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A Novel Hybrid Brain Mapping Technique with Computational Enhancements

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***Abstract*: A novel scheme that analyses and helps with mapping of the human brain in an accurate way is proposed. In contrast to the conventional techniques, we proceed to quantify the collection, classification, sorting of data in a well-ordered manner. The method jointly utilizes computer science and neuroscience, consequently outperforming the initial observations. We aim to review the state-of-art technologies and investigate the performance of the human brain in its own limelight. Integrating machine learning in mapping of the brain helps in advancement of AI by which discrete tasks can be fed as codes to the machine. Results of computer simulations to verify the superiority of the proposed techniques are also presented in due sense. The proposed scheme has features that are designed to solve the weaknesses of the earlier model and also plays a crucial role in predicting the brain disorders and diseases early on. The ultimate goal is to revamp the way we approach brain sickness and maladies so that timely action can be taken in strict sense.**

***Keywords*: Mapping of brain, Machine learning(ML), Artificial Intelligence(AI), brain sickness and disorders, quantify data.**

1. Introduction

The foundation of all living organisms, the most essential organ of the human body, which is delicate and imperative in the tiniest of manners is the wonderful human brain. The entirety of it is composed of several thousand neurons which perform the crucial aspects that we rely on in our day to day life. They also bring about necessary actions such as transmitting and emitting electrochemical signals throughout the body for various purposes. The brain is a store house of data in the form of charges. Scientists have been studying the human brain to understand the working principle of this complex organ so that brain disorders can be treated in their primitive stages. Another advantage of studying the human brain is that we can use the data collected for better AI integration to hardware. This is essential and crucial to advance the understanding of the anatomical and functional organization of the human brain, which has become a necessity in this modern era.

There are many techniques and devices to study the human brain. Each of these methods uses a characteristic of the brain to further investigate and map the brain. The fundamental principle is, integrating 2 or more of the techniques in a precise and error-free manner using computational powers to obtain a new set of data which is easier and accurate thereby, being universal to use. From what we studied; the present-day techniques are facing 4 major issues in brain mapping [1].

2. Problems

- Brain mapping spans over 2 vast areas of sciences– Neurosciences, Cognitive and behavioral sciences. Both are to be studied using different techniques. Even though the equipment is best-in-class, there are still some problems which can be solved by improving the techniques of using the machine. Solving these problems might take us one step ahead in reaching the optimal brain mapping.
- Massive diversity in methodology- Contrasting various regions of the brain in aggregate, turns out to be quite the costly operation in terms of time and space. The approaches that are being followed rigorously today, are trivial in the sense that the resolution obtained is infinitesimally small, hence not being of practical use at all. The graphic related simulation procured assimilate plenty of neurons into a single voxel which is our prime drawback. Since, the functionality is brain-centric, this estimate is unreliable, fallacious in nature and is of no use to the general public. They also determine how the various tasks are congregated and divided which derives a completely wrong estimate of how the human brain operates and works.
- Massive amount of data collected (quantity, quality and form) – The data obtained is humongous and can be measured in several terabytes which is physically almost impossible to store as it is raw and unsorted. In this realm, even if a collection of vital information is acquired, the quantification process becomes extremely difficult as this size is impossible to appraise or determine clearly. Approximately, this is several times larger than a typical placental code. Planners and strategists of the human brain are unable to find the critical point of end, combatting several issues of inexhaustible details in all shapes, sizes and forms which becomes intangible to portion out, assemble and shed light on.
- Multiple scales of abstraction- Levels of abstraction is a key architectural approach in computer science. This approach to hierarchical systems is not sufficiently utilized in other fields. Here, the abundance of significant techniques and strategies are kept away from the end users, saving a multitude of time and parallelly increasing efficiency of the

media. A common difference of opinion is posed in this field as to whether the operation of brain is one dimensional, hierarchical or hybrid and the answer is dependent on the same factors as mentioned.

3. Proposed methodology

A stereotypical perspective to this dilemma of filtering out the aspects through neural mannerisms, is to deploy safe and sophistical instruments in all such platforms which can detect the electrochemical impulses in and around the brain. The portrayal methods of the human brain are changing day by day and are pivoted around the blooming, expanding and honing of the image accession, visualization scrutiny, explicit elucidation and predominantly on the phases of neuro-imaging such as the utilitarian, systemic and constructional aspects of the same.

Nearly about twenty percentage of the total energy acquired by the body is consumed by the brain. Out of this if two third of the energy is used to fire impulses, the remaining is however used for what researchers call as "housekeeping". This feature of the brain keeps the neurons charged and healthy. The final cessation was derived when the images came into possession using the amplified technique of resonance combined with magnetism in terms of the branch of science involved that is spectroscopy. This system yielded colorful results as the uncovering of devastating defects and damages could be detected early on, thereby giving a significant boost to the much-needed health sector. The diagnosis was also delivered much earlier than usual.

The major ways of mapping are MRI, fMRI, PET, Magnetoencephalography [3] etc. All of these techniques are an overall mapping of the brain, where the scanners consider the brain as one big lobe of neurons. This creates a problem, as the brain behaves different in different environment conditions.

For example, in a typical MRI scan, we use a strong electromagnet to project a magnetic field around the brain. The hydrogen atom (acting as a proton) which is present in the water layers around the brain gets excited and are received by the receiver on the other end. On the other hand, the fMRI scan doesn't make use of the hydrogen atoms, as the position of the atoms vary from time to time. It scans the amount of blood flow into the brain to find out the active parts of the brain.

