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POWERING NANOTECH WITH ADVANCE AI TECHNIQUES FOR BETTER FUTURE: A REVIEW

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Artificial intelligence (AI) and **Machine learning (ML)** are advanced methodologies used in the field of computer sciences that have the ability to make decisions independently , and this process can be accomplished by various tools, such as rule-based systems, decision trees, genetic algorithms, artificial neural networks (ANN), and fuzzy logic systems. **Nanotechnology** is a field of research and innovation concerned with building things at the level of atoms and molecules for the betterment of humanity's future. AI and nanotechnology, together, are adopted by various industries to get results in shorter intervals of time.

Through accelerated innovation and tiny robotic systems to treat and prevent life-threatening illnesses, AI and nanotechnology boost the healthcare industry. For more than a decade, researchers have been advancing the confluence of artificial intelligence with nanotechnology, which is encouraging a scientific and technological revolution. Together, artificial intelligence and nanotechnology create a bridge that is capable of enhancing research and techniques modified in disciplines for better communication and information sharing with the new generation , which will have a significant impact on our society and possibly provide the means for the fusion of biology and technology**,** there has been a lot of research done to develop new products like ultra-efficient solar cells, which have special features that will last into the future for humans. AI and nanotechnology are two cutting-edge fields that can work with nanoparticles and create devices at the nanoscale that can do things like heal damage or distribute medication (1-4).

Keyword: Artificial Intelligence (AI), Nanotechnology, Machine Learning (ML), Communication, research, Artificial neural networks (ANN), Genetic Algorithms

Introduction

A recent development that has taken centre stage in our modern life is artificial intelligence and machine learning. Virtually every sector that handles a sizable volume of data is employing AI by integrating it into regular business processes. AI is capable of making future predictions thanks to its capacity for data processing and some degree of autonomous learning. The vast quantity of data itself serves as its main raw resource, artificial intelligence is focused on extracting insight from data, which becomes the main economic value. Over the past few decades, this

technology has influenced research into nanotechnology and been applied in a variety of areas and companies. (5-7)

What is Artificial Intelligence? A computer's artificial intelligence is the ability to make decisions independently. The process can be accomplished by various tools, such as rule-based systems, decision trees, genetic algorithms, artificial neural networks, and fuzzy logic systems.

The end goal of artificial intelligence is to create machines that can accurately simulate or even exceed human intelligence. (8-10) This technology has several potential applications, including:

- Automated customer service agents
- Fraud detection in financial institutions
- Autonomous vehicles
- Speech recognition
- Predicting consumer behaviour

ARTIFICAL INTELLIGENCE DIVIDED INTO SUB-CLASSES such as :-
1.Machine Learning
2.Deep Learning

The discipline of artificial intelligence known as **machine learning (ML)** focuses on creating computers that autonomously analyse knowledge from data in a comprehensive manner. Predictive analytics or statistical learning are other names for this area of research, which is situated at the nexus of statistics and computer science. (11)

Deep Learning (DL) is a subset of artificial intelligence that is designed to behave like a human brain to modulate all the complex data into simpler assets. It basically uses a multi-layered structure of algorithms called **neural networks**. Just as humans use their brains to identify patterns and classify different types of information, neural networks can be taught to perform the same data tasks. (12)

Nanotechnology (NANOTECH) The term was coined in 1974 by Norio Taniguichi of Tokyo Science University to describe semiconductor processes such as thin-film deposition that deal with control on the order of nanometres. His definition still stands as the basic statement today: "Nano-technology mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule."(13) Nanotechnology is a fast-growing science of developing and using nano-sized particles, which is measured in nanometer. The science and engineering behind the design, synthesis, characterisation, and use of materials and devices whose smallest functional organisation, in at least one dimension, is on the nanoscale scale, or one billionth of a metre, is termed as nanotechnology. As it has control over the fundamental molecular framework, which allows control over the macroscopic chemical and physical properties, consideration of individual molecules and interacting groups of molecules in relation to the bulk macroscopic properties of the material or device becomes crucial at these scales.(14) In other words, nanotechnology is the practice of systemically characterizing, manipulating and arranging matter on a nanometer scale, creating a revolution in science, engineering, technology, drug delivery and therapeutics. (15) It plays an important role to develop the Fluorescent biological labels, drug and gene delivery, pathogen bio-detection, protein detection, DNA structure probing, tissue engineering, tumour detection, separation and purification of biological molecules and cells, MRI contrast enhancement, and pharmacokinetic studies are a few examples of applications. (16)

