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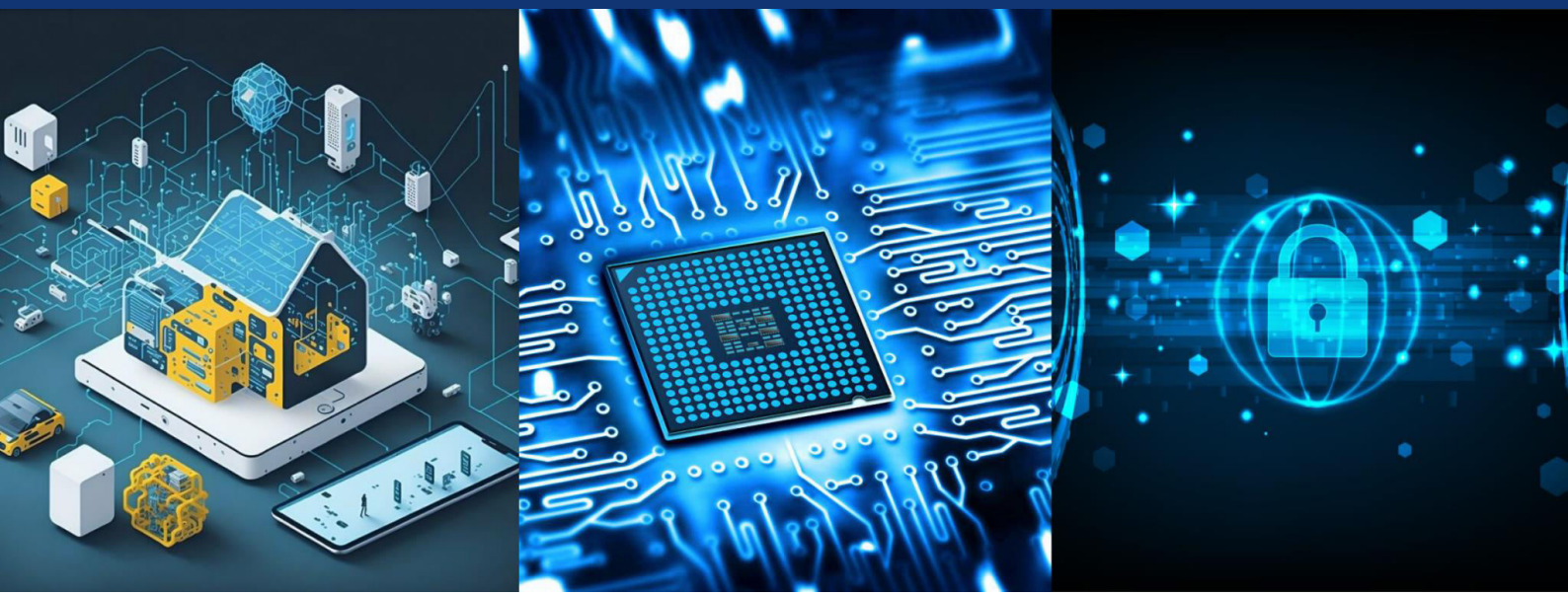

