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Harnessing Artificial Intelligence for Veterinary Medicine: Bridging Gaps in Global Health

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Abstract

Artificial intelligence is a rapidly developing technological breakthrough with applications across numerous scientific and technological domains. Particularly in veterinary clinical practice, AI holds great promise for improving patient outcomes by streamlining the provision of veterinary care. AI has applications in epidemiology, disease monitoring, medication, vaccine development, cancer research, antimicrobial resistance study, and genomics. Here, we emphasized and talked about the possible effects of various AI features on veterinary healthcare, suggesting that this technology is a vital instrument for tackling urgent global health issues in a variety of fields.

Introduction

Artificial intelligence (AI) is the capacity of computer programs or robots operating under computer control to carry out tasks that are typically carried out by intelligent entities. AI, which simulates cognitive processes like learning as well as problem-solving that are seen in both animal and human beings, is essentially machine intelligence. Since its inception as an area of study in 1956, AI has delved into various domains, including brain simulation, human behaviour emulation, logic, knowledge libraries, and modelling human problem-solving. Veterinary medicine encompasses a wide spectrum of disciplines, including animal production, zoonotic illnesses, public health, and pet health. In a similar vein, AI exerts influence across a broad array of scientific realms, including computer engineering, data sciences, neuroscience, control theory, mathematics, and cybernetics. The intersection of these expansive and dynamic fields offers prospects for mutual influence and collaboration. Promising opportunities arise from the tremendous achievements and potential uses of AI in the healthcare domains of humans and animals. The assimilation of AI into veterinary medicine opens up novel pathways for enhancing animal health and well-being. However, these auspicious prospects are accompanied by distinct challenges, particularly concerning the comprehension, interpretation, and assimilation of such powerful and evolving technology. Given the quick pace of advancements in research and industry, effectively navigating these challenges is essential while embracing the revolutionary promise of AI in veterinary care.

Role of AI in disease diagnosis

Early disease identification is paramount for effective treatment and better patient outcomes. AI assumes a critical role by harnessing cutting-edge algorithms and machine learning to analyse vast medical datasets, encompassing clinical and imaging data. In veterinary medicine, the application of AI techniques addresses intricate challenges in predictive and quantitative epidemiology, precision healthcare for both human and animal populations, and comprehension of host-pathogen interactions. AI-driven systems facilitate continuous monitoring, enabling swift identification of deviations in health indicators, particularly advantageous for managing chronic conditions through early intervention. Research demonstrates the efficacy of machine learning algorithms in diagnosing ailments such as chronic hypoadrenocorticism (CHA) in canines and distinguishing among various neurological disorders in dogs. Initiatives are underway to incorporate AI and radiomics into routine clinical procedures, augmenting accuracy, sensitivity, and reproducibility in diagnostics through quantitative analysis of medical imaging data.

Role of AI in zoonotic disease monitoring

AI tools show great promise in monitoring and surveilling zoonotic diseases, addressing challenges linked to emerging illnesses. AI presents novel prospects for understanding, predicting, and mitigating the consequences of zoonotic illnesses through the amalgamation of cutting-edge algorithms and machine learning with conventional disease control techniques. Various AI forecasting models can identify risk variables and estimate an individual's likelihood of contracting a disease, enabling early identification and intervention. Web servers and AI models, for instance, Word2vec and VIDHOP, utilize machine learning approaches to predict viral hosts and assess the potential for human infection. Tools like FluSPred aid in prioritizing high-risk virus strains for further research, contributing to the study of novel influenza viruses and their potential for human-to-human transmission.

Role of AI in epidemiology and surveillance

AI can aid in pathogen detection, allowing researchers and veterinarians to rank cases or samples with potential positivity for effective resource management and laboratory capacity utilization. These methods are frequently utilized in the surveillance of animal diseases and the identification of food-borne diseases, capitalizing on metadata linked to biological samples. Biosurveillance systems and platforms such as PADI-web incorporate machine learning algorithms to quickly identify new animal diseases. Additionally, machine learning algorithms are employed to simultaneously utilize genomic and epidemiological data for surveillance of food and water-borne diseases.

