

Integrated Brain Implant using Nano Memory

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Abstract— The main aim of this paper is to make the human to use their intelligence and the memory which the computer works with. This bio medical document is the live aspects that make the human to target everything with this tiny memory device, connected to the human brain. Internet is ruling the world for many years, like that this brain memory integrated technology will have the same effect among every people. The vast world is really our memory, we circle every minute of our thinking around it. This device makes it possible to recollect the memories simply as the same way you felt during that moment. This device makes a revolution in the thinking of a human. It is a mini-device, compatible to the size as similar to the phase maker and it has some extra features as follows: (1) placed inside of human body, (2) connected to our Neurons and works with the help of battery, and (3) consist of Nano memory (CNT) having vast storage. So now we can see the intelligence of this great device. This memory is processed through voice and optical support signal that travel through nervous system of neurons. Every nerve in our body produces electrical pulse that carries information and these information are processed as fast as the device can. Hence this device is called intellectual chip. Using this device, humans will be free of memorizing things because this device stores everything they have been encountered in the Nano memory.

Keywords: Nano memory, electrical pulse, CNT.

I. INTRODUCTION

Brain is the most complex system in our body. Brain makes a man to be an intellectual individual. Many researches are undergoing to create an artificial brain to make use of a robot, which functions with the intelligence of a human, but this paper lets the human to make use of their intelligence and the memory which the robot works with. Thus instead of using the intelligence of human brain to the robot, the memory that is being used by robot is made to be used by the human. The usage of brain varies with every individuals. This brain memory is a confined storage device, where humans can withstand their memories for a longer period. Sometimes they can be even accurate about the year, date and time at which the incident has happened. These things can also be remembered by the proposed device and can process these memories in a fraction of seconds like functions of our normal brain. This device will eliminate the mug up process and the functionality of the device makes tremendous change in human future. The neural network becomes stronger by experiencing same kind of things which have been already encountered. Thus the strengthening of neurons help us in securing our memory. Humans spend more time for memorizing things and they follow several methods to remember. Even certain wearable equipment's are present for

increasing concentration. The proposed device will provide a solution to all. The proposed device will store things which are studied by humans. Not only studying, he can store the things which are seen by him and heard by him. The device is placed beneath the surface of the brain. It is placed in the grey matter. It collects the electrical signal from the neural network and stores them in the processor through machine learning algorithms. Nano memory is used in this system. Thus the device can be placed in the brain for a long period without replacement. During retrieval, the signal is passed from the processor to the brain.

II. DEVICE THEORY ON BRAIN

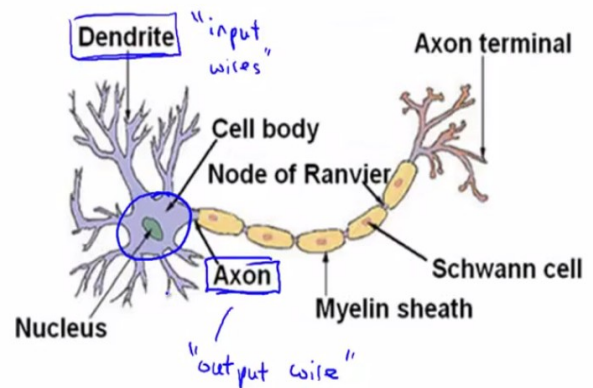


Fig 1: A single neuron in the brain

Neurons are the cells that pass chemical and electrical signals along the pathways of the brain. Normally a neuron has three major parts—cell body, dendrite, and axon. Dendrites receive input from other neurons and do some calculation and give output via axon. After this, the axon transmits the output to the neighboring neurons through other neuron's dendrites. Normally the neurons communicate to each other with little pulses of electricity's which are commonly called spikes.

Our senses and muscles work in this way. If you want to do some action, the way it works is that a neuron sends these pulses of electricity's to your muscle and makes it to contract and if your eye wants to transmit a message to your brain, what it does is it sends its pulses of electricity to a neuron in your brain. Size and Shape differ from every neuron. Controlling muscle movements and storing memories are functions of neurons. These functions are carried out by the connections and shapes of neurons.