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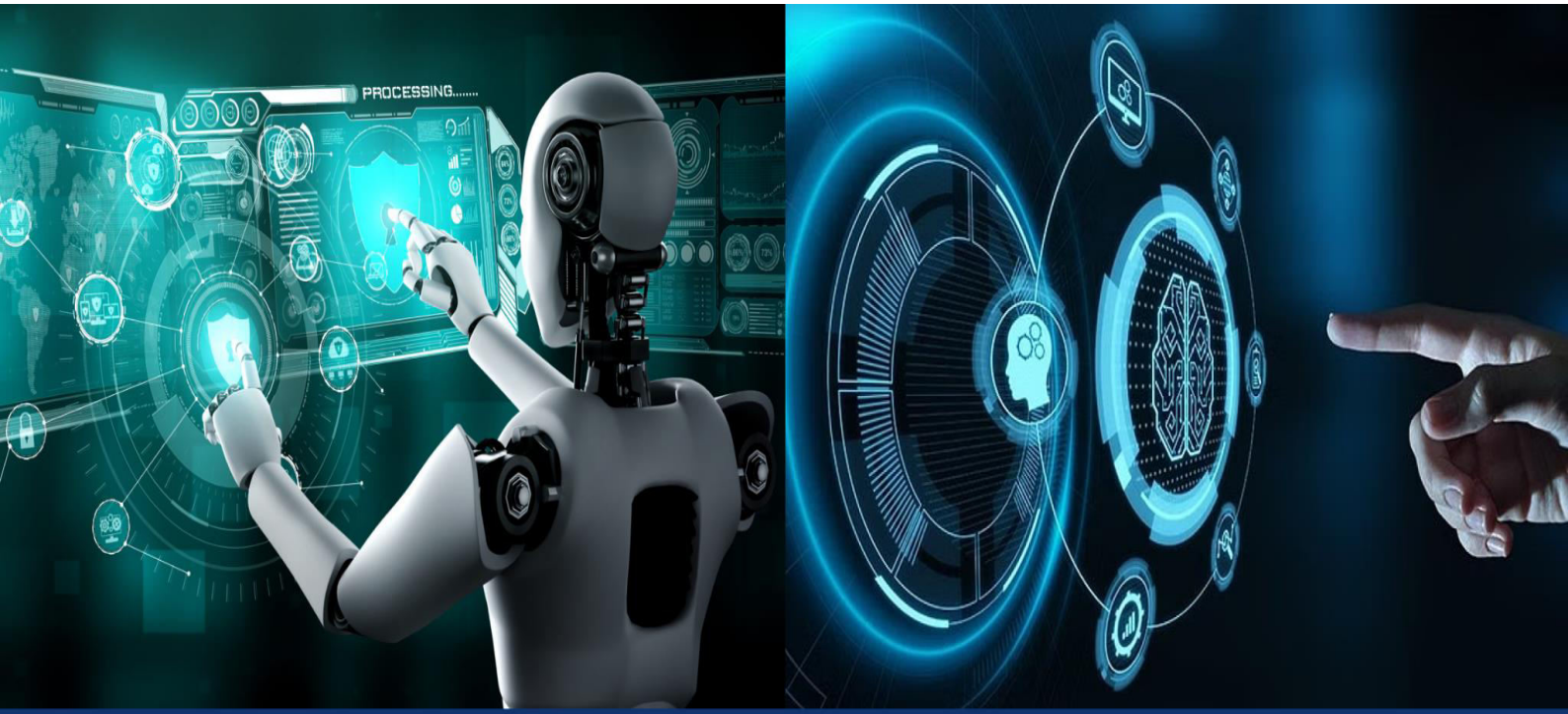

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Deep Learning Approaches for Cancer Detection

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ABSTRACT: Cancer is one of the major causes of death in the world. It plays a significant role in the survival rate of patients. So far, various detection techniques have been used to identify cancer in patients. However, traditional detection techniques are based on manual interpretation of results, which are often time-consuming and lead to inaccurate results. In recent times, deep learning has been identified as a significant technique in cancer detection. This paper seeks to give a detailed review of deep learning in cancer detection based on various studies published between 2020 and 2025. Deep learning techniques have been identified as significant in cancer detection. Convolutional neural networks are among the deep learning techniques that have been used in cancer detection in recent times. They have been used to identify various types of cancer in patients using various medical images such as MRI scans, mammograms, and computer tomography scans. Deep learning techniques have been identified as accurate in detecting various types of cancer in patients. Recent advancements in deep learning have been identified as significant in cancer detection.

KEYWORDS: Deep Learning, Cancer Detection, Convolutional Neural Networks (CNN), Medical Image Analysis, Machine Learning, Early Diagnosis, Computer-Aided Diagnosis (CAD), Deep Learning Models, MRI, CT Scan, Histopathology, Multimodal Learning, Artificial Intelligence in Healthcare

I. INTRODUCTION

Cancer is one of the most serious health problems in the world, causing millions of deaths annually. Early and precise detection of cancer is known to increase the chances of successful treatment and survival. Conventional methods of cancer detection, such as biopsy tests, CT scans, MRI scans, and mammograms, heavily rely on the interpretation of medical experts. However, these methods are often considered cumbersome and sometimes prone to errors due to the complexity of medical data.

In recent years, the rapid development of Artificial Intelligence (AI), especially deep learning, has revolutionized the medical diagnostic field. Deep learning methods, especially Convolutional Neural Networks (CNNs), have shown impressive potential in processing complex medical images and detecting patterns that are not easily recognizable to the naked eye. These methods are known to automatically learn complex features from large data sets, making them ideal for cancer detection.

Deep learning has been used for various types of cancer detection, including lung cancer, breast cancer, brain tumor, and skin cancer. Various techniques such as transfer learning, data augmentation, and multimodal learning have also been used for improving the performance of deep learning models. Moreover, the integration of image data and genomic data for improving cancer diagnosis is another important application of deep learning models in healthcare.