Role of AI in soft tissue and invasive surgery

Computer-aided visualization (CV) is transforming the way images are produced and interpreted using ultrasound machines, particularly in diagnosing conditions through imaging and guiding surgical procedures. This technology is applicable across diverse medical domains, encompassing Ultrasound , X-ray, Magnetic resonance imaging (MRI), Computed tomography (CT), and others. By integrating AI and advanced learning techniques, the aim is to eliminate subjectivity from image analysis, benefiting both human and veterinary medicine. While significant strides have been made in analysing medical images for human health, progress in veterinary clinical practice, particularly in low to middle-income areas, is still underway. Studies have showcased the potential of merging radiomics and AI in medical imaging tasks such as disease identification and prognosis assessment. Furthermore, AI-assisted surgeries, exemplified by the "smart tissue autonomous robot" (STAR) developed at Johns Hopkins University, offer enhanced precision and reduced error risks by providing real-time imaging overlays and surgical guidance tailored to individual patient characteristics.

Role of AI in antimicrobial resistance study

The rise of antimicrobial resistance presents a substantial peril to global health, particularly in regions with constrained healthcare resources. Given the pressing nature of the issue, there exists a crucial imperative to expedite the development of new drugs, vaccines, and diagnostic tools. AI holds immense promise in combatting antimicrobial resistance by hastening drug discovery and enhancing detection techniques, such as identifying antibiotic residues in food. AI-driven algorithms can analyse vast datasets to pinpoint possible therapeutic targets and formulate more potent antibiotics, while also surveilling resistance trends and guiding public health interventions. Tailored AI methodologies, including Naïve Bayes, decision trees, random forest, and support vector machine, have been devised for antimicrobial resistance research, revolutionizing diagnostic and therapeutic approaches. Additionally, AI streamlines Antimicrobial Susceptibility Testing and Whole Genome Sequencing, significantly compressing development timelines from 10-15 years to as little as 2 years. AI's scope extends to identifying susceptible individuals, monitoring the dissemination of resistant bacteria,

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overseeing antibiotic usage, and detecting resistance outbreaks. Moreover, in animal husbandry, AI aids in discerning and regulating antibiotic usage, thus curtailing resistance dissemination. Its implementation in food production, particularly in meat and dairy sectors, guarantees the identification of antibiotic residues and traces their sources. In summary, AI emerges as a promising technology with profound implications for antimicrobial resistance research in both animal agriculture and human healthcare, offering inventive solutions to combat this global menace.

Role of AI in vaccine development study

AI plays a key role in the research and development of vaccines, as exemplified by the swift discovery of vaccines against the SARS-CoV-2 virus amid the COVID-19 pandemic. It expedites the identification, creation, and assessment of vaccine contenders by scrutinizing vast biological datasets to find putative antigens and forecast their binding affinities with immune molecules. Moreover, AI streamlines vaccine formulation by selecting adjuvants that augment immune responses and analysing intricate datasets to uncover synergistic interactions, thus leading to the production of more effective and long-lasting vaccines. Additionally, AI forecasts the effectiveness and safety of prospective vaccine contenders before clinical trials, thereby saving time and resources by directing the selection of contenders based on the analysis of historical data.

Conclusion

AI is leading the way in addressing critical global health issues across diverse fields, encompassing antimicrobial resistance (AMR), vaccine development, zoonotic diseases, genomic exploration, and drug innovation. In combating AMR, AI expedites the creation of essential tools by scrutinizing extensive datasets to pinpoint therapeutic targets and optimize the usage of antibiotics. In cancer research, AI enhances diagnostic techniques, treatment approaches, and the process of discovering new drugs, holding the promise of better outcomes for patients. Moreover, AI emerges as an indispensable tool in human and veterinary health research for the early identification, containment, and precise diagnostics of zoonotic and re-emerging diseases, as evidenced during the COVID-19 pandemic. Additionally, AI's capabilities in genomic studies contribute significantly to personalized medicine initiatives. In the arena of drug research and development, AI simplifies processes, identifies fresh drug targets, and refines clinical trial designs. However, challenges persist in veterinary diagnostic imaging datasets due to species variability and the scarcity of standardized instances of emerging diseases for algorithmic training. Encouraging the utilization of veterinary databases like the Veterinary Medical Database (VMDB) can aid in training of AI algorithms for veterinary practice and research. While interest in adopting AI in human medical radiology is growing, a gap in knowledge persists in veterinary medicine. A hybrid approach that combines new and traditional methodologies could facilitate a seamless transition to AI integration in veterinary practice and research.

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