Nanotechnology is sometimes proposed as a general-purpose technology, because it will have a significant impact in its advanced version on almost all areas of society and all industries. (17)

Today, there are many procedures that take a lot of time and are very costly as well. Faster and much cheaper therapies can be produced using nanotechnology in the pharmaceutical sector. Another aspect of using pharmaceutical nanotechnology is available. Drugs usually work through the entire body until they enter the region affected by the disease. The medication can be targeted to the specific region with this pharmaceutical nanotechnology, which will make the drug even more successful and decreases the chances of potential side effects. (18) Pharmaceutical nanotechnology, through early diagnosis, prediction, prevention, personalised treatment and medication, offers a novel approach and advanced technology against cancer. The main research areas in which nanotechnology will play a crucial role are target-specific drug therapy and methods for early detection of diseases. (19)

Types of nanotechnologies

1) Nano devices: They are used in delivery of diagnostic and therapeutic agents. It can be categories into three potent molecular technologies:

• Nanoscale materials and tools to be used in advanced diagnostics and biosensors, controlled drug delivery and smart medicines.

• Molecular machines and medical nanorobots assist in the rapid diagnosis and treatment of microbials and in the development of physiological function.

• Molecular medicine by genomics, proteomics, artificial biobotics (microbial robots)

2) Nano pharmaceuticals: Applications of the nano pharmaceuticals include lung disease, antiviral agents, cancer, arteriosclerosis, tissue cell repair, gene therapy, tissue engineering and diabetes.

Nanoscience is the study of the unique properties of materials between 1-100 nm, and nanotechnology is the application of such research to create or modify novel objects. The ability to manipulate structures at the atomic scale allows for the creation of nanomaterials. Unlike other large-scaled engineered objects and systems, nanomaterials are governed by the laws of quantum mechanics instead of the classical laws of physics and chemistry. In short, nanotechnology is the engineering of useful objects and functional systems at the molecular or atomic scale. (20)
Nanotechnologies have had a significant impact in almost all industries and areas of society as it offers
i) better built,
ii) safer and cleaner,
iii) longer-lasting and
iv) smarter products for medicine, communications, everyday life, agriculture and other industries. (21)

How Artificial Intelligence and Nanotechnology is integrated?

The development of modern science and technology depends entirely on information, nano, and biological sciences. The thought of biology, artificial intelligence, and nanotechnology convergence promoting a scientific and technical revolution has been lingering for more than a decade now. (22) Knowledge of engineering, chemistry, and physics is combined by nanotechnology meanwhile artificial intelligence highly depends on the biological inspiration for developing some of its most effective paradigms, for instance, evolutionary algorithms or neural networks. (23)

Drug Discovery with Artificial Intelligence (AI) and its two subcomponents, namely Machine Learning (ML) and Deep Learning (DL) can help to improve productivity and ensure regulatory compliance, and in nanotechnology its help in transform data at the speed of your computer Central Processing Unit (CPU), digital at scale and speed (i.e., nanotechnology), optimizing your business.(24**)** If the link between current artificial intelligence and nanoscience's is bridged then it is capable of boosting research in these disciplines and offering communication technologies and information to the new generation which will impact our society on a large scale, and possibly will provide the means for the merging of biology and technology. Alongside this, tools have been used by different efforts from artificial intelligence in basic and applied nanoscience research, for instance, for interpreting the experimental techniques or for helping in the structural design of devices and nanomaterials. (25) these enabling technologies will be applied more broadly in the next few years, leveraging the high throughput synthesis and characterization and ML modelling methods developed for bulk materials. (26)
Artificial intelligence has been an increasingly growing area for many decades now, not just within itself where the areas of Machin learning, Deep learning, and artificial neural network work simultaneously, but also in the number of fields and industries that they are now prevalent in. Nanoscience and nanotechnology are the study and application of tiny things. there are some growing areas where AI converges with nanotechnology. During the last decade, there has been increasing use of artificial intelligence tools in nanotechnology research. In this paper, we review some of these efforts in the context of interpreting scanning probe microscopy, simulations, and nanocomputing.

