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A review of Artificial Intelligence techniques for intelligent monitoring, disease diagnosis and smart system applications

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Abstract

Artificial Intelligence (AI) and Internet of Things (IoT) technologies are playing a crucial role in the development of intelligent monitoring and decision-support systems across multiple domains. These technologies enable automated data collection, real-time analysis, and rapid response mechanisms for improving safety, efficiency, and decision-making in complex environments. Recent research has demonstrated the successful application of AI techniques across smart infrastructure monitoring, healthcare diagnostics, education systems, and industrial predictive maintenance. IoT-based monitoring frameworks have been proposed to enhance urban safety by detecting hazardous environmental conditions, while deep learning models have shown promising results in medical image analysis for early disease detection, including pneumonia, cardiovascular disorders, and various cancers. In addition, machine learning and deep learning approaches have been widely applied to analyse ECG signals, medical imaging data, and biomedical signals for accurate disease diagnosis. AI-driven educational platforms and recommender systems have also been developed to improve student learning outcomes and employability. Furthermore, predictive maintenance systems using advanced deep learning models have been applied in industrial applications to monitor equipment health and predict failures. Recent studies also explore advanced computational models in fluid dynamics, renewable energy systems, and nanofluid heat transfer analysis. This review provides a comprehensive overview of recent advancements in AI-driven intelligent systems and highlights their growing impact across engineering, healthcare, and smart technology applications.

Keywords: Artificial Intelligence; Machine Learning; Deep Learning; IoT; Predictive Maintenance; Intelligent Monitoring Systems; Smart Applications

1. Introduction

Artificial Intelligence (AI) and Internet of Things (IoT) technologies are increasingly used to develop intelligent monitoring and decision-support systems for smart infrastructure and urban safety. These systems enable real-time data collection, automated analysis, and rapid response mechanisms to detect hazardous conditions in urban environments. For example, IoT-based monitoring frameworks have been developed to supervise underground sewer systems and detect dangerous conditions such as toxic gas accumulation and abnormal temperature levels. Gandhi et al. proposed an IoT-based sewer vault monitoring and cautioning system that continuously monitors environmental parameters and issues alerts during hazardous situations [1]. AI techniques have also demonstrated strong potential in healthcare diagnostics, particularly in medical image analysis. Deep learning models, especially convolutional neural networks (CNNs), have been applied to detect respiratory diseases from chest X-ray images, enabling faster, more accurate diagnosis of pneumonia and other pandemic pathogens [2]. Similarly, AI-driven systems are being used in educational platforms to improve student employability through intelligent learning management systems that provide skill assessment, career guidance, and predictive placement analysis [3]. In industrial applications, AI-based predictive

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maintenance frameworks integrate techniques such as YOLOv5, Random Forest regression, and neural networks to monitor aircraft components and predict remaining useful life of critical systems [4].

AI-based sensor systems are also used in safety applications, such as smart borewell rescue systems that detect accidents, automatically alert emergency services, and activate rescue mechanisms [5]. Furthermore, machine learning-based recommender systems using the VAK learning model have been proposed to personalize learning strategies and improve student academic performance [6]. Artificial intelligence techniques are increasingly used for diagnosing cardiovascular disease. Deep learning models analyze electrocardiogram (ECG) signals to detect heart disease, and hybrid approaches combining GAN and LSTM help address imbalanced datasets and improve detection accuracy [7]. Deep learning techniques have also been used for detecting coronary artery disease from ECG signals. Ensemble models that combine architectures such as autoencoders and self-organizing maps have shown improved diagnostic performance when evaluated on standard datasets like MIT-BIH and PTB-ECG [8]. Machine learning techniques have also been applied for heart disease detection using heart sound signals. For instance, ML-based diagnostic models have been developed to analyze imbalanced phonocardiogram datasets and improve the accuracy of automated heart disease detection systems [9]. Deep learning techniques have also been applied for cancer diagnosis using medical imaging data. For example, an intelligent framework integrating deep learning, meta-heuristic optimization, and multi-criteria decision-making (MCDM) algorithms has been proposed to detect thyroid cancer from ultrasound and histopathological images with improved diagnostic performance [10].