However, various challenges still exist in using deep learning models in healthcare, including insufficient labeled data, class imbalance, lack of interpretability, and difficulty in using deep learning models in real-world environments. The paper presents a detailed review of deep learning techniques in cancer detection, with a focus on recent developments, popular techniques, and challenges associated with deep learning methods. In addition, the study reveals future research directions in deep learning techniques for cancer detection.

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II. REVIEW OF EXISTING PAPERS

1. Deep Learning Approaches for Lung Cancer Detection — Ganesh et al. (2024)
A comprehensive analysis of deep learning techniques in the detection of lung cancer by Ganesh et al. (2024) uses medical imaging data. In the analysis, the performance of different CNN-based architectures is evaluated, and their efficiency in detecting lung nodules from CT scans is highlighted. In addition, the analysis showed that deep learning techniques are significantly better than conventional techniques in terms of accuracy and speed of detection. However, some of the challenges identified in the analysis include dataset limitation and generalization of the models.

2. Deep Learning for Cancer Detection Using Genomic and Imaging Data — Wang and Su (2025)
In a study by Wang and Su (2025), the focus was on integrating genomic and image data for cancer detection using deep learning algorithms. In their review, they emphasized how multimodal learning helps improve accuracy in making predictions. However, they also noted some of the challenges, such as complexity and computational costs, in integrating data and using these algorithms for cancer diagnosis.

3. Real-Time Deep Learning for Cancer Diagnostics — Sriraman et al. (2024)
Sriraman et al. (2024) published a systematic review on real-time deep learning techniques used in image-based cancer diagnostics. The paper focuses on various real-time detection techniques and their applications in real-world environments. The authors conclude that deep learning techniques can help in quicker and more accurate diagnostic procedures. However, they also highlight some of the real-time processing and hardware dependency issues.

4. Clinical Cancer Detection Using Deep Learning — Yao et al. (2025)
Yao et al. (2025) discussed the application of deep learning models for clinical cancer detection and the challenges associated with it. This paper demonstrates the contribution of AI models towards the assistance of doctors for better diagnoses and decisions. In the paper, various challenges and their solutions are discussed.

5. Machine Learning in Early Cancer Detection — Zou (2025)
In the research paper "Review of Machine Learning and Deep Learning Techniques for Early Cancer Detection," Zou (2025) discusses the importance of early cancer detection in increasing survival rates. Various algorithms are described in the research. There are certain limitations mentioned in the research, such as data imbalance and lack of strong data sets.

6. Deep Learning in Breast Cancer Image Analysis — Debelee et al. (2020)
A survey by Debelee et al. (2020) discussed various deep learning techniques for the analysis of images related to breast cancer. In the survey, various CNN models are discussed, along with the performance of these models on mammogram images. The survey concludes that deep learning models are very effective for the analysis of images related to breast cancer. However, these models require a large amount of labeled data for proper performance.

7. Artificial Intelligence in Healthcare and Cancer Detection — Jiang et al. (2020)
Jiang et al. (2020) discussed the impact of artificial intelligence in healthcare services, including cancer detection. The paper focuses on an overview of artificial intelligence and its evolution in healthcare services. The authors highlight that artificial intelligence helps in improving diagnostic accuracy, along with data privacy concerns.

8. Deep Learning in Medical Image Analysis — Litjens et al. (2021)
The paper by Litjens et al. (2021) gives an overall review of deep learning methods for image analysis in medicine. In their paper, they discuss various architectures, including CNNs, and their applications for detecting various diseases, e.g., cancer. They conclude that deep learning methods are dominant in medicine, although they have their challenges too.

9. Breast Cancer Detection Using Deep Learning — Brancati et al. (2022)
Brancati et al. (2022) suggested a deep learning method for breast cancer detection using images of mammograms. This model was more accurate in detecting cancerous tumors. This study also indicates the need for preprocessing and feature extraction methods in improving the accuracy of models.

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10. Convolutional Neural Networks for Cancer Detection — Khan et al. (2023)
Khan et al. (2023) published a paper titled "Guide to Convolutional Neural Networks for Cancer Detection." In the paper, the authors describe how CNNs work for feature extraction from images and how they help increase the accuracy of classification. They also describe the challenges associated with CNNs, including overfitting and the need for large training sets.

