Current Research and Future Prospects of Neuromorphic Computing in Artificial Intelligence

R Vishwa¹, R Karthikeyan², R Rohith³ and A Sabaresh⁴

¹,²,³,⁴Student, Department of Mechanical Engineering, SNS College of Technology, Coimbatore, Tamil Nadu
²Assistant Professor, Department of Mechanical Engineering, SNS College of Technology, Coimbatore, Tamil Nadu

E-mail: vishwaraj9566@gmail.com¹, karthikeyanr909@gmail.com², harirohithsr@gmail.com³, ashwinsabaresh@gmail.com⁴,

Abstract. Neuromorphic computing is a budding avenue though it has been known since the 80’s. The extensive research and development in the field of artificial intelligence particularly in the last decade is tremendous. The growth of artificial intelligence is expected to grow exponential in the years to come. Technologies like machine learning and IoT has made possible for many fields from industrial automation to business model prediction very affordable and far less complex. With growing digital devices, the number of devices connected to the cloud and in a network is doubling and in some cases are tripling in some ventures. Technologies like drones, autonomous cars, smart healthcare, smart cities and many other are moving towards more and more data and connected devices to the cloud. The present hardware system is at the verge of giving away as the data generation rate and processing volumes of the same is becoming a challenge. The hardware of today, though are advance are simply not adequate to support the expansion rate of growth of artificial intelligence in all fields. Increased devices result in increase data, increased processing raising challenges for current storage devices and processing devices. Neuromorphic chips, which promise to overcome this challenge, are currently being researched extensively by many computer giants who fear the future incompetency of hardware of which IBM is a major player. Ground breaking research in the field of memristor and artificial synapse have paved the way for neuromorphic chips which are expected to revolutionized the field for the better. This paper deals with the current research, physical and technical limitations and future scope of neuromorphic chips. The significance of memristor and artificial synapse towards neuromorphic computing is also dealt in detail.

1. Introduction
Artificial intelligence is known a the machine intelligence that is artificial intelligence build by humans as the substitute for the use of human brains that can do every work that humans do and work which cannot be done b the humans and implemented as an artifact. It is used in natural language generation which is used in the airport to help the other languaged peoples. It is used in speech recognition alexa or google AI.
Machine learning provides algorithms, computer program interface development and each coaching tool kits that can help to do work very easily. It gives the computer with extra power with processing in CPU’s and GPU’s [1].

Deep learning platforms that is artificial neural network that works like a human brain that can process a sort of information in some seconds. Now this is used in AI to recognize face reading that opens your mobile phone or any type of lock used in any electronic devices such as computer, laptop etc.. Biometrics uses unique recognition of humans to unlock the phone or our laptop etc.. In some devices we can store the passwords that can use our fingerprint and can use the passwords and can access your control. Currently used in every phones, laptops and the work place where we take the attendance using biometrics.

1.1 Future of Artificial Intelligence

1.1.1. Transportation. As the growth of artificial intelligence it is slightly entering into automobile or mechanical stream with the huge growth and soon it’ll be the future of autonomous vehicles.

Manufacturing: AI, nowadays it is used in the manufacturing sectors avoiding the labour works. Big automobile companies use AI that can make no mistakes compared to human made errors [2].

1.1.2. Health care: In the field of medical, if we use the AI powered robots that can diagnose the disease correctly, especially for the heart attack patients, the blocked calcium in the blood vessels are drilled by a diamond instrument. The operation is done only by some doctors if we use the AI in this field this operation can be done successfully [2].

1.1.3. Education. Nowadays, textbooks are getting digitalized and we are learning through it mostly. If this AI is used in the field of education it can show the example or take classes. We can learn from anywhere without any pressure that can be seen in the movie Iron man, Robert downey jr use Jarvis that is the AI powered thing that use to make or take classes.

1.1.4. Media. In the field of mass media AI can be used for the wish list and making the thumbnail for example: If a series narcos is ran successfully now you are creating a netflix account and going inside it shows asks the genre it shows the series you should see or it present.

1.1.5. Customer Service. Customer service can be done by AI, that is when you have a question you can send or report it to the customer service. The question can be find and the statement for the question can be answered by the AI. But first you have to report the question that’s enough for the AI to answer the problems.

The artificial intelligence market was valued at USD sixteen.06 billion in 2017 and is anticipated to achieve USD a hundred ninety.61 billion by 2025, at a CAGR of thirty six.62% throughout the forecast amount. the bottom year thought of for the study is 2017, and therefore the forecast amount is between 2018 and 2025.

2. Artificial Intelligence

Amazon uses AI to search a product or to show the best result of the product that is if ou search for a product if the and the cost is high or an other reasons it shows the other deals which is good for value or the product of the other companies. And the other famous company Apple, that is siri used everywhere in the apple phones if you need to call someone named Jack you should say call Jack it makes call to the right person. Banjo, DJI, Facebook, Google, HiSilicon, IBM etc..

There is an excellent increase within the discussion regarding the importance of AI within the recent time resulting in future discussions regarding the existence of AI within the world. the concept creating) AI is geared toward making human life easier. An animal can sense the natural calamities (or) the weather outside. If the tsunami is about to reach the place which we stay it can be
predicted by the animal first. If the use of AI is more in this field it can be predicted before and it will be useful in this field

3. Application and Challenges in Artificial Intelligence

3.1 Application
AI has been dominant in various fields such as –

3.1.1 Gaming. Playing of games is very high now, when we play online we used to play with AIs, the first game we play in Pubg, we will be playing with AIs so that we will be winning the match and it turns on the feeling and it tends to play again and again.

