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ARTIFICIAL INTELLIGENCE AND NANOROBOTICS IN RECENT PHARMACEUTICAL ADVANCED

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Abstract : There is various researches going on in artificial intelligence ,and this improve lots of thing in artificial intelligence in the last twenty years and also capability of both service system and manufacturing .this branch of computer science deal with the treatment of computer such as humans .This study provided a content analysis of studies aiming to disclose how artificial intelligence (AI) has been applied to the education sector and explore the potential research trends and challenges of AI in education. Nanorobotics is the technology of creating machines or robots at or close to the microscopic scale of a nanometer. These devices are ranging in size from 0.1-10 micrometers and constructed of nanoscale. Due to their small size and wide functional properties, nanorobots have created exceptional prospects in medical, biomedical and pharmaceutical applications. Nanorobotics offers an emerging frontier in biomedicine, potentially revolutionizing diagnostic and therapeutic applications through its unique capabilities in manipulating biological systems at the nanoscale. The study ascertained that AI has extensively been adopted and used in education, particularly by education institutions, in different forms. AI initially took the form of computer and computer related technologies, transitioning to web-based and online intelligent education systems, and ultimately with the use of embedded computer systems, together with other technologies, the use of humanoid robots and web-based chatbots to perform instructors' duties and functions independently or with instructors.

Keywords : Artificial intelligence(AI),Nanorobotics,3D emerging, QSAR, Nanobots

Introduction:

Welcome to this investigation into the intriguing convergence of artificial intelligence (AI) and nanotechnology. In the last few years, both areas have received considerable attention and demonstrated substantial potential to transform many elements of our daily lives. By utilizing the capabilities of AI and capitalizing on the distinctive characteristics of nanotechnology, scientists and researchers are exploring new possibilities in technology, healthcare, energy, and more[1].The area of computer science known as artificial intelligence, or AI, focuses on creating intelligent machines that can carry out tasks that normally require human intelligence [2,3]. AI systems are capable of analyzing enormous volumes of data, identifying patterns, and coming to well-informed conclusions thanks to sophisticated algorithms and machine learning techniques.The integration of artificial intelligence (AI)

Putting together artificial intelligence (AI) with nanotechnology is really creating some exciting new possibilities for medicine. A really big deal in this area of study is the creation of nanobots, which are like tiny robots that can work inside our bodies, right down at the cell and molecule level, to do specific jobs. These nanobots, also called nanobots, are super-small machines, usually somewhere between 0.1 and 10 micrometers. We can design them to do all sorts of things, like delivering medicine exactly where it needs to go, fixing damaged tissues, or even performing surgery on a microscopic scale. But because they're so tiny and have such complex workings, it's pretty tough for us humans to steer and control them precisely. [4]

When creating nanobots, a really important thing to think about is how to make sure they're safe to use inside the body. We can use AI to model how nanobots might interact with the body, which helps scientists spot any possible safety problems before they're actually used on people. Plus, AI can also help fine-tune the nanobot designs so they work well with current medical tools, like how drugs are made and delivered.[5]

APPLICATIONS OF NANOROBOTS

When we're building nanobots, a big deal is figuring out how to make them safe for use inside the body. We can actually use AI to simulate how these tiny robots might behave when they're in us, which is super helpful for scientists to catch any potential safety issues before they're ever tried on real people. On top of that, AI can also help tweak the nanobot designs so they can play nicely with the medical tools we already have, kind of like how we develop and give out medicines.

1. In Dentistry:

As more people are born, there's a greater need for advancements in dental technology. This has given rise to a new area called Nanodentistry. Tiny robots, or nanobots, can be used to numb the mouth, make teeth less sensitive, reshape tissues for better alignment, and make teeth stronger. Nanodental methods involve tissue engineering to create nanobots that can be put into place. When replacing teeth, it's important to remember that they are made up of both minerals and living cells.