III. COMPARISON WITH EXISTING PAPERS

Based on the existing literature, it can be observed that deep learning methods, especially CNNs, are used for various types of cancer detection tasks. Most existing literature, such as the works done by Ganesh et al. (2024), Debelee et al. (2020), Brancati et al. (2022), highlight the use of deep learning methods for image-based cancer detection tasks and report high accuracy for detecting tumors using various medical images such as CT scans and mammograms. In addition, the works done by Khan et al. (2023) and Litjens et al. (2021) emphasize the significance of CNNs for feature extraction and image analysis.
On the contrary, various sophisticated methods such as multimodal deep learning proposed by Wang and Su (2025) report better predictive accuracy for detecting various types of cancers by considering various inputs such as genomic and imaging data. However, the methods require high computational power for better performance. In addition, real-time deep learning methods proposed by Sriraman et al. (2024) report high accuracy for detecting various types of cancers and emphasize the significance of real-time diagnosis. However, the methods require specialized hardware for better performance.

The work done by Yao et al. (2025) highlights the application of deep learning methods for clinical environments. However, lack of interpretability and trust are significant challenges for the application of deep learning methods. It can be concluded that although the performance of deep learning models in cancer detection tasks significantly outperforms other methods, there are challenges that need to be addressed in the future.

Author & Year	Technique Used	Data Type	Application	Key Strength	Limitation
Ganesh et al. (2024)	CNN-based deep learning models	CT scan images	Lung cancer detection	High accuracy in detecting lung nodules	Limited dataset and generalization issues
Wang & Su (2025)	Multimodal deep learning	Genomic + imaging data	General cancer detection	Improved prediction using combined data	High computational complexity
Sriraman et al. (2024)	Real-time deep learning models	Medical images	Real-time cancer diagnostics	Faster processing and detection	Requires specialized hardware
Yao et al. (2025)	Deep learning in clinical AI	Clinical data	Clinical cancer detection	Assists medical decision-making	Lack of interpretability
Zou (2025)	Machine learning & deep learning	Imaging datasets	Early cancer detection	Improves early diagnosis accuracy	Data imbalance issues
Debelee et al. (2020)	CNN architectures	Mammogram images	Breast cancer detection	Strong performance with CNNs	Requires large labeled datasets
Jiang et al. (2020)	AI & machine learning techniques	Healthcare data	General healthcare applications	Broad overview of AI benefits	Ethical and privacy concerns
Litjens et al. (2021)	Deep learning models	Medical images	Medical image analysis	Comprehensive review and analysis	Model interpretability issues
Brancati et al. (2022)	Deep learning model	Mammogram images	Breast cancer detection	Improved classification accuracy	Limited dataset generalization
Khan et al. (2023)	CNN-based approach	Medical images	Cancer detection	Strong feature extraction capability	Overfitting problems

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IV. RESEARCH GAP

From the analysis of existing literature on various deep learning models for cancer detection, some gaps were identified, which need to be filled for further improvement of these models. Firstly, from the analysis of existing literature on various deep learning models for cancer detection, it was identified that most of the existing models were tested on small-scale data sets, which impacts the performance of these models on unseen real-time data sets. Secondly, class imbalance is a major problem in cancer detection using medical images, as the number of images containing cancer is much lower compared to images containing healthy tissue.

Another major gap was identified in the existing literature on various deep learning models for cancer detection, i.e., lack of interpretability of these models. Most of the CNN-based models are considered "black box" models, and it is difficult for medical experts to trust these models for cancer detection purposes. Furthermore, it is difficult to deploy these models in real-time applications because of their high computational requirements.

Furthermore, though multimodal models using images and genomics data show improved performance, integrating multimodal models is complex and requires a lot of computation power. Lastly, only a handful of studies are aimed at real-world validation of models, which is critical before they are applied in hospitals.

In conclusion, it is critical in the future that more emphasis is put on creating efficient, robust, and explainable models of deep learning that are capable of dealing with large and diverse data sets and are easily deployable in hospitals.

V. CONCLUSION

Deep learning has been found to be an effective and efficient tool for the detection of cancer, which has greatly enhanced the accuracy of detection while minimizing the dependency on human understanding. Based on the analysis of existing literature between 2020 and 2025, it has been found that deep learning techniques, especially CNNs, have achieved remarkable results for the detection of various types of cancers using various forms of medical imaging techniques such as CT scans, MRI scans, and mammograms. Even new forms of techniques such as multimodal learning have been found to enhance the prediction capabilities for cancer detection.

Although deep learning has achieved significant success in the detection of cancer, various issues still need to be addressed. These issues include the lack of labeled data, class imbalance, lack of interpretability, high computational costs, and the lack of validation of existing models for real-world environments.

To overcome these problems, it is recommended that in the future, research should be conducted to create efficient, robust, and explainable deep learning models that can easily generalize across various data sets. Furthermore, efforts should be made to incorporate these models in such a manner that doctors can use them to make appropriate and timely decisions. Deep learning has the potential to revolutionize cancer detection and can prove to be a key player in increasing the survival rates of cancer patients.

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