3.1.2 Natural Language Processing. The language that is if a man in India doesn’t know English he can speak only hindi by turning on the language processing in your phone or any devices it can change the language to the language that he can understand.

3.1.3 Expert Systems. The expert systems that supercomputers and the mainframe computers are the expert systems that can do more calculations in fraction of seconds and the rendering can be done more quickly and etc.

3.1.4 Handwriting Recognition. Handwriting recognition is used in samsung galaxy flagship phones and the use stylus in the phone are used to change our handwriting to text the use of AI that is the writing of the words the use of shapes in the letters can be recognised and the words are entered.

3.1.5 Intelligent Robots. Robots as we discussed they can do more works like human and more works it should have sense, the sense are generated only by artificial intelligence and the day to day life is done by only artificial intelligence.

3.2. Challenges
Artificial Intelligence has changed lives but it has to be adopted under appropriate and pertinent policies since it has several challenges Driving in a jam-packed city can be a problem for automation due to unpredicted events. Artificial Intelligence can become significant for millions of people for their health but only if trust of doctors, nurses and patients can be gained. Quality education will necessitate active engagement of teachers. Artificial Intelligence can be used efficiently if teachers accept it and they are trained to use it.

4. Neuromorphic Computing
Neuromorphic computing simulates analog processes of the human brain. Digital (more properly binary) computing can “simulate” but not “duplicate” analog processes. Various scientists are working to integrate actual analog computing in binary systems. See link below. Apart from the inherent dichotomy between analog and digital, we tend to have a limited view of the “brain.” We can’t divorce its biological host. The brain developed and always remains an integrated, inseparable part of the physical body. It is not a “thing” but a process.

Perhaps most importantly, only humans have consciousness. A brain without consciousness is, well, brain dead. We do not yet know the “architecture” of consciousness. We do know we all have intellect, which helps us to survive and to reason. We also have an identity created by our upbringing, cultural environment, etc., and we have a “database”, the knowledge we accumulate during our life and which is strictly personal and shaped by culture. The brain is more that a binary calculator. Designing a computing system that makes logical decisions is relatively easy. An example is IBMs Big Blue beating the world chess champion. But only biological entities can have a brain that can develop its own consciousness - and sub consciousness.
5. **Artificial Synapse**

Machine learning is a subset of wider area of artificial intelligence and it focuses on allowing the program and/or the computer to access and interpret the data themselves with no manual intervention. To be concise, machine learning tries to mimic the ability of the brain to adapt and make changes in the form of interpretation of the data depending on the need and the surrounding. Brain is a wide network of tightly and complexly knit wires of neural network interconnected with neurons. The brain passes electrical signals from one neuron to the other by which it both transfers and processes the data received from the sensory organs. This process is called synapse and artificial synapse is an attempt made to mimic this transfer of data in artificial neural network. By using Artificial synapse it is possible to transfer, store and process the data, all at the same time without having the need to have a separate space for data storage.

6. **Memristor**

Electronic circuit is often designed by victimisation many passive parts specifically resistors, capacitors, yet as inductors, however there'll be a vital fourth element that is termed as a memristor. These are semiconductors used for jointing passive parts to create a fourth element, and therefore the resistance is called as memristance. It's a resistance depends on charge in memristor circuits & the emu [3, 4].

A memristor (named as a portmanteau of memory and resistance) could be a non-volatile electronic storage device that was initial theorized by Leon Ong Chua in 1971 because the fourth elementary two-terminal circuit component following the resistor, the capacitance, and also the electrical device [5-8]. The Leon Chua academician had ascertained the models of capacitance, resistance & electrical device. And he ascertained a missing half that is known as a memristor or memory resistance [9]. The sensible illustration of this memory resistance was dilated in 2006 by the soul Stanley Williams. This technology was discovered quite some decades past, though it got made-up in recent times.

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![Diagram of a memristor](image)
The memristors are referred to as matrix switches as a result of it's principally used for connecting many inputs further as outputs within the style of a matrix. The construction of memristor is shown below. It's a 2 terminal element and therefore the memristor operating is, its resistance principally lies on the magnitude, applied voltage, and polarity [10, 11]. Because the voltage isn't applied, then the resistance leftover, and this makes this as a non-linear and memory element.

The higher than showed diagram is that the memristor construction. The memristor uses a pigment (TiO2) sort of a resistive material [12-15]. It works superior to other forms of materials like oxide. Once the voltage is given across the Pt electrodes then the Tio2 atoms can unfold right or left within the material supported voltage polarity that makes diluent or thicker, thus provides a remodel in resistance [16-18].

7. Conclusion
The entire world is moving at a rapid rate towards artificial intelligence. By the end of 2030, the number of devices connected to the cloud will grow exponential to that of what we have now. Increased devices on cloud means increased data traffic and larger hardware architecture requirement. Unfortunately even for the current devices, the data traffic is high and considerable amount of energy and resources are being used. It is further worrying to know that the advancements in the support structures of information technology is not growing as fast as the technology itself and we are to face a situation sooner or later where the present hardware and software may not be able to keep up with the loads of information that the smart devices will provide in the future. Neuromorphic computing is seen as a solution to these problems as it is much capable of handling larger volumes of data with drastically reducing the energy consumption for the same. Artificial synapse is the ground breaking technology that makes the neuromorphic computing into a reality. Still research is going on to fully understand and utilize the benefit of artificial synapse. Memristors are the best examples and proof of the level of advancement that we have achieved in the recent past to take us further into the world of artificial intelligence. Despite having physical and technical limitations and challenges, neuromorphic computing is steadily growing in a significant rate and is expected to change the approach to computing for good in the near future.

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