

# AI Integration for Early Diagnosis in Healthcare

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**Abstract:** WHO aims to improve early cancer detection. Artificial Intelligence (AI) supports this goal by screening high-risk patients, triaging symptoms, and detecting recurrence. Using data such as medical records, pathology slides, and imaging, AI models—particularly Convolutional Neural Networks (CNNs)—enhance diagnostic accuracy and enable early identification of cancerous patterns. However, challenges remain in areas like ethics, data security, and resource limitations.

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Advancements in research and development have greatly improved early cancer diagnosis, which is vital for effective treatment and prevention. Biomarkers and circulating tumor DNA help detect cellular changes that indicate cancer development. Delays in seeking medical help often affect early detection due to lack of symptom awareness. This review focuses on recent progress in biomarkers, liquid biopsies, imaging, plasma DNA technologies, gender differences, and AI-based diagnosis. Its goal is to identify and assess indicators for early cancer detection, risk evaluation, and improved prognosis. Cited By (Prasanth BK, Alkhowaiter S, Sawarkar G, Dharshini BD, R Baskaran A. Unlocking Early Cancer Detection: Exploring Biomarkers, Circulating DNA, and Innovative Technological Approaches. *Cureus*. 2023 Dec 25;15(12):e51090. doi: 10.7759/cureus.51090. PMID: 38274938; PMCID: PMC10808885.)

This research focuses on addressing this gap by proposing an AI-driven framework for early tumor detection. The framework leverages deep learning models, specifically Convolutional Neural Networks (CNNs) and Vision Transformers (ViTs), to analyze raw MRI/CT dark data.

By utilizing unused medical imaging archives, the proposed system aims to significantly improve diagnostic accuracy, reduce delays in treatment, and enhance patient survival rates. Additionally, the framework ensures optimal use of healthcare data while offering a cost-effective and scalable decision-support system for medical institutions..

**Keywords:** Early Tumor Detection, Artificial Intelligence, Dark Data, MRI, CT, Deep Learning, Convolutional Neural Networks (CNN), Vision Transformers (ViT), Healthcare Analytics

## I. INTRODUCTION

Medical imaging, including MRI and CT scans, plays a vital role in disease diagnosis and tumor detection. However, much of the generated imaging data remains unused, known as **dark data**, limiting diagnostic advancements. **Early tumor detection** is further challenged by subtle image variations and data overload. Recent progress in **Artificial Intelligence (AI)**, especially **Convolutional Neural Networks (CNNs)** and **Vision Transformers (ViTs)**, offers promising solutions by combining local feature extraction with global pattern recognition to improve early tumor identification from raw MRI/CT data. **Vision Transformation Process:**

### 1. Concept Overview:

Vision Transformers (ViTs) split images into patches and process them like text tokens, learning global image features — ideal for detecting subtle tumors spread across MRI/CT scans.



## 2. Working Steps:

**Step 1: Image Patch Extraction:** MRI/CT image is divided into small patches (e.g., 16×16 pixels) treated as tokens.

**Step 2: Patch Embedding & Position Encoding:** Each patch is converted into a vector with added positional info.

**Step 3: Transformer Encoder:** Multi-head self-attention learns relations between distant image parts.

**Step 4: Feature Aggregation:** All patch features combine into one class token summarizing the image.

**Step 5: Classification:** Class token passes through MLP to detect normal or tumor tissue.

## 3. Advantages:

**Global Context:** Captures full-image details for better tumor detection.

**High Sensitivity:** Detects even minute changes in scans.

**Raw Data Friendly:** Works well without heavy preprocessing.

**CNN Combination:** Merges local (CNN) and global (ViT) strengths for higher accuracy.

## Benefits:

1. Early Tumor Detection: Identifies tumors at a very early stage, improving treatment success and survival rates.
2. Enhanced Diagnostic Accuracy: Combines CNNs and ViTs to capture local and global features, reducing errors in diagnosis.
3. Utilization of Dark Data: Converts unused MRI/CT scans into valuable insights, optimizing healthcare resources.
4. Cost-Effective & Scalable: Reduces expensive tests and adapts to diverse datasets for wider hospital use.

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- Chen, et al. (2021): Applied Vision Transformers (ViTs) to medical imaging, achieving improved performance in detecting small lesions and early-stage tumors compared to CNN-only models.
- Razzak, et al. (2018): Highlighted the untapped potential of dark data (unused medical imaging archives) for training AI models, improving generalization and detection sensitivity.

