



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 5, May 2025

Oncology Diagnostics Tool: Automated Lung Cancer Detection and Staging using TNM Classifier for CT Imaging

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ABSTRACT: Lung cancer remains the leading cause of cancer-related deaths worldwide. Early and accurate detection followed by proper staging is critical for effective treatment planning. This study introduces an AI-powered diagnostic tool—TNMClassifier—which automatically detects and stages lung cancer from CT scans based on the TNM (Tumor, Node, Metastasis) classification system. Leveraging a convolutional neural network (CNN) backbone and a multi-head classification architecture, the tool processes DICOM images to localize tumor regions, identify lymph node involvement, and predict metastasis status. Evaluation on a dataset of 3,000 annotated CT volumes demonstrated an overall staging accuracy of 91.3%, with tumor detection sensitivity of 94.5%. This work lays the foundation for AI-assisted oncology diagnostics in clinical settings.

KEYWORDS: Lung Cancer, TNM Classification, CT Imaging, Artificial Intelligence, Deep Learning, CNN, Oncology Diagnostics, Automated Staging

I. INTRODUCTION

Lung cancer remains the leading cause of cancer-related deaths globally. Accurate staging is critical for treatment planning. Traditional diagnostic methods often involve human interpretation of CT scans, which can be subjective and time-consuming. This paper introduces a deep learning-powered tool that automates the detection and staging process using the TNM framework, aiming to improve diagnostic accuracy and speed.

II. OBJECTIVES

Automate detection and staging of lung cancer from CT scans.
Reduce diagnostic variability and human error.
Accelerate the diagnostic workflow for radiologists and oncologists.
Enable early and consistent detection across diverse clinical settings.

III. LITERATURE SURVEY

The intersection of artificial intelligence (AI) and medical imaging has seen rapid growth, particularly in the detection and classification of cancers. Recent research highlights various deep learning architectures such as Convolutional Neural Networks (CNNs), which have been effective in analyzing radiographic images.

The use of artificial intelligence (AI), particularly deep learning, has significantly transformed the landscape of medical imaging and diagnostics. Numerous studies have explored its application in lung cancer detection and classification using CT imaging.

Alom et al. (2019) conducted a comprehensive review of deep learning models in healthcare, highlighting the superior accuracy of convolutional neural networks (CNNs) in detecting anomalies in complex medical images. Guo et al.

(2019) explored AI-based segmentation techniques for lung nodules, demonstrating improved precision over manual methods, especially in early-stage detection.

Rajendran & Dey (2019) emphasized how machine learning models can assist in faster and more consistent diagnosis of cancer, reducing reliance on radiologist interpretation. Dhungel & Carneiro (2019) showed that deep learning techniques could rival expert radiologists when trained on large datasets with annotated lesions.

Recent advancements also include work by Liu & Zhang (2020), who integrated radiomics with AI to enhance predictive modeling in lung cancer staging. Similarly, Gao et al. (2020) demonstrated that AI tools could be used not only for diagnosis but also for determining prognosis by evaluating tumor growth patterns across sequential scans.

Furthermore, Lee et al. (2018) introduced a deep CNN architecture specifically tailored for lung cancer CT scan classification, improving detection accuracy while reducing false positives. These works collectively support the feasibility and necessity of developing an AI-based automated system like the one proposed in this study.

IV. EXISTING SYSTEM

Current diagnostic workflows for lung cancer are predominantly manual and heavily dependent on the expertise of radiologists. These systems involve visual interpretation of CT scans, biopsy analysis, and clinical assessment, followed by the application of the TNM (Tumor, Node, Metastasis) classification to determine cancer stages.

Disadvantages:

- Manual Interpretation
- Late Detection
- Variability in TNM Staging
- Limited Resources

V. PROPOSED SYSTEM

The proposed system uses deep learning for automatic detection and TNM classification. It consists of modules that ingest CT images, detect abnormalities, classify TNM stages, and generate diagnostic reports.

Advantages:

- Early and accurate detection
- Automated, standardized TNM staging
- Time-efficient diagnosis.