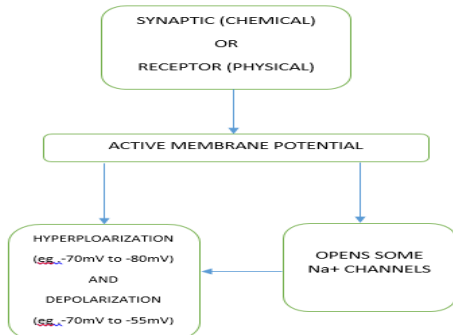


Fig 2: Chemical energy to spike formation

In Fig.2, the chemical energy to spike formation process (chemical energy to electrical energy) is displayed. This is an example of Hodgkin-Huxley cycle. The resting potential of neuron is -70mV . The human brain has both sodium ions and potassium ions. This attains three stages of process such as Hyperpolarization, depolarization and threshold of excitation are as follows. When the negative charge inside the axon increases hyperpolarization occurs (e.g. -70mV to -80mV). This hyperpolarization is due to the Na and K ions in the brain. Depolarization occurs when the negative charge inside the axon decreases (e.g. -70mV becomes $+50\text{mV}$). The threshold of excitation is the level that a depolarization must reach for an action potential to occur. When the action potential (potential greater than threshold of excitation) reaches high considerable amount of voltage difference is obtained. Signals cause ionic fluctuations in the neuron's plasma membrane which creates an electrical current flow in the neuron. This is sensed by the electrode at the synapse region and the signals are sent to the system.

III. ELECTRODE AND NANO MEMORY USED IN THE SYSTEM

The hat pin electrode is an electrophysiological device that is used to record signals from multiple neurons with array of micro electrodes. This device can easily capture signals from the neural structure. It is designed to be chronically implanted to isolate the neural unit and local field potentials that are recorded over a several minutes or times.

The memory used here is Nano RAM (NRAM). It is a non-volatile RAM which is based on the position of the carbon Nano tubes (CNTs) deposited like a substrate to that of a chip. A three terminal NRAM semiconductor device is used in the first generation. Some extra features has been added to it in the second generation. The cell size is small and a better scalability to sub-20 nm nodes. During fabrication the memory cell is protected which is the main feature it. Each NRAM cell consists of interlinked network of CNTs (carbon Nano tubes) located between two electrodes. Photo-lithography process is used for CNT fabrication. NRAM serves as a resistive non-volatile memory.

A. CNT contact

The NRAM is placed in two or more resistive modes depending upon the resistive state of CNT fabric. When there

is no contact between the CNTs due to the stiffness of the CNTs, the resistance state of the fabric goes high, represented as OFF or 0, resulting in low current measurement state between the top and bottom electrodes. when the CNTs are in contact due to Van der Waals force between the CNTs, the resistance state of the fabric goes low which is represented as ON or 1, resulting in a high current measurement state between the top and bottom electrodes. Since the two resistive states are stable NRAM acts as a memory.

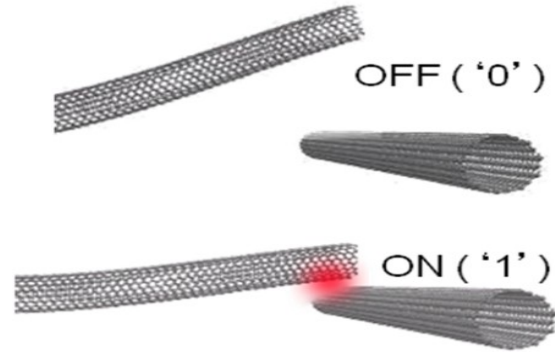


Fig 3: Carbon nanotube (CNT) logic conditions

A small voltage greater than the read voltage is applied between top and bottom electrodes when switching NRAM between the states. The voltage applied will cause an electrostatic attraction between the CNTs together resulting a SET operation, when the NRAM is in the state 0. When the NRAM is in the state 1, the applied voltage which is greater than read voltage will generate CNT photons excitations which tends to separate the CNT junctions which resulting a RESET operation. The activation energy for the physical attraction is 5eV in state 1 and the activation energy for the separation of CNTs due to stiffness of CNTs is greater than 5eV in state 0. Due to the high activation energy ($>5\text{eV}$) required for switching between the states, the NRAM switch can able to resist the outside interference like radiation and operating temperature which can erase or flip conventional memories like DRAM.