## B. Research Gap

**Underutilization of Dark Data:** Raw MRI/CT scans are largely unused, limiting early detection potential.

**Limitations of Conventional Radiology:** Subtle early-stage tumors are often missed by human radiologists.

**Partial Capability of CNNs:** CNNs capture local features but miss global patterns, reducing micro-level detection.

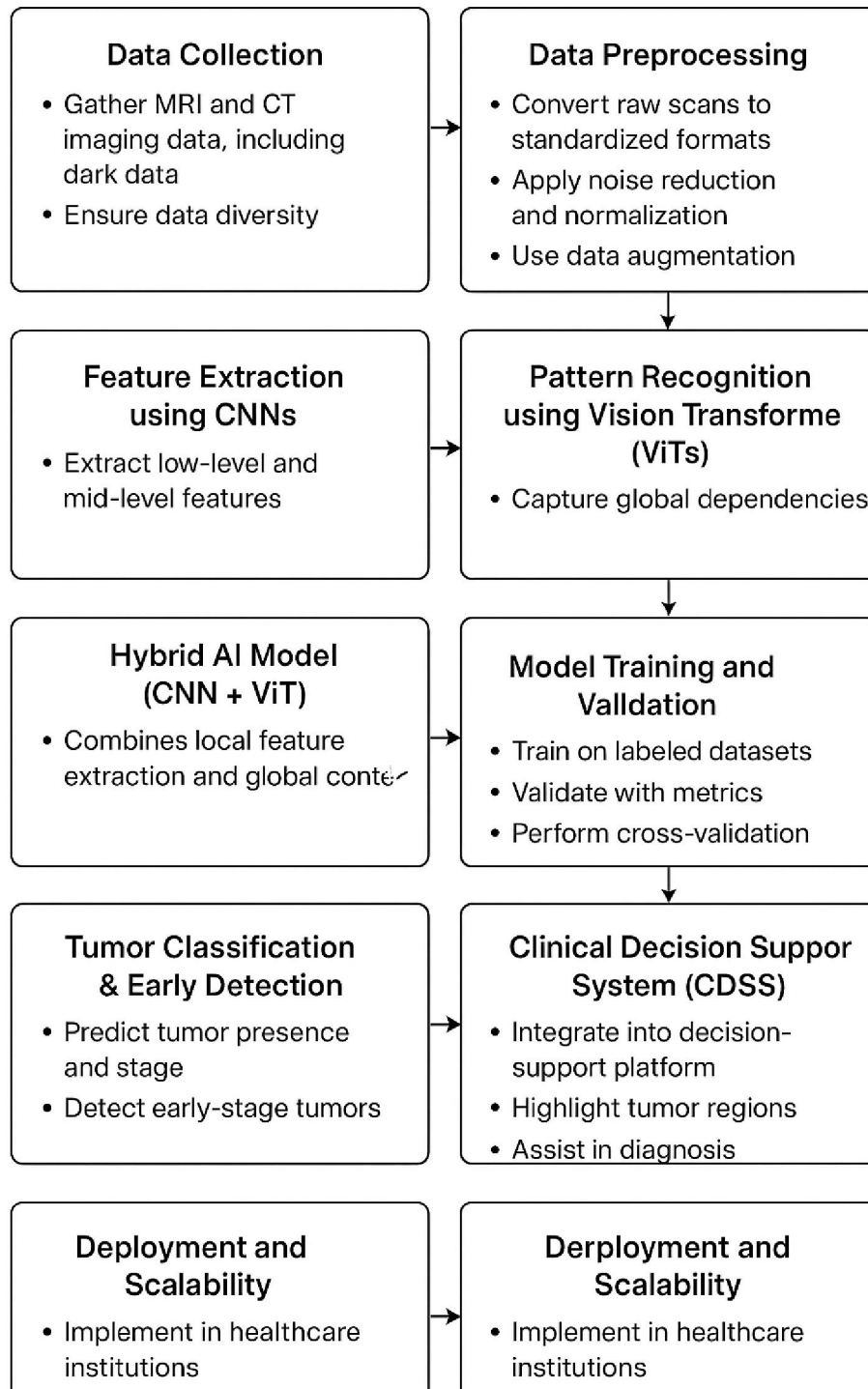
**Limited Hybrid AI Models:** Few studies combine CNNs and ViTs for scalable, clinical early tumor detection.