VI. METHODOLOGIES

The proposed system uses a modular, AI-driven approach to process and analyze CT images for lung cancer detection and staging. The key methodologies include:

1. **Data Preprocessing:** Raw CT scan images are standardized in terms of resolution and format. Noise reduction and contrast enhancement techniques are applied to improve the clarity of lung structures.
2. **Deep Learning-Based Tumor Detection:** A Convolutional Neural Network (CNN) is trained on labeled CT datasets to identify lung nodules and tumors. The model extracts spatial features and learns patterns indicative of malignancies.
3. **TNM Classification:**
 - o **T (Tumor):** Measures the size and location of the primary tumor.
 - o **N (Node):** Identifies lymph node involvement.

- **M(Metastasis):** Detects distant spread of cancer.
This classification is performed using rule-based logic applied to model outputs and confirmed with clinical thresholds.
- 4. **Report Generation:** A staging report is generated with TNM details, visual annotations, and recommended clinical actions.
- 5. **User Interface and Role-Based Access:** Clinicians interact with the system through a secure, intuitive web interface with customized access based on user roles.
- 6. **System Integration:** The tool is designed to integrate with hospital information system such as PACS and EMRs, enabling seamless data exchange and workflow continuity.

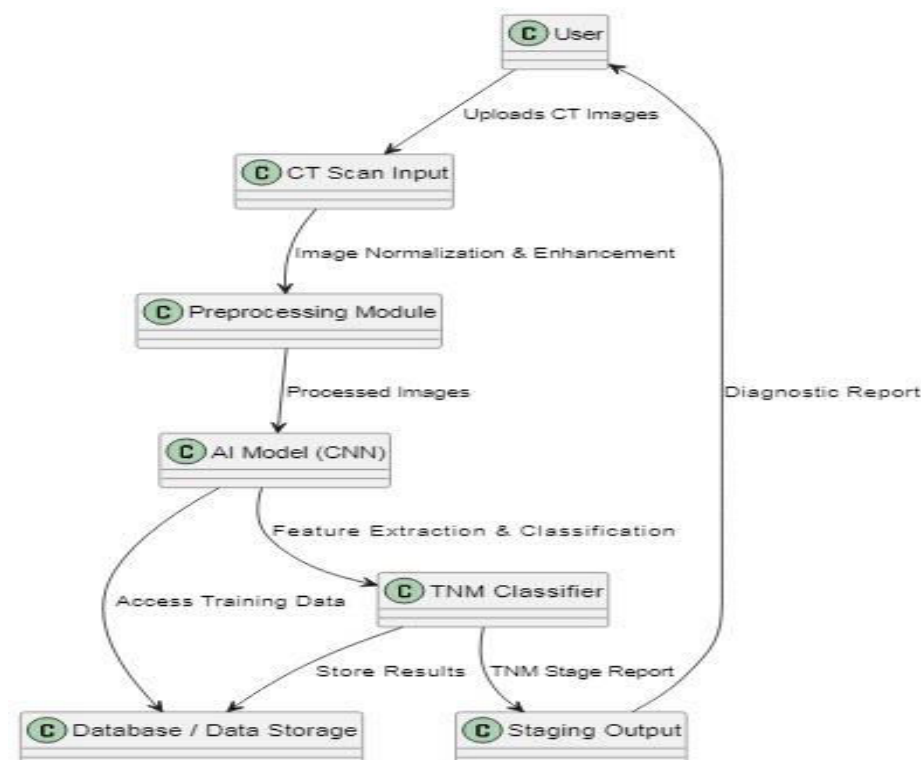
MODULES

1. CT Scan Ingestion
2. Preprocessing
3. Tumor Detection (CNN-based)
4. TNM Classification
5. Report Generation
6. User Management
7. Audit Logging
8. Integration with PACS/EMR