B. NRAM FABRICATION

By depositing a uniform layer of CNTs onto a prefabricated array of drivers is used for the fabrication of NRAM. The bottom electrode of the NRAM cell is in contact with underlying via which is used to connect the cell to the driver. The photo-lithography is used to fabricate the bottom electrode. Before the cell is photo lithographically etched the top electrode is deposited as a metal film onto the CNT layer so that the top electrode will get etched. A single cell can be selected by applying the proper voltages to the word line (WL), bit line (BL), and select lines (SL) without disturbing the other cells in the array.

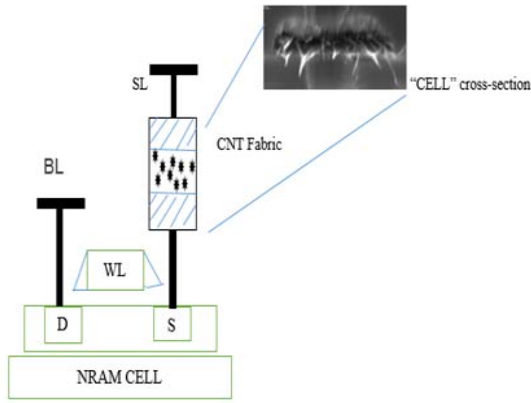


Fig 4: Nano memory structure

IV. DEVICE DESCRIPTION

First, this a small device that has Nano memory ,a mini battery (lithium battery),processor and finally a transmitter to transmitted data from our memory to the desired place . As this is implantable, it does not corrode when reacting with blood and it can be placed outside the body like pacemaker, and other added feature is that it is liquid proof. Neurons are cells specialized for the integration and propagation of electrical events. The visual size of this device is of approximately 49mm x 46mm x 6mm/47mm x 41mm x 7mm/45mm x 52mm x 7mm based on the IBM neuro synaptic system. This dimensions vary from one model to other so that the memory can also be increased according to the needs

V. WORKING PRINCIPLES

Brain takes input in the form of images, audio, sensing etc. The complex portion of the system is how to recognize the incoming signals. The incoming signals are not known by the processor initially. Hence in this system, machine learning algorithms such as Supervised and Unsupervised algorithms are used. For supervised learning algorithms, algorithms are trained by examples. Each example contains both training set

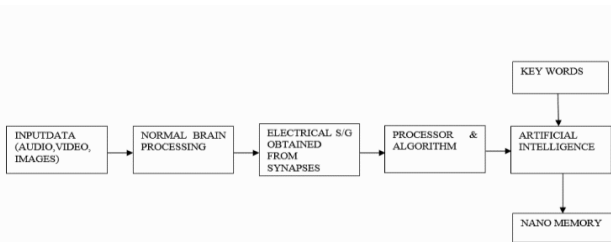


Fig 5: Data transfer from human memory to Nano memory

data and their desired output value. Hence algorithm learns from the examples and then predicts the output for the unknown examples. Unsupervised learning algorithm is used to draw conclusions from datasets (examples) consisting of

input data without labelled responses. It tries to find the hidden structure in an unlabeled data or from various group of similar datasets. The incoming electrical pulses are formed as separate groups called clusters. Clusters are formed for same kind of signals (i.e.) under each cluster same kind of signals are allocated. If a person is studying, some signals are generated and while he tries to retrieve those information that he studied, different kind of signals are generated. The signals generated while studying forms clusters and the signals generated while retrieving forms another cluster. For taking those signals, the device is placed on the skull and the signals are analysed. Even though the signals having less power and frequency, it can be amplified afterwards. Thus by experiencing a person to learn and retrieve, the input signals are analysed and stored. These signals are used as reference for a person whether he is studying or retrieving (thinking). In this device, initially unsupervised algorithm is used to separate the electrical signals resulting from the electrode and hence grouping of signals is done between the signals generated while studying and the signals generated while retrieving it. The resultant output cluster data is given to supervised algorithm. Supervised algorithm learns about the signals generated while studying and the signals generated while retrieving based on the information given by the unsupervised algorithm. After taking decision as studying, the unsupervised algorithm again plays a major role. While studying, the signals generated at the synapse portion are obtained by the device and amplifies it and then stores it as clusters. Thus while retrieving, those clusters are again feed to the particular region.