2. Nanomedicine:

You know, nanomedicines are looking really promising for tackling tough medical issues like cancer and COVID. When we're talking about nanobots for surgery, it's super important that they can work with what's going on inside the body. They shouldn't be able to make copies of themselves, because if they start replicating once they're in there, it can get complicated and mess with where they're supposed to be working. A really cool thing about nanobots is that they can be used to create specialized tissues, like for sensing. Plus, they can help us keep tabs on the nanobots and guide them around the body, setting up a strong way to communicate and navigate.

3.In Cancer Detection and Treatment:

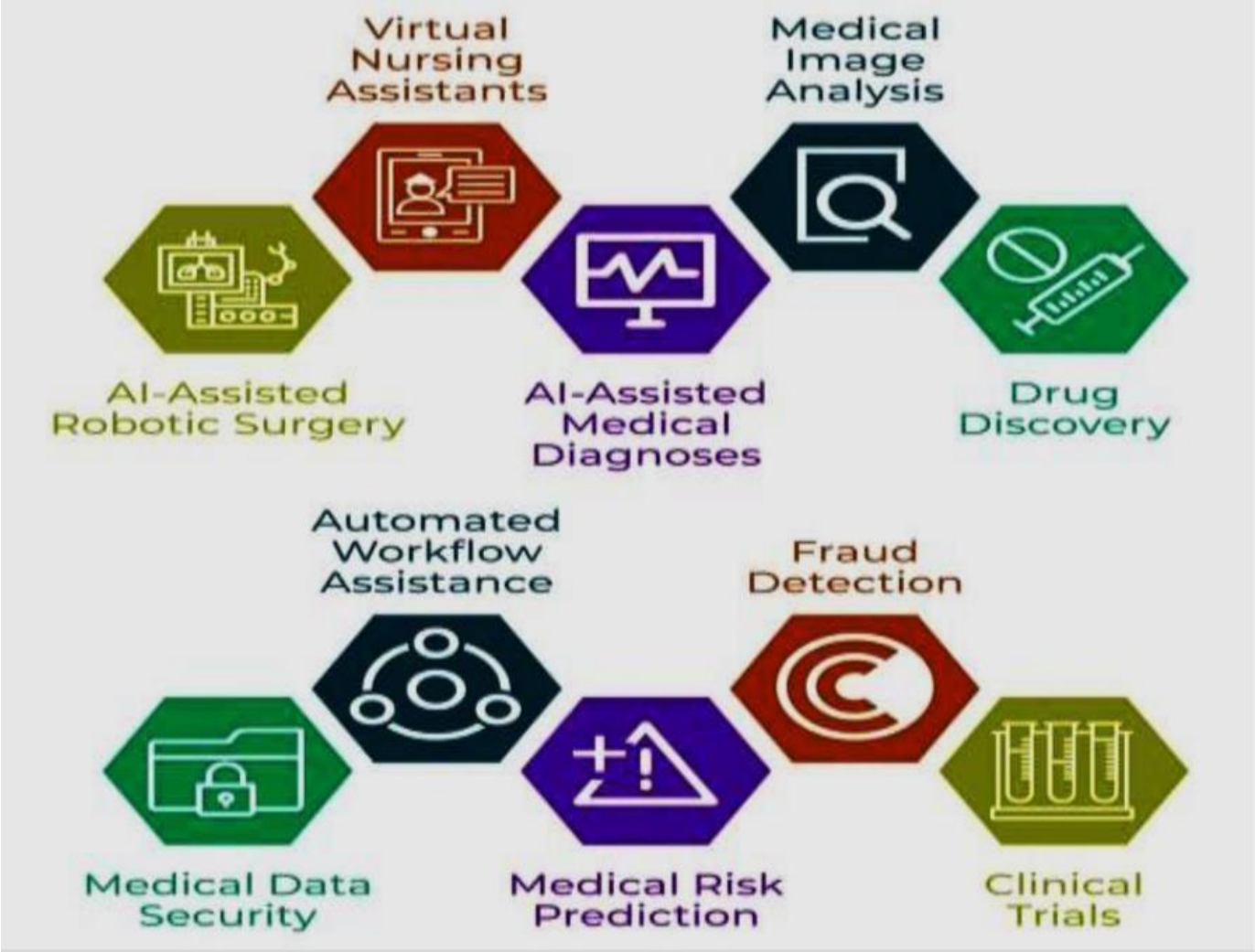
Cancer can be effectively identified and can be treated with integration of nanotechnology utilizing nanobots and the past strategy of cancer discovery.

