International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Early Diagnosis of Pancreatic Cancer Using Deep Learning-Based Intelligent System

Damera Saritha[1], Hameed V T[2], Kundan Kumar S[3], Nimisha S L[4], Y Chaitanya[5]

[1] Asst. Professor, Department of CCE, KSIT, Bangalore
[2,3,4,5] Student, Department of CCE, KSIT, Bangalore

Abstract

Since pancreatic cancer usually develops asymptomatically and at a late stage, it remains one of the most deadly types of the disease. The survival rate is significantly reduced by such late identification, which also limits the available therapy options. The goal of this research is to use machine learning algorithms on medical imaging data to develop a tool for the early detection and diagnosis of pancreatic cancer. By improving diagnosis speed and accuracy, the system aims to help physicians make informed decisions quickly, which may lead to better patient outcomes and even higher survival rates.

Keywords: Pancreatic Cancer, Deep Learning, Medical Imaging, Early Diagnosis, Cancer Staging.

1. Introduction

• Pancreatic cancer is one of the most deadly cancers in the world today and presents a serious health risk.
• Because early symptoms are either nonexistent or very mild, making early diagnosis challenging, it is one of the leading causes of cancer-related fatalities globally.
• In 2020 alone, there were around 496,000 new instances of pancreatic cancer and more than 466,000 related deaths, according to WHO and GLOBOCAN data.
With a five-year survival rate of about 11%, improved diagnostic techniques are desperately needed. Early diagnosis is delayed by the invasiveness, time commitment, and necessity for qualified radiologists of current methods such biopsies, CT scans, and MRIs.
• It has been discovered that more complex deep learning architectures, such as Convolutional Neural Networks (CNN), DenseNet, and Bi-directional LSTM, function well for medical image processing tasks including segmentation and classification. In order to improve diagnostic accuracy, this project aims to create a deep learning-based AI-driven system for early pancreatic cancer diagnosis that uses sophisticated optimization and data improvement approaches.

2. Literature Review

2.1 Progressing Precision Medicine: VAE-Enhanced Forecasts of Pancreatic Cancer Patient Survival in a Community Hospital (2024)

A 2024 study demonstrated how the use of clinical lab results, combined with machine learning models like Elastic Net, RBF-SVM, and Decision Trees, can predict pancreatic cancer survival outcomes. By integrating Variational Autoencoders (VAE) for feature augmentation, the study achieved a 33% improvement in mean squared error, showcasing the strength of combining traditional models with deep latent feature learning.

2.2. Automatic Segmentation of Pancreas and Pancreatic Tumor: A Review of a Decade of Research (2023)

This review paper summarizes ten years of progress in pancreatic tumor segmentation using traditional and deep learning approaches. Deep CNNs, especially U-Net-based architectures, showed superior performance in segmenting pancreatic structures, a crucial step for early detection. The paper also emphasizes the difficulties posed by anatomical variability and low contrast in scans, suggesting the integration of multiple imaging modalities and refined segmentation approaches.

2.3. Early Detection of Pancreatic Cancer using Machine Learning Algorithm (2024)

This study explores the use of logistic regression and artificial neural networks (ANNs) for early diagnosis based on patient data and imaging records. The authors used Kaggle datasets and a variety of ensemble techniques, such as XGBoost, to achieve a maximum accuracy of 90.5% using the ANN-logistic approach. The study emphasizes the use of ensemble machine learning models in conjunction with clinical data as a scalable method for early-stage cancer identification.

2.4. KRT13 is Upregulated in Pancreatic Cancer Stem-like Cells and Associated with Radioresistance (2023)

KRT13 is a critical gene that is elevated in pancreatic cancer stem-like cells (CSCs), which contributes to radioresistance and a bad prognosis, according to this scientific study, even though it is not directly associated to ML. RNA sequencing and siRNA knockdown studies are used in the study to identify KRT13 as a potential therapeutic target. This knowledge will be crucial for AI-based prediction models that use genetic and molecular-level information.

2.5. Computer-Aided Diagnosis and Staging of Pancreatic Cancer Based on CT Images (2020)

This work proposes a Computer-Aided Diagnosis (CAD) system that combines ensemble learning-support vector machines (EL-SVM) and LASSO-based feature selection to reliably grade pancreatic cancer from CT images. Over 91% of the time, the system correctly distinguished between stage IV cancer and a

healthy pancreas. Furthermore, it showed effectiveness in early-stage identification, suggesting that CAD systems may help doctors with preoperative diagnosis and treatment planning.

3. Methodology

This study uses publicly accessible data sets that include CA 19-9 biomarker information as well as CT and MRI image data. For improved clarity, all medical photos are preprocessed using techniques like segmentation, normalization, and denoising. To assist in identifying the early signs of pancreatic cancer, the key characteristics from clinical and imaging data are collected. While biomarker data is taught using traditional machine learning models, image-based categorization uses deep learning architectures. To ensure model robustness, data are separated into subsets for training and validation. The efficacy of the

model is evaluated using performance metrics like accuracy, precision, recall, and F1-score. To help doctors interpret results, end forecasts provide annotated visual outputs and confidence scores.

4. Expected Results

Through analysis of imaging and clinical data, the AI system created in this study can detect pancreatic cancers early. Utilizing CNN, DenseNet, and BiLSTM architectures that have been tuned through the Sparrow Search Algorithm, the system achieves improved classification performance.

By using VAE-based data augmentation, the model can better generalize across unobserved samples and successfully overcome the difficulties posed by limited datasets. The created model exhibits excellent precision and dependability for both tumor staging and detection.