AI and Nanotechnology have increasingly exhibited similar synchronization in aspects of them working together with mutual assistance. The following article discusses how AI and Nanotech could come together for a better future –

The medical advancement

One of the biggest beneficiaries of the integration of AI and Nanotech undoubtedly will be the medical field. The areas using or studying the application of Nanotechnologies, such as microscopy and organ regeneration from stem cells, can greatly benefit from the precision, command, improved signal, etc., offered by the AI. (27)

1.Microscopy
The greatest issue with atomic force microscopy is that the end signals are not of high quality. As a result, atom interactions that these microscopes analyze are unpredictable and complex. Analysing sample interactions and resulting signals are intended for machine learning algorithms.
The AFM (atomic force microscopy), despite the substantial progress in recent years, continues to struggle when it comes to receiving high-quality signals from imaging devices. It is considered versatile since it can image in three-dimensional topography and provides various surface measurements for scientists and engineer's needs. Although atomic force microscopy is considered a significant advance in recent years, it has the challenge to get high quality-signals imaging devices. The predominant problem in atomic force microscopy is that many of the tip-sample interactions these microscopes rely on are complex, varied, and therefore not easy to decipher, especially when trying to image samples at the nanoscale and manipulate atomic level AI can be beneficial in dealing with these kinds of signal-related issues (28). The AI approach in nanotechnology known as functional recognition, which help in resolving issue by directly identifying local actions from measured spectroscopic reactions and generated high quality images with accurate topographic map of the surface features.
Functional recognition imaging (FR-SPM), an AI approach, is based on directly identifying the local actions through measured spectroscopic reactions. The focus of the particular process will be on streamlining input data to the neural network using an integration of ANNs (artificial neural networks) can recognize the local behaviour of the material being imaged, leading to a simplification of the data and a reduction in the number of variables

that need to be considered. An PCA (principal component analysis), an advanced ML approach to deal in reduce the dimensionality of a dataset. (29)

2.Treatment

The long-term goal of nanomedicine research is to characterize the quantitative molecular-scale components known as nanomachinery. (30)

In any medical research and treatment, precision is imperative, even more so when using nanotechnology. AI helps not just by supporting intricate programming of the nanobots but also by making the transformation of stem cells to bone cells through command plausible, treating multiple diseases (31). Furthermore, the commands from AI can also guide the nanobots into creating and manipulating stem cells to generate human organs for replacement or even repair the ones damaged.

Nanobots can utilize the vast data offered by AI to differentiate between the bad and the good cells to treat diseases like cancer (32). The massive amount of data can be used to train a model to differentiate the appearance of normal cells from those infected, making it such that nanobots only target and destroy infected cells.

3.AI For Nanotech in research

From the massive scale of research to the quantification of the variables, recording, and the interpretation of data, everything becomes difficult by multiplying when the particles in question are that in the range of nanometres. (33)

Development and designing of nanosystem artificial intelligence neural networks have been used to explore the non-linear relationship between input variables and output responses in the deposition process of transparent conductive oxide. Evolutionary optimization has also been used to find improved nanoantenna structures (34).

The focusing quality of integrally gated CNT field-emission devices have been optimized by numerical methods that include genetic algorithms (GAs) (35). It was very well established in radio frequency antenna engineering because they can be easily implemented and because of their effective use of parallelism.