4.Application of Nanobots in Nano Impression:

Nano impression may be a procedure utilized to make designs on surfaces at the nanoscale. The utilize of nanobots in this prepare can incredibly move forward its precision and productivity. Nanobots can be modified to accurately control particles and molecules, permitting for the creation of complex designs with tall exactness and speed. This innovation has potential applications within the fabricating of electronic gadgets, sensors, and other nanoscale structures.

5.Application of Nanobots in Surgery:

Nano impression may be a method utilized to make designs on surfaces at the nanoscale. The utilize of nanobots in this handle can significantly progress its exactness and effectiveness. Nanobots can be modified to accurately control particles and molecules, permitting for the creation of complicated designs with tall accuracy and speed. This innovation has potential applications within the manu.[6]



Figures 1: Application of AI in healthcare

This study examines the complex relationship between artificial intelligence and nanotechnology. We'll explore their current uses, potential future applications, associated challenges, and ethical considerations. By analyzing recent research and advancements, we aim to understand how AI and nanotechnology can impact our world and contribute to a more sustainable and technologically advanced future [7].

Drug discovery and development:-

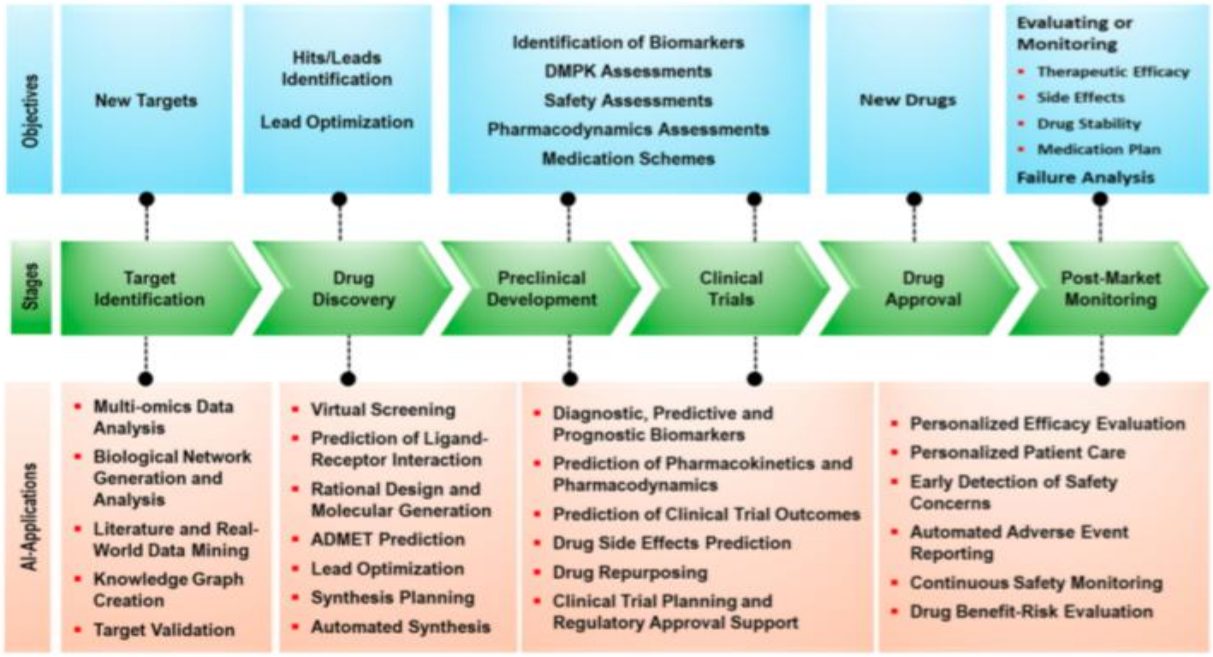


Figure 2 .Applications of AI in distinctive stages of drug discovery and development. The drug development process comprises of many crucial stages such as target identification, drug discovery, preclinical development, clinical trials, drug approval by regulatory authorities, and postmarketmonitoring. AI-based approaches hold promise in facilitating all stages of drug development.[8]

AI in drug discovery:

The enormous chemical space, consisting of more than 10^{60} possible molecules, enables the discovery of numerous potential drug candidates [9]. However, the absence of advanced technological approaches makes the drug development process slow and costly, a challenge that can be effectively addressed through the application of artificial lintelligence.[10]