MODULES DESCRIPTION

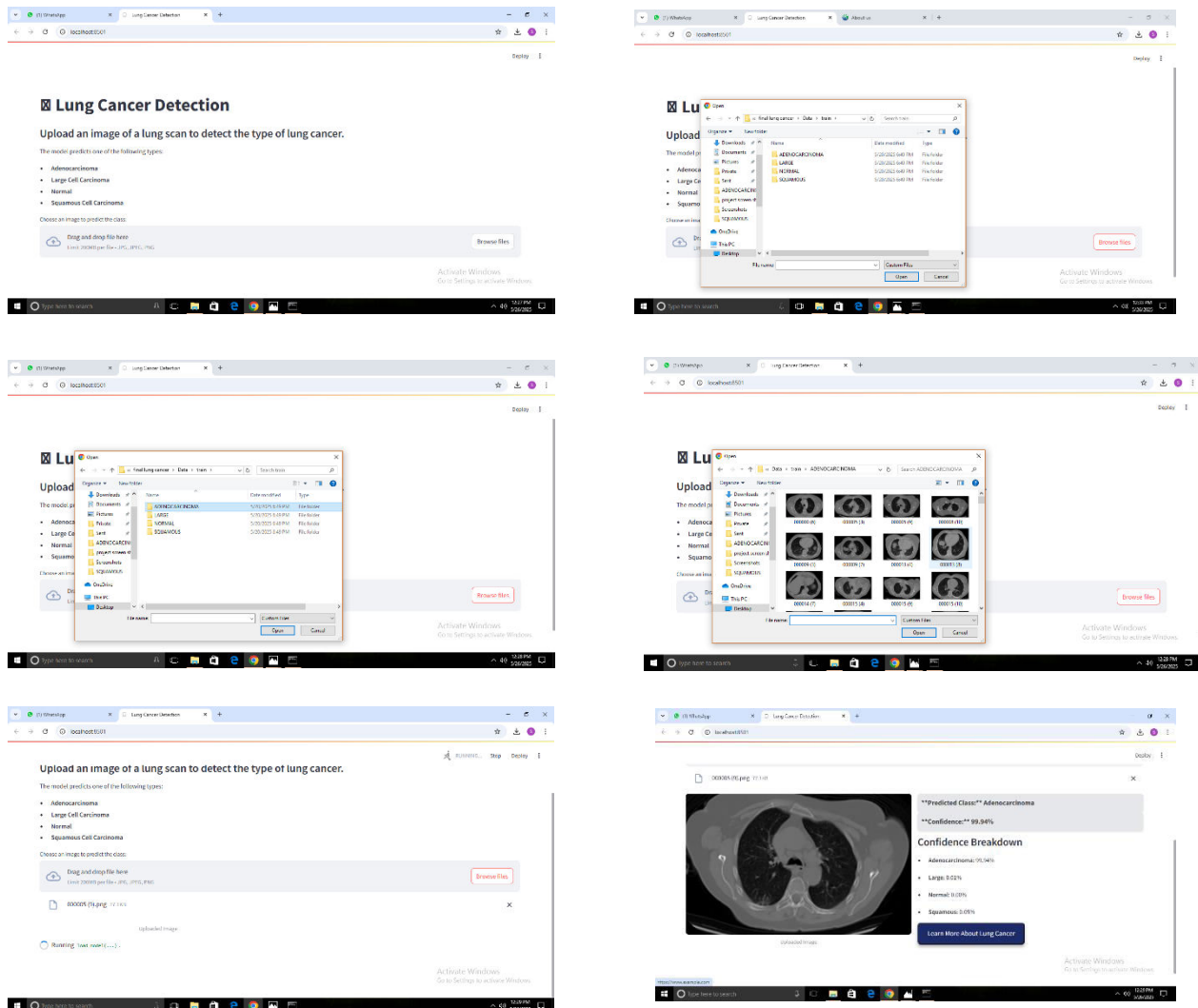
Each module performs specific tasks—from image ingestion and noise removal to tumor localization and classification using AI models. The TNM module assigns appropriate cancer stages, and a reporting module generates annotated PDF/web-based.

SYSTEM ARCHITECTURE:



VII. EXPERIMENTAL RESULTS

Figures shows the results



VIII. CONCLUSION

The Oncology Diagnostics Tool proves that AI can play a pivotal role in clinical decision-making. Automating the detection and staging of lung cancer improves efficiency, diagnostic consistency, and early treatment planning, significantly impacting survival rates.

IX. FUTURE ENHANCEMENT

Future versions aim to:

- Include multimodal imaging (MRI, PET)
- Predict tumor progression and recurrence
- Enable remote specialist consultations
- Integrate real-time collaboration and telemedicine
- Continuously update the AI model with new clinical data.

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