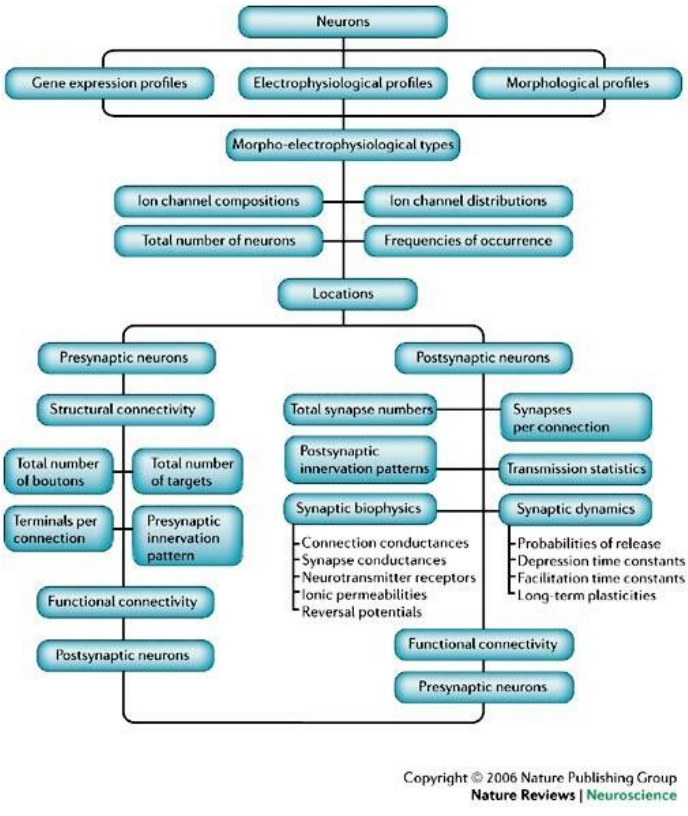

Fig-9: Elementary neural microcircuit

CHAPTER 6

CHALLENGES,MERITS & DEMERITS

6.1 CHALLENGES

- **Neural complexity**

  The probability and frequency of neural notice are affected by the complex dendritic computations. These computations involve linear, sub linear and superliner trimmings besides production of dendritic spikes and inhibitory computations that jolt internal cell voltage to inactive potentials or reduce the potential, in actual fact subtracting voltage.

- **Scale**

  The largest supercomputer of today has thousands of processors, whereas cortex of human has tem billions of neurons and a quadrillion synapses. We are not even close to scale of cortex, it is unclear To state whether one computer processor could emulate thousands of neurons and that would be accurate enough.

- **Interconnectivity**

  The axon rising from each neuronal cell body estimates to an average 10,000 destinations, each synapse gives a discrete input to a neuron and each postsynaptic neuron shares average of 10,000 synapses and other presynaptic neurons. Hence each neuron has about 10,000 input and 10,000 output. Emulation of the cortex with hardware gives wiring problem. it wouldn't be complicated if connections were local.

- **Plasticity**

  The excitatory or inhibitory connection strength should change with learning and neurons must be capable to create new synapses resulting new connections along learning process. Do research is going on the mechanism by means of which neurons learn, make, rupture connections and possess memory, through hypotheses and biased data appearing repeatedly. This lead to a fundamental understanding of synaptic and structural plasticity.

- **Power consumption**

  The power consumed by the evaluation of brain simulation with 50 billion neurons and 500 trillion connections hence heat dissipation takes place. The human brain uses power around 25 watts and

there is no such computing system near this power, even though nanotechnology and ultrapower technology design offer guarantee.

6.2 ADVANTAGES

- We can use a person's intelligent even after his death.
- It can help in the study of the animal's thoughts by interpretation of the electrical impulses from the brain of the animals.
- This project can help a deaf to get information directly via nerve stimulation.
- The information of the brain can be used to provide a solution to mental disorder.
- The blue brain is a project which can help in utilizing the human intelligence present in the mind.
- This machine will be able to think and make self decision.
- We are trying to make an intelligent machine.
- This can be used as an interface between animal minds and human.

6.3 DISADVANTAGES

- This will increase the dependency on the computer.
- Computer virus can be a critical threat.
- This may lead to human cloning.
- The human can depend on blue brain every time.
- If a particular person's neural system is hacked then it can create a big problem.
- The machine can conduct war against humans as we are making machines intelligent.

CHAPTER 7

APPLICATIONS

- **testing and accumulating years of data**

  The working model can help to store over years of information about microstructure and mechanism of the neocortical column that can be worn to gather and examine. The model can also provide 3D micro-architecture of neocortex and access information pertaining to its composition and purpose.

- **Encoding neural code.**

  The neural code is nothing but the object that is built by the human body using electrical impulses. The neuron is the basic cell of brain; similarly the neocortical column is the base reason of computing the neocortex. Having a perfect duplicate of NCC eventually creates electrical dynamics of real microcircuit which instructs how the processing, storing and retrieving of information of neocortex is done.

- **Neocortical information processing**

  The accurate simulation depends on the predictions that can be generated of the neocortex. The accurate copy also depends on the iterations between simulations and experiments. These iterations reveals the functioning of each fundamentals, pathways and physiological processes.

- **A fresh implement for drug discovery for brain disorders**

  A tangible establishment to discover the cellular and synaptic bases of a wide variety of neurological and psychiatric diseases depends upon understanding the flow of different elements and pathways of the neocortical column.

- **A overall ability**

  The parameters that are used and measured in the experiments are determined by the simulation. Immersive 3D visualization system will permit “imaging” of neural dynamics through processing, retrieval and storage of information. These experiments are impossible in idealism or expensive to carry out.

- **Reinforcement for whole brain simulations**

  A mammalian brain can be simulated with full cellular and synaptic complexity with recent and advanced technology. In order to generate compact models that preserve critical functions and computational capabilities an accurate replica of neocortical column is required. This can be duplicated and interconnected to form regions of neocortical brain.

- **A base for molecular modelling of brain function**

  The neocortical column will supply the first and crucial step to a steady increase in model complexity with a precise copy of the column moving towards a molecular level depiction with biochemical pathways being simulated. The NCC at a molecular level offers the substrate for interfacing gene .This connection will allow predictions of consequences of genetic disorders and reverse engineering of cognitive deficits to conclude the genetic and molecular causes.

Fig-10:blue brain 5

CHAPTER 8

CONCLUSION & FUTURE SCOPE

8.1 Conclusion:

The Blue Brain Project is that we will able to transfer ourselves into computer. The human brain and reform it at molecular level inside a computer simulation. They are simply require future time of technology to increases. The combination of biological and digital technologies would provide an impetus for the overall growth and development. However, it would be more feasible if this technology is exclusively developed for the treatment of chronic and cognitive neurological disorders as it would truly prove to be magic in that field of medicine. And other positive outcomes of the BBP can also be seen as also solve a lot of societal issues. The Blue Brain project would work wonders or precisely for the human society in the near future.

8.2 Future Enhancement:

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.

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.

CHAPTER 9

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