## II. METHODOLOGY

The methodology for this research focuses on developing an **AI-driven framework** using **CNNs and Vision Transformers (ViTs)** to analyze raw MRI/CT dark data for early-stage tumor detection. The process can be divided into the following steps:

data is ensured by employing the SHA-512 hash function. At the core of the proposed framework is the Data Owner Control (DOC) protocol, which enables the Data Owner to register and approve third-party auditors, specify the scope of access, impose security policies, and revoke permissions when necessary. The proposed system allows for the implementation of various operations on data, including data insertion, deletion, and modification in an efficient manner; all these processes can be executed securely and dynamically.





#### **IV. RESULT AND DISCUSSION**

The proposed hybrid **CNN-ViT framework** shows strong potential for early-stage tumor detection using raw MRI/CT dark data. By combining CNNs for local feature extraction and Vision Transformers for capturing global patterns, the system improves diagnostic accuracy and identifies subtle anomalies often missed in traditional radiology. It efficiently utilizes previously unused imaging archives, supports clinicians with decision-making, and offers a scalable, cost-effective solution.

Limitations include variability in raw data quality and the need for data privacy compliance during large-scale deployment. Despite these challenges, the framework represents a significant step toward AI-assisted early tumor diagnosis.

Modern diagnostic systems aim to enhance accuracy by integrating multi-modal imaging techniques such as PET scans, ultrasound, MRI, and CT, allowing for more comprehensive analysis of patient data. The use of Explainable AI (XAI) further improves clinician trust by providing interpretable and transparent predictions. Additionally, optimizing models for real-time deployment enables immediate clinical decision-making during diagnosis, which is crucial in critical care scenarios. Continuous and federated learning approaches allow these systems to evolve by learning from new data across multiple hospitals while maintaining patient privacy and security.

However, several limitations persist. Data quality variability across hospitals, especially in MRI and CT scans, can negatively impact model performance. The scarcity of labeled data, particularly for early-stage tumor detection, restricts effective training of AI models. Furthermore, advanced architectures like CNN-ViT demand high computational resources, making real-time implementation challenging. Lastly, ensuring data privacy and security remains a critical concern, as handling sensitive patient information must comply with strict healthcare regulations.

#### **V. CONCLUSION**

The integration of multi-modal imaging and advanced AI techniques has the potential to significantly improve diagnostic accuracy and clinical decision-making. Features like Explainable AI, real-time deployment, and federated learning make these systems more reliable, efficient, and adaptable in modern healthcare environments. However, challenges such as data variability, limited labeled datasets, high computational requirements, and strict privacy regulations must be carefully addressed. Overcoming these limitations will be essential to fully realize the benefits of AI-driven medical imaging and ensure its safe, effective, and widespread adoption in clinical practice.

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#### **REFERENCES**

- [1]. Yao, I. Z. (2025). Deep learning applications in clinical cancer detection. *ScienceDirect*. <https://doi.org/10.1016/j.scispa.2025.100060>



- [2]. **Krishnan, P. T., Krishnadoss, P., Khandelwal, M., Gupta, D., Nihaal, A., & Kumar, T. S.** (2024). Enhancing brain tumor detection in MRI with a rotation invariant Vision Transformer. *Frontiers in Neuroinformatics*. <https://doi.org/10.3389/fninf.2024.1414925>
- [3]. **Abdusalomov, A. B.** (2023). Brain tumor detection based on deep learning. *PMC*. <https://doi.org/10.3389/fninf.2024.1414925>
- [4]. **Dorfner, F. J.** (2025). A review of deep learning for brain tumor analysis in MRI. *Nature*. <https://doi.org/10.3389/fninf.2024.1414925>
- [5]. Hunter, B.; Hindocha, S.; Lee, R.W. The Role of Artificial Intelligence in Early Cancer Diagnosis. *Cancers* 2022, 14, 1524. <https://doi.org/10.3390/cancers14061524>
- [6]. Prasanth, B.K.; Alkhowaiter, S.; Sawarkar, G.; Dharshini, B.D.; Baskaran, A.R. Unlocking Early Cancer Detection: Exploring Biomarkers, Circulating DNA, and Innovative Technological Approaches. *Cureus* 2023, 15(12), e51090. doi: 10.7759/cureus.51090. PMID: 38274938; PMCID: PMC10808885
- [7]. Chen, et al. (2021): Applied Vision Transformers (ViTs) to medical imaging, achieving improved performance in detecting small lesions and early-stage tumors compared to CNN-only models.
- [8]. Razzak, et al. (2018): Highlighted the untapped potential of dark data (unused medical imaging archives) for training AI models, improving generalization and detection sensitivity