Magnetoencephalography on the other hand makes use of the static neuron charges by using highly sensitive instruments to pick up the field emitted by those charges. This technique is used to detect the neurons that aren't used for communication but for storing charges which, furthermore, might conclude that memory is stored in these regions. What we propose is, instead of collecting one single set of data from the brain, for different parts of the brain, we conduct scanning's using optimal scanners for that specific part. By doing this, we get a more precise map of the brain. This can be understood by an example.

The cerebrum is the biggest part, and is associated with reasoning, planning, visual perception, stimulus perception and other important functions like orientation, recognition etc. Here, it can be easily concluded that charges are continuously fired throughout. thus, for studying this specific part, the Event-related optical signal scanning method can be used.

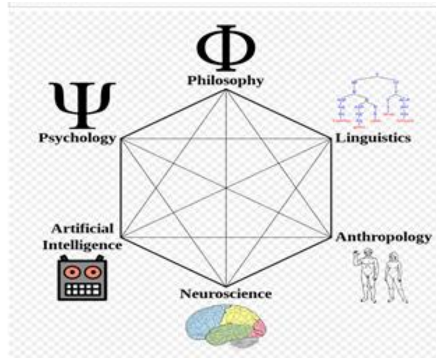

Fig. 1. Architectural map of Human Brain

Another noteworthy tactic would be to use infrared radiation that plays a vital role in the field of mapping and processing, by combing this alongside the secure and speedy optical fibers. This helps us determine and understand the rate of variation of the optical related characteristics in the energetic, agile areas of the erudite cortical areas. The expeditious optical indications determine variance in infrared light dispersion that happen alongside that of neural activity.

The hippocampus is a part of the limbic system which is associated with memory and learning. Thus, it has a bundle of constantly charged neurons which are mostly not participating in pulsating charges. We can use the magnetoencephalography scanning technique here to pick up charges from around the region and analyze the data. Like this, different regions of the brains can be mapped using different scanning techniques. This gives us a proper and a more detailed map of the brain and the data can be generalized and can be used for further research.

Data management: Collection and storage of data is an arduous task as the data collected from each of the tests is in the magnitude of terabytes. These data are stored in sets and each set can scale larger than a complete mammalian genome. Neuroscientists from all over the world now put a concerted effort to integrate and invent exhaustive tools to decipher the neural data.

Why is this happening? It is due to the fact that the human brain is a dense network of constantly firing neurons which when function properly, can make us do complicated tasks. Electrophysiology [5] studies now require more computational space due to the same reason.

Therefore, what neuroscientists can do is,

- Write algorithms to assign the information in smaller bits for efficient storage. This method enables the testing devices to compress the data collected.
- Create different maps of the brain using the data collected from each test and merge them to get a seamless, integrated, 3D map of the brain. Each point in the 3D system must be scaled down to cellular level,

so that by clicking on one point, the user gets to analyse the data from different perspectives

- Categorizing data on these parameters namely – Structure of the cell, gene expression, point of location in the 3D map of the brain and electrochemical impulses.
- Data has to be logically bent into classes of cells using optimization algorithms.
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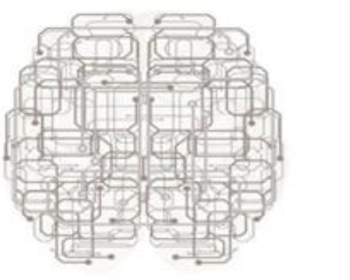

Fig. 2. Brain computation as hierarchical abstraction

Chemicals as an inherent part of solution: The other way of studying the brain is to monitor the amount of chemicals and hormones released by the brain. The brain releases many chemicals and a handful of hormones. By subjecting the brain to different stress environments and later analyzing the blood samples of the body, we can learn what parts of the brains are active at different stress levels. This data collected has the missing piece of puzzle in knowing why behavior of humans is different as compared to other animals. Abstraction, a phenomenon: All the data we collect about the brain is by considering the brain as a whole organ. This gives rise to a problem of resolution since the brain has a dense network of data. Present-day maps have a resolution which includes billions of neurons in a single voxel.

Each test is designed to test only one parameter of the brain. Relying on one test to study more than one phenomenon is unverifiable. By studying the brain as one whole organ, we wrongly assume the functioning of the brain. To rectify these errors, each unit of the brain needs to be studied separately using sophisticated instruments meant to be used only for those particular units of the brain. Breaking up of data and integration of small units of data in large numbers is more feasible and efficient than taking bulk data and breaking it up. If a data is broken into bits by wrong assumptions, it cannot be reproduced. Some of the devices used might have poor calibration. Thus, studying a whole block of brain at once isn't really feasible [6].

Thus, instead of studying the brain as a whole block of neurons, what we can do is to slice the brain into very discrete layers and stitch them digitally using computers.

4. Computational modelling of brain mapping

- How can computation be related to brain? It is the metaphor "brain-as-computer" that inspired us to reproduce human brain processes in the form of artificial intelligence. Thus, cognitive sciences and AI are expected to go hand-in-hand.
- AI is similar to the nervous system of our body. Both have a complex set of data and tricky connections. AI is just a small example of how some of the complex processes and decisions are taken by our brain.
- Computers, for a fact, are rigorously used as equipment to study some cognitive functions.
- Human brain has a lot of computational power. To imitate this on a machine, data is collected and coded with links between each part of the algorithm. This provides an economic machine which has faster response rates in solving problems that previously depended on the human brain to solve.
- Just like the human brain, AI is coded in such a way that every time new data is input to the machine, it learns it and compares it to the stored data. It also tries to perform one operation in multiple approaches, which makes the operation exhaustive.
- In our case, we will stick to the reinforcement learning model where you can then effectively learn every possible scenario occurring in the human brain thereby predicting diseases in the long run.

5. Conclusion

This paper presented an overview on novel hybrid brain mapping technique with computational enhancements

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