Although AI offers many benefits, it also encounters major data-related challenges, including issues of data scale, rapid growth, heterogeneity, and uncertainty. In pharmaceutical drug development, datasets may contain millions of compounds, which can exceed the handling capacity of traditional machine learning methods. QSAR-based computational models enable rapid prediction of large compound libraries or basic physicochemical properties such as log P and log D; however, they remain limited in their ability to accurately predict complex biological outcomes, including drug efficacy and adverse effects. Furthermore, QSAR models are constrained by factors such as small training datasets, experimental errors within training data, and insufficient experimental validation. To address these limitations, advanced AI techniques, particularly deep learning and related modeling approaches, have recently been applied to evaluate the safety and efficacy of drug candidates using large-scale data analysis. Notably, in 2012, Merck sponsored a QSAR machine learning challenge that demonstrated the superior predictive performance of deep learning models over traditional machine learning methods across 15 ADMET datasets for drug candidates [11,12].

AI in advancing pharmaceutical product development:

The identification of a new drug molecule must be followed by its formulation into an appropriate dosage form with optimal delivery properties. In this context, artificial intelligence offers an effective alternative to conventional trial-and-error methods. [13] A range of computational approaches can address formulation-related challenges such as stability, dissolution behavior, and porosity through the application of quantitative structure–property relationship (QSPR) models[14]. Decision-support systems employing rule-based algorithms assist in selecting suitable excipients, as well as determining their type and quantity, based on the physicochemical characteristics of the drug. [13]These systems function via feedback mechanisms that continuously oversee the formulation process and allow for periodic adjustments.[15]

Guo and colleagues developed a hybrid approach by integrating expert systems with artificial neural networks (ANNs) to design direct-fill hard gelatin capsules of piroxicam that meet specific dissolution requirements. In this system, the model expert system provides formulation decisions and recommendations based on input variables, while the ANN, using backpropagation learning, establishes relationships between formulation parameters and the desired outcomes. A control module coordinates both components to enable a smooth and efficient formulation process.[16,17]

In addition, mathematical modeling techniques such as computational fluid dynamics (CFD), discrete element modeling (DEM), and the finite element method have been applied to study the effects of powder flow characteristics on die filling and tablet compression. CFD has also been used to evaluate how tablet geometry influences dissolution behavior.