Comprehensive studies have also reviewed the application of machine learning and deep learning techniques for heart disease diagnosis, highlighting their effectiveness in analyzing medical data and improving early detection and clinical decision-making [11]. Advanced image processing and deep learning techniques have also been applied for ophthalmic disease diagnosis. For instance, glaucoma detection systems have been developed using Discrete Ripplet-II Transform-based feature extraction combined with metaheuristic-optimized feature selection to improve classification performance in retinal fundus images [12]. Optimization-based machine learning techniques have also been explored for medical diagnosis. For example, thyroid cancer detection frameworks have been developed using binary variants of the FOX optimization algorithm combined with ensemble ranking methods to improve feature selection and classification performance [13]. Deep learning methods have also been applied for automated cancer detection from medical images. For instance, efficient deep learning frameworks have been developed to detect Acute Lymphoblastic Leukemia from microscopic blood cell images, improving the accuracy and reliability of computer-aided diagnostic systems [14]. The integration of IoT and deep learning technologies has also been explored in healthcare systems for remote disease diagnosis. For example, an IoT-enabled smart healthcare framework has been proposed for thyroid cancer detection using deep learning techniques to analyze medical data and support early clinical decision-making [15].

Advanced deep learning techniques have also been used for heart disease diagnosis by analyzing multiple medical data sources. For instance, fast detection frameworks using Winograd transform-based models have been developed to analyze ECG signals and chest X-ray images for accurate identification of heart disease [16]. Recent studies have also reviewed advancements in computational models of fluid flow and their applications in solving complex engineering and scientific problems [17]. Recent studies have also explored the integration of renewable energy sources and storage systems in multi-carrier energy systems (MCES) to address operational uncertainties and improve energy efficiency using stochastic optimization frameworks [18]. Recent studies have also investigated fluid-flow and heat-transfer behavior in two-phase boundary layer systems over inclined stretching surfaces, considering factors such as electrification, transverse forces, and particle interactions to improve the understanding of complex thermal and flow dynamics in engineering applications [19]. Recent studies have also examined nanofluid flow behavior over inclined stretching sheets in porous media to understand heat transfer and fluid dynamics in advanced thermal systems. For instance, investigations on Fe_3O_4 -ethylene glycol nanofluid flow analyzed the combined influence of inclination angle and porous medium on velocity and temperature characteristics, contributing to improved modeling of nanofluid-based heat transfer applications [20]. This technique aims to improve system dependability by tackling the inherent uncertainty associated with green energy supplies. The chief aim of this effort is to speech the complex issue of power organization fashionable a smart city, including the doubts related with renewable energy sources then the incorporation of demand response programs (DRPs). To tackle these difficulties, the paper utilizes the integrated inside the Python program while doubts fashionable the scheme is demonstrated using the Monte Carlo technique. The findings indicate that accounting for the variability of green energy supplies may decrease the overall system cost by 504 \$ via the use of Demand Response Programs (DRP) [21]. This paper presents an efficient full approximation scheme-full multilevel (FAS-FML) algorithm for the radial basis function-based finite difference (RBF-FD) method. The algorithm produces an accurate solution by solving the discretized equations from the coarsest level to the coarser level and then to the finer level to desire the finest level node points [22]. The Kansa method, the Hermite symmetric approach, the localized method, and the hybrid method are some of the generalized RBF approaches we study in this

paper. We also talked about how mesh-free solutions like RBF are preferred over mesh-based ones. Also mentioned is a recent advancement in RBF approximation for PDE solution [23].

2. Conclusion

Artificial Intelligence technologies have become essential tools for developing intelligent monitoring and diagnostic systems across various domains. Machine learning and deep learning models enable efficient analysis of large datasets and provide accurate predictions in healthcare, industrial monitoring, and smart infrastructure applications. The integration of AI with IoT technologies further enhances the capability of real-time monitoring systems by enabling continuous data collection and automated analysis. Despite the significant progress in AI-based systems, several challenges remain, including data privacy concerns, computational complexity, and the need for large annotated datasets. Future research should focus on developing more interpretable AI models, improving data integration techniques, and designing scalable intelligent systems capable of handling diverse real-world applications.

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest among the authors

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