In the last few years, genetic algorithms have also found application in the field of nano-optics. For example, one method for designing plasmonic particles with desired resonance spectra exploits the interaction of local geometry with surface charge distribution and applies an evolutionary algorithm. (36) so, the use of AI can make the task easier and more precise, right from optimizing the data, designing the algorithms for technology, estimating multiple parameters, and interpreting results from the experiments. Therefore, it is little wonder why many nanotechnology facilities have begun integrating AI in their research segments for greater accuracy and effectiveness (37).

4.Introducing better and sustainable food alternatives: -

Livestock farming is one of the world's largest and most resource-intensive markets, which also makes for 60% of total greenhouse-related emissions. The researchers believe that the integration of nanotech and AI can bring about the next big food evolution for humans with sustainable options. (38) The efforts to build plant-based meat, which in terms of taste, smell, and look mimic the meat but without any. The idea of artificial meat has revolved around the vegan community for some time now (39). However, since the micro-components of any food determine every basic aspect of its flavour and smell, which in turn are made with a combination of specific molecules including proteins, fats, etc., replicating the same becomes an extremely difficult task, especially without using any animal product (40). But, there's a solution to it. Creating artificial meat through AI and Nanotech is based on finding the end results through a series of permutations and combinations of the micro-components (41). If not just another vegan substitute, a new formulation for the ingredient is found using the algorithms to develop a satisfactory alternative. (42)

5.Artificial Intelligence in Nano-Computing

Nano computing basically in act used of advanced techniques to develop extremely small or nanoscale devices (43). Unsurprisingly, AI is also beneficial concerning the future of nano computing, which is computing conducted through nanoscale mechanisms. There are many ways nano computing devices can execute a function, and these can cover anything from physical operations to computational methods (44). Due to a great deal of these devices depending on intricate physical systems to allow for intricate computational algorithms, machine learning procedures can be used to generate novel information representations for a broad range of uses (45). A few companies successfully implemented the method to replicate liquid food, including scrambled eggs, mayo, etc., given the complexity of replicating solid foods. However, it is not far from reality when the alternatives to livestock farming using AI and nanotech are made into accessible and scalable products. (46)

6.Nanomaterials and AI in Precision Diagnostics

For the treatment of cancer, biomarkers are synthesized by using nanotechnologies techniques nanomaterials like nanopores are designed to severe for the diagnosis of patient illness. (47) Nanopores are create in order to measure the changes in ionic current when a DNA strand is transported through a lipid membrane, nanopores offer a unique single-molecule sequencing technique for DNA and RNA. The raw nanopore signal is translated into a nucleotide sequence using AI (48). Nanopore sequencing frequently employs a group of algorithms known as artificial neural networks. An ANN typically consists of layers of interconnected nodes (49). To get the better outcomes, the weight of each connection is changed in accordance with its impact on the output using training data with known output (known oligonucleotide sequences in the case of nanopores). Because the accuracy rate for current nanopore sequencing technologies is 90%, further post-sequencing computer analysis is necessary for read correction (50). Depending on the extent of DNA coverage, several additional algorithms generate a consensus sequence from numerous reads and make utilisation of them to improve the level of sequencing accuracy to 97% and higher. (51)

CONCLUSION

In today's technology of artificial intelligence and nanoscience/ nanotechnology, together emerged new techniques for treating different diseases have been developed in the last few years
(52). It seems their integration of these is inevitable scenario. Artificial intelligence tools in nanotechnology help in research, development and medical treatment advancement to arise impact on healthy life style. In this review article we highlighted some of important context of AI incorporated in nanotech region to interpreting machines with biological systems (53). Current trends and future perspectives in the development of nanocomputing hardware that can boost artificial-intelligence-based applications are also mentioned. Convergence between artificial intelligence and nanotechnology can shape the path for many technological developments in the field of information sciences that will rely on new computer architectures and data representations, hybrid technologies that use biological entities and nanotechnological devices, bioengineering, neuroscience and a large variety of related disciplines.

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