Integrating these mathematical models with AI techniques holds significant potential for accelerating pharmaceutical product development.[18,19]

AI in the lifecycle of pharmaceutical products:

AI has the potential to play a significant role throughout the pharmaceutical product lifecycle, from laboratory research to patient care. It supports rational drug design, [20]enhances decision-making processes, enables selection of appropriate and personalized therapies, and efficiently manages clinical data for use in future drug development.[21] E-VAI is an AI-based analytical and decision-support platform developed by Eularis that combines machine-learning algorithms with a user-friendly interface. It generates strategic analytical pathways by evaluating competitors, major stakeholders, and existing market share to forecast key factors influencing pharmaceutical sales[22]. This helps marketing professionals optimize resource allocation, recover declining sales, and identify areas for strategic investment. The various roles of AI in drug discovery and development are illustrated in

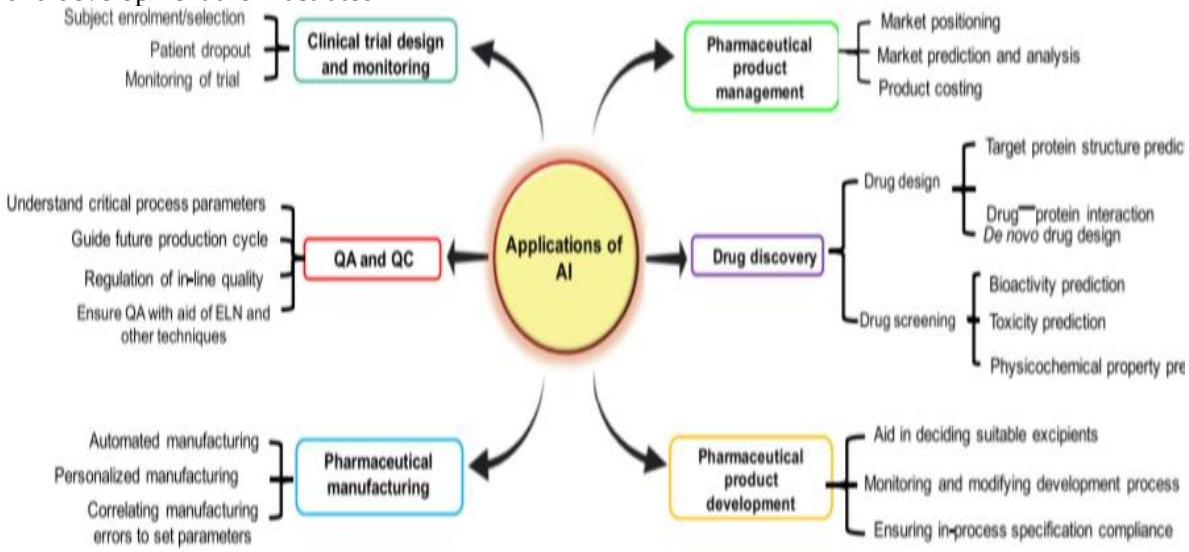


Figure 3.

Applications of artificial intelligence (AI) in different subfields of the pharmaceutical industry, from drug discovery to pharmaceutical product management.This study aims to investigate the impact of advanced grammar checkers, specifically Grammarly, on thesis writing in academic settings. Employing a qualitative methodology, the research involved semi-structured interviews with three experienced thesis supervisors from two academic institutions. The findings highlight that while Grammarly enhances writing quality through immediate, personalized feedback, it raises concerns about potential over-reliance, which may hinder the development of students' writing skills and academic independence. The research underscores the need for a balanced integration of AI tools in academic writing, advocating for their use as supplementary aids rather than primary solutions. It also calls for comprehensive training and clear policies to maximize the benefits of these tools while maintaining academic integrity and fostering critical thinking skills among students.(23)

AI in 3D printing : AI evaluates cost parameters, improving material selection to reduce manufacturing costs and environmental effect (24) The VAE model was implemented in PyTorch, and 200 samples were drawn from low dimensional space. These samples, along with obtained decoded RVE images, underwent computational homogenization. Principal component analysis compressed the latent space into a 2D representation. Experimental validation involved 3D printing multi-material structures using UV-assisted replica molding. The consistently higher Young's modulus values than predicted indicate a manufacturing process consistently favoring PU over soft silicone, resulting in a high macroscopic Young's modulus**.** (25) address this need by utilizing an ANN approach to assess the impact of various printing parameters on printed specimen performance, aiming to optimize process parameters for optimal tensile strength. Examined factors included infill pattern, nozzle temperature, layer thickness, printing speed, and raster angle. Using an L27 orthogonal array for experimental design, specimens were printed and tested.(26)

