IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Exploring the Latest Biosensing Trends with Artificial Intelligence (AI) and Machine Learning (ML)

KIRTI AKSHAYA[1] *

[1] Department of Science and Humanities, CHRIST (Deemed to be University), Kanminike, Bengaluru, Karnataka, India.

***Corresponding author**

Kirti Akshaya

[1] Department of Science and Humanities, CHRIST (Deemed to be University), Kanminike, Bengaluru, Karnataka, India.

Abstract

Machine learning algorithms can uncover relationships in data that cannot be detected by traditional analysis methods. Biosensors are known to provide greater accuracy and sensitivity when producing complex data. In this article, the authors explore current issues in the application of artificial intelligence and machine learning for biosensing applications. The authors will discuss how these techniques can be used to increase the accuracy and efficiency of information. The potential impact of these advances on healthcare and other sectors will also be examined. Surprisingly, machine learning algorithms learn from large amounts of data, allowing them to find hidden relationships.

Keywords: Artificial intelligence, Artificial intelligence of things, Machine learning, Biosensing.

Introduction

Biosensors have proven useful in many important fields such as medicine, food safety, environmental monitoring, security, medical and research science. One of the biosensor business areas is diagnostic equipment [1]. While traditional analytical methods are important in centralized laboratories where large sample volumes and immediate responses are not required, easy-to-use and rapid point-of-care biosensors that can be used effectively anywhere may be a revolutionary tool for disease control [2]. Early diagnosis is important in many diseases such as infectious diseases, cancer, heart diseases, autoimmune diseases, and inflammatory diseases, and time is critical for treatment (3). Artificial intelligence and machine learning algorithms analyze biosensor data to tailor treatment plans to individual patients. This approach is particularly useful in oncology, where biosensors can monitor tumor markers and adjust treatments accordingly. Artificial intelligence and machine learning are helping create compact, wearable biosensors that can continuously and instantly monitor a variety of biomarkers. These sensors are used in applications such as health monitoring, health tracking, and early disease detection [4]. Biosensors equipped with intelligent algorithms can help diagnose and treat neurological diseases such as epilepsy and Parkinson's disease by monitoring real-time neural activity and neurotransmitter levels [5]. Artificial intelligence-powered biosensors are used to monitor the environment and detect bacteria, viruses and toxins in air, water and soil. These sensors help ensure the safety of our environment and have applications in disaster management. Biosensors and machine learning models are used to detect contaminants, allergens, and spoilage, helping to improve food safety and quality control [6]. Machine learning algorithms are used to analyze biosensor data generated during drug testing. This accelerates drug discovery by identifying potential drug users and predicting their effectiveness. The combination of biosensors and artificial intelligence creates interventions for people with disabilities that can convert nerve signals into commands for artificial or assistive devices [7]. Intelligent biosensors can help us understand the impact of pollution on human health by monitoring air quality, water quality and other environmental factors. As telemedicine services grow, biosensors and artificial intelligence play an important role in remote patient care, allowing doctors to monitor patients' conditions and intervene by making necessary improvements [8]. This article describes the latest biosensing trends in artificial intelligence (AI) and machine learning (ML).

Advanced Machine Learning (ML) in Biosensors

ML can improve accurate chemometrics Learn and make smart biosensors. Additionally, these smart biosensors can be easily integrated into the Internet of Things (IoT). It provides a comprehensive introduction to various machine learning algorithms and their applications in various biosensors [9]. Advanced machine learning methods have an advantage over traditional methods because they can identify abnormal biological patterns by identifying anomalies. This particular ability has the potential to be interesting for solving difficult problems in the field of biosensors [10]. The relationship between AI, ML, DL and various ML algorithms is shown in the diagram (Figure 1).

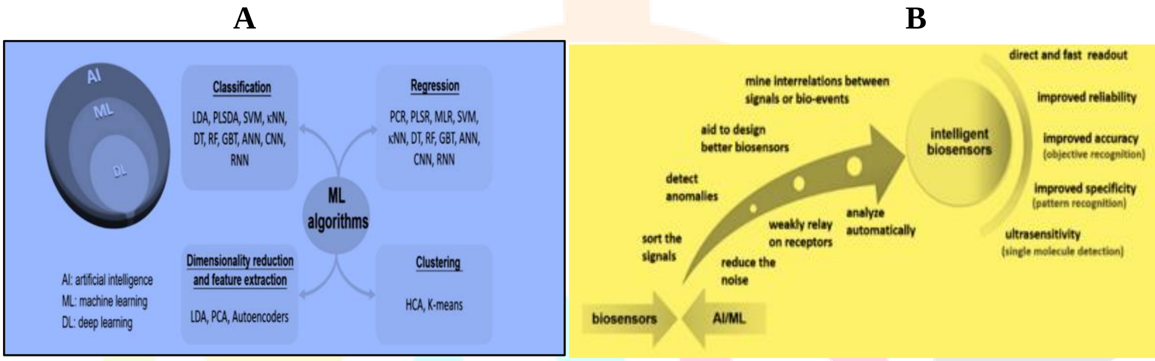

Figure.1 A, This image shows the relationship between AI, ML, and DL, and various ML Algorithms involved in this review. B, ML improves biosensing capability of biosensors.