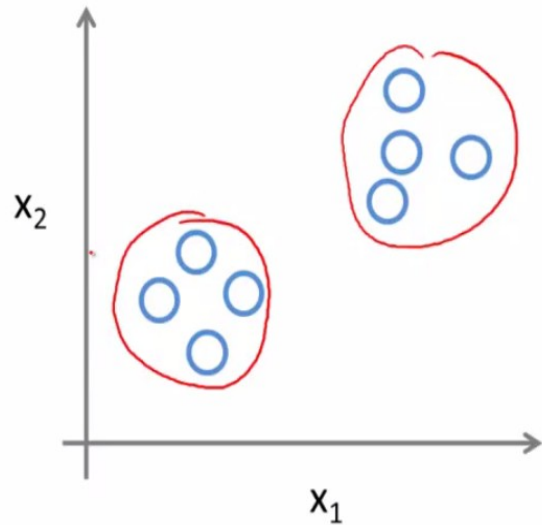


Fig 6: Unsupervised learning cluster formation

After training these algorithms programming certain conditions are made as follows. If unsupervised algorithm detects the input as studying signal

Human memory content is stored in Nano memory else If it detects the input as retrieving signal Nano memory passes information to human memory

After studying, if we think about the information that we had read, the supervisor algorithm takes the information signal from the Nano memory and pass it to the brain and brain respond to the signal. In programming part, while retrieving based on keywords whole content is provided from Nano memory to brain. Consider you are studying a book about cricket, then each information you gather will be send as a signal with a key provided. So if you try to remember the thing you read after a long time and you remember only a line in 10 lines. Here the keyword plays a major role and it helps to retrieve the related information quickly which makes time consumption lesser. Supervised algorithm makes use of these signals as inputs.

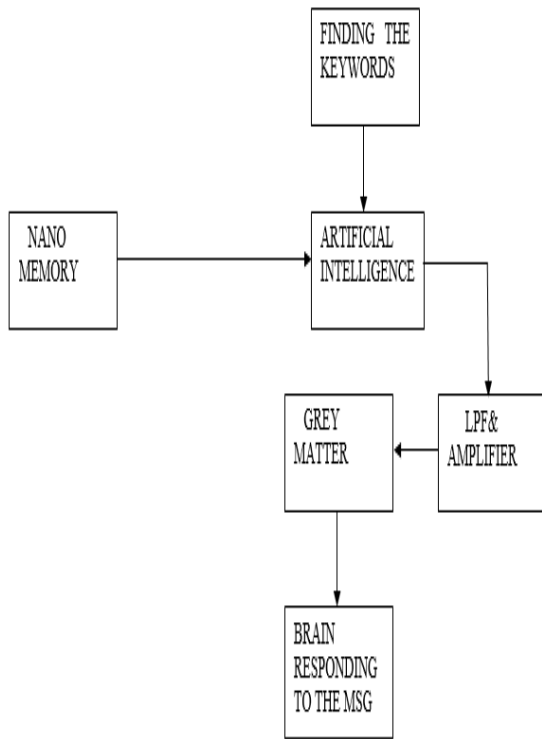


Fig 7: Data retrieval from Nano memory to human brain

VII. SOME COMMON AWARENESS

This device is not recommended for the children below 18 years. This is for their security. This cannot be disposed easily and the internal crystal is used to recharge the battery. And this device is connected to the brain in such a way that it cannot affect other organs.

VI. COMPARISON BETWEEN NATURAL MEMORY AND IMPLANTED MEMORY

| Naturalmemory | Implantedmemory |
|--|--|
| In natural memory some neurons are used to represent the states permanently .when the information is required these states are represented by the brain so we can remember the past things that are stored in brain. | In implanted memory (NRAM), we can store the information by secondary memory. Here the stored information can be received and used by the states of the registers permanently. |
| While processing the memory , the decision making ,thinking ideas , computing solutions can be done by neural circuitry and the input which is given to memory is stored and then processed and the output representation are done by the neuron states. | While processing the memory , the stored states of the registers are used to process the input to give the certain output and all other processes like decision making ,computing etc. |
| The processing speed of the memory is varied with persons. And Information stored is depending upon the person's memory capacity and IQ. | Here the processing speed and storage capacity is same to all persons. |

VIII. APPLICATIONS

- Can be used to save our memories.
- Used for Amnesia patients.
- Implanted for scientists

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