Finite Element Analysis (FEA) assesses stresses, strains, and fatigue under actual loading conditions, while process simulation considers thermal gradients, residual stresses, and distortions during layer deposition. Leveraging simulation-driven design helps engineers validate designs earlier and iterate faster before any physical build.

Multi-scale modeling of lattice structures captures overall stiffness and local failure modes, optimizing unit-cell geometry to enhance the strength-to-weight ratio. Virtual validation reduces trial builds, minimizes defects, and ensures mechanical performance without costly redesigns.(27) The overarching aim of AI is to replicate human intelligence such that machines can perform tasks, including those deemed complex or dangerous (28) A unique selling point of AI is its ability to handle

large and complex datasets. Moreover, AI can comprehend data of different formats, such as numeric and text. These features collectively allow AI to work towards replicating human intelligence.(29) In material synthesis and processing, AI technologies have been applied to accelerate developments, including predicting formulation processability, real-time quality control of dosage forms and elucidating drug interactions (30) GANs have gained significant attention in recent years due to their ability to generate realistic and diverse data in a number of fields, including material science and medicine(31) The study successfully demonstrates the utility of AI for generating de novo 3D printing formulations, thereby demonstrating that AI has the creativity to generate new pharmaceutically-functionalised formulations(32) The formulation dataset was a combination of in-house and literature-extracted data.(33) The formulation dataset was a combination of in-house and literature-extracted data.(34) Machine learning-based technologies are used every day in tools from personalized news feeds to financial fraud detection.(35)

Conclusion:

Artificial Intelligence (AI) technology has been developing for many years now, not only as an area of technology but also in the various spaces and industries where it can now be found. Developing and improving efficient algorithms and software to address the remaining unanswered issues is crucial due to the exponential growth in computational costs as these systems become larger and more advanced. The purpose of this review is to highlight the technological advancements in nanotechnology for medical applications, specifically in the field of cancer treatment. Cancer is a complex disease that involves the uncontrolled growth and spread of malignant cells, and its incidence is increasing worldwide. Nanorobotics has emerged as a promising tool for cancer therapy, as it can enable targeted drug delivery with minimal side effects. Programmable nanorobotic devices that can operate at the cellular and molecular level hold great potential for precise and effective treatment. These devices can also be used for a range of other medical applications, including dentistry, pharmaceutical research, and clinical diagnosis. In the future, the development of nanomechanics could allow for the creation of microscale robots with nanoscale components that are programmable and controllable, enabling medical professionals to perform healing and rehabilitative surgeries at the cellular and molecular level. Ultimately, the goal of nanorobotics is to enhance the body's natural healing processes and maintain homeostasis. While there are challenges to overcome, such as safety concerns and ensuring accuracy, the potential benefits of nanorobotics in medicine are enormous, and they are likely to play an increasingly important role in medical practice in the years to come.

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(38) Impact of Artificial Intelligence (AI) on Drug Discovery and Product Development Ravi Ram Narayanan,Narayanamoorthy Durga, Sethuraman Nagalakshmi*Department of Pharmaceutics, Sri Ramachandra Faculty of Pharmacy, Sri Ramachandra Institute of Higher Education and Research,
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(40) NANOROBOTS AND ITS Indo American Journal of Pharmaceutical Research, 2019 IN MEDICINE Nikhil Arun Shete*, Mohan R. S, Gore S.J, Tagad R. RAssistant professor at Shri Sai College of Pharmacy, Khandala. NANOROBOTS AND ITS APPLICATION IN MEDICINE