First of all, machine learning can work effectively with large data sets consisting of matrices or patterns. Another benefit of machine learning in biosensors is that appropriate analytical results can be obtained from noisy and low resolution data. Additionally, using machine learning, the relationship between parameters and indicators from visual data, and the relationship between signals and events can be found biologically [11]. Machine learning can be used to analyze data from biosensors in a variety of ways, including classifying recognition signals based on target analytes. Therefore, machine learning models can be trained to distinguish between noise. Object recognition and pattern recognition. ML algorithms can easily interpret the desired data by discovering potential objects and patterns. ML algorithms can easily interpret desired data by discovering potential objects and patterns [12].

The use of machine learning (ML) can increase the accuracy and speed of sensor data in biosensor reading for detection and diagnostic purposes. For example, the Oringer team developed a visual aid from a CNN algorithm that could predict diagnostic results in 150 seconds [13]. However, interpretation of the images still requires approximately 30 minutes of manual guidance from the doctor. ML can also create better biosensors by using materials with negative magnetic and dielectric constants to display the signals of surface plasmon resonance (SPR)-based biosensors [14]. To ensure good resonance, it is important to prepare metamaterials with various interference properties. To estimate the sensitivity of metamaterial SPR biosensors, researchers used autoencoders (AEs) and multilayer detectors (MLPs). Then, they used t stochastic neighbor embedding (t-SNE) and AE to reduce redundancies and perform k-means clustering of metamaterials [15]. This combination could help researchers create more efficient tools without the need for extensive testing.

AI-ML Revolutionizing Biosensing

To better understand the latest AIML trends in biosensing, it is important to understand the importance of biosensing. Biosensors are analytical devices that combine biological materials with physical or chemical properties to detect specific signals or molecules. They have many applications, including diagnostics, environmental monitoring, food safety and biotechnology [16]. The combination of AIML technology with biosensor increases the potential of biosensors. So let's take a look at how AIML is changing biosensing:

- Data analysis and pattern recognition: AIML algorithms are very good at analyzing complex data generated by biosensors. They can identify patterns, anomalies, and trends within the data, improving the accuracy and reliability of biosensing devices.
- Real-time Monitoring: AIML-powered biosensors provide real-time monitoring of biological parameters, enabling quick interventions in healthcare and environmental contexts.
- Sensitivity and Specificity: AIML algorithms can optimize biosensors to achieve higher sensitivity and specificity, reducing the occurrence of false positives and negatives in diagnostic assessments.
- Predictive Analytics: AIML models can predict future trends and events based on biosensor data, helping to forecast diseases and environmental changes.

Despite the remarkable advancements, integrating AIML into biosensing faces several challenges that need to be addressed [17]. These challenges include:

- Data Privacy and Security: The collection of sensitive health and environmental data raises concerns about privacy and security. Therefore, it is crucial to ensure robust data protection and secure data transmission.
- Ethical Considerations: The use of AIML in biosensing, particularly in healthcare, requires careful examination of ethical implications. Issues like informed consent, data ownership, and algorithmic biases demand meticulous scrutiny to ensure that ethical standards are met.
- Interoperability: To maximize AIML's potential in biosensing, devices and systems must seamlessly exchange and integrate data. This integration is essential for the efficient functioning of the system.
- Regulation and Standardization: As AIML-fuelled biosensors evolve, regulatory authorities must establish precise guidelines and standards to ensure safety and effectiveness. This step is necessary to prevent possible damage.
- Bias and fairness: In AIML algorithms, especially in diagnosis, it is necessary to be careful against bias and ensure fairness. This measure will encourage participation and prevent discrimination based on factors such as race, gender, age.

Conclusion

Artificial Intelligence (AI) and Machine Learning (ML) have brought about biosensing, healthcare reform, environmental monitoring and many other industries. AIML is advancing our ability to detect and respond to biological and environmental diseases through wearable biosensors, point-of care (POC) diagnostics, neurobiological sensing, and precision agriculture. However, ethics, privacy, and regulatory issues need to be addressed to fully implement AIML-driven biosensing technologies and ensure that they benefit society while reducing risk. Collaboration at AIML will continue to shape the future of biosensing through greater personalization, efficiency and effectiveness in solving health and environmental problems.

Acknowledgements
The author would like to thank and acknowledge Prof. Hari Murthy for his supervision and Christ University, Kengeri campus, Bangalore for providing the resources to write the current manuscript.

References

[1] Ates HC, Nguyen PQ, Gonzalez-Macia L, Morales-Narváez E, Güder F, Collins JJ, Dincer C. End-to-end design of wearable sensors. Nat Rev Mater. 2022;7:887–907.
[2] Cheol Jeong I, Bychkov D, Searson PC. Wearable devices for precision medicine and health state monitoring. IEEE T Bio-Eng. 2018;66:1242–58.
[3] He T, Wen F, Yang Y, Le X, Liu W, Lee C. Emerging Wearable Chemical Sensors Enabling Advanced Integrated Systems toward Personalized and Preventive Medicine. Analyt Chem. 2023;95:490–514.
[4] He T, Lee C. Evolving Flexible Sensors, Wearable and Implantable Technologies Towards BodyNET for Advanced Healthcare and Reinforced Life Quality. IEEE O J Circuits Sys. 2021;2:702–20.
[5] Guo K, Yang Z, Yu CH, Buehler MJ. Artificial intelligence and machine learning in design of mechanical materials. Mater Horiz. 2021;8:1153–72.
[6] Kar A, Ahamad N, Dewani M, Awasthi L, Patil R, Banerjee R. Wearable and implantable devices for drug delivery: Applications and challenges. Biomaterials. 2022;283: 121435.
[7] Kwak JW, Han M, Xie Z, Chung HU, Lee JY, Avila R, Yohay J, Chen X, Liang C, Patel M, Jung I, et al. Wireless sensors for continuous, multimodal measurements at the skin interface with lower limb prostheses. Sci. Transl. Med. 2020;12:eabc4327.
[12] Langley P, Carbonell JG. Approaches to machine learning. J Am Soc Inf Sci. 1984;35:306–6.
[8] Li P, Lee GH, Kim SY, Kwon SY, Kim HR, Park S. From Diagnosis to Treatment: Recent Advances in Patient-Friendly Biosensors and Implantable Devices. ACS Nano. 2021;15:1960–2004.
[9] Lekha S, Suchetha M. Recent Advancements and Future Prospects on E-Nose Sensors Technology and Machine Learning Approaches for Non-Invasive Diabetes Diagnosis: A Review. IEEE Rev Biomed Engin. 2021;14:127–38.
[10] Sun Z, Zhu M, Zhang Z, Chen Z, Shi Q, Shan X, Yeow RCH, Lee C. Artificial Intelligence of Things (AIoT) enabled virtual shop applications using selfpowered sensor enhanced soft robotic manipulator. Adv Sci (Weinh). 2021;8: e2100230.
[11] Shi Q, Dong B, He T, Sun Z, Zhu J, Zhang Z, Lee C. Progress in wearable electronics/ photonics—Moving toward the era of artificial intelligence and internet of things. InfoMat. 2020;2:1131–62.
[12] Shi Q, Zhang Z, Yang Y, Shan X, Salam B, Lee C. Artificial Intelligence of Things (AIoT) enabled floor monitoring system for smart home applications. ACS Nano. 2021;15:18312–26.
[13] Mohankumar P, Ajayan J, Mohanraj T, Yasodharan R. Recent developments in biosensors for healthcare and biomedical applications: A review. Measurement. 2021;167: 108293.
[14] Tan M, Xu Y, Gao Z, Yuan T, Liu Q, Yang R, Zhang B, Peng L. Recent advances in intelligent wearable medical devices integrating biosensing and drug delivery. Adv Mater. 2022;34:2108491.
[15] Zhou H, Xu L, Ren Z, Zhu J, Lee C. Machine learning-augmented surfaceenhanced spectroscopy toward next-generation molecular diagnostics. Nanoscale Adv. 2023;5:538–70.
[16] Zhang Z, Wang L, Lee C. Recent advances in artificial intelligence sensors. Adv Sens Research. 2023: 2200072.
[17] Zhu J, Liu X, Shi Q, He T, Sun Z, Guo X, Liu W, Sulaiman OB, Dong B, Lee C. Development trends and perspectives of future sensors and MEMS/ NEMS. Micromachines (Basel). 2019;11:7.