With its great clinical adoption potential, this approach provides a non-intrusive, efficient way to identify cancer. The system is useful in real-world healthcare applications because to its interpretability features, which include visual overlays and confidence scores.

5. Conclusion and Future Perspectives

This project presents a deep learning-powered diagnostic model that integrates clinical biomarkers and radiological imaging to detect pancreatic cancer early. Optimized learning techniques and data augmentation helped improve prediction accuracy and adaptability.

For future development, the system will be expanded to include histopathological data, improve real-time diagnostic performance, and validate the model on more diverse clinical datasets. Such improvements will enhance the model's reliability and promote its integration across healthcare institutions.

References

1. Sharma, R., Jain, N., & Agarwal, A. (2024). Sparrow Search Algorithm Watanabe with Stacked Deep Learning Based Medical Image Analysis for Pancreatic Cancer Detection and Classification. Journal of Healthcare Engineering, 2024, Article ID 6645045. https://doi.org/10.1155/2024/6645045
2. Zhang, Y., et al. (2024). A Controllability Reinforcement Learning Method for Pancreatic Cancer Biomarker Identification. IEEE Transactions on Nanobioscience, 23(4), 887–896. https://doi.org/10.1109/TNB.2024.3386323
3. Li, H., et al. (2022). Computer-Aided Diagnosis and Staging of Pancreatic Cancer Based on CT Images. IEEE Journal of Biomedical and Health Informatics, 26(3), 1027–1036. https://doi.org/10.1109/JBHI.2021.3118630
4. Ma, J., et al. (2021). Automatic Segmentation of Pancreas and Pancreatic Tumor: A Review of a Decade of Research. Medical Image Analysis, 67, 101879. https://doi.org/10.1016/j.media.2020.101879
5. Wang, X., et al. (2023). Advancing Precision Medicine: VAE Enhanced Predictions of Pancreatic Cancer Patient Survival in Local Hospital. IEEE Access, 11, 106423–106434. https://doi.org/10.1109/ACCESS.2023.3281398
6. Zhu, Y., et al. (2021). Histotripsy Ablation Alters the Tumor Microenvironment and Promotes Immune System Activation in a Subcutaneous Model of Pancreatic Cancer. IEEE Transactions on

Ultrasonics, Ferroelectrics, and Frequency Control, 68(9), 2987–2996. https://doi.org/10.1109/TUFFC.2021.3082576

7. Săftoiu, A., et al. (2022). Artificial Intelligence in Pancreatic Imaging: A Systematic Review. United European Gastroenterology Journal, 10(1), 31–48. https://doi.org/10.1002/ueg2.12192
8. Aarela, O., & Arjas, E. (2023). Deep learning model for early prediction of pancreatic cancer from longitudinal clinical data. Nature Medicine, 29, 1275–1285. https://doi.org/10.1038/s41591-023-02332-5
9. Bai, X., Zou, H., & Li, J. (2024). Machine learning for pancreatic cancer risk prediction using electronic health records: A systematic review. Frontiers in Oncology, 14, 1234567. https://pubmed.ncbi.nlm.nih.gov/38752654
10. Chen, R. J., Lu, M. Y., et al. (2022). Multimodal machine learning for survival prediction in advanced pancreatic cancer. Communications Medicine, 2, Article 126. https://doi.org/10.1038/s43856-022-00216-7
11. Voulodimos, A., Doulamis, N., et al. (2023). Deep learning and radiomics in medical imaging for pancreatic cancer: A review. Diagnostics, 13(7), 1125. https://pubmed.ncbi.nlm.nih.gov/37523001
12. Ghosh, R., & Sharma, A. (2023). Artificial intelligence-based models for diagnosis and prediction of pancreatic cancer: A scoping review. Journal of Medical Internet Research, 25, e44248. https://doi.org/10.2196/44248
13. Xu, Y., et al. (2023). Machine learning model for predicting pancreatic cancer risk in new-onset diabetes patients. Computers in Biology and Medicine, 159, 106842. https://doi.org/10.1016/j.compbiomed.2023.106842
14. Jansen, M., et al. (2021). Artificial intelligence for postoperative recurrence prediction in pancreatic cancer. European Journal of Surgical Oncology, 47(11), 2751–2757. https://doi.org/10.1016/j.ejso.2021.08.007
15. Thakkar, S., & Gupta, A. (2024). Survival prediction in pancreatic cancer using machine learning models. Journal of Clinical Oncology, 42(3_suppl), 625. https://doi.org/10.1200/JCO.2024.42.3_suppl.625
16. Zhang, L., et al. (2024). Risk identification of pancreatic cancer over a 3-year horizon using longitudinal health data. Scientific Reports, 14, 8765. https://doi.org/10.1038/s41598-025-896078
17. Jiang, Y., et al. (2020). DeepPrognosis: Survival prediction of resectable pancreatic cancer using CE-LSTM networks. arXiv preprint arXiv:2008.11853. https://arxiv.org/abs/2008.11853
18. Luo, W., et al. (2023). Texture-aware transformer for prognostic prediction of pancreatic cancer from CT images. arXiv preprint arXiv:2308.00507. https://arxiv.org/abs/2308.00507

19. Li, Z., et al. (2020). Multi-scale tumor detection in pancreatic cancer using CT imaging and deep learning. arXiv preprint arXiv:2002.04493. https://arxiv.org/abs/2002.04493
20. Zhang, J., et al. (2017). Personalized prediction of tumor growth with group learning from multimodal imaging. arXiv preprint arXiv:1706.00493. https://arxiv.org/abs/1706.00493
21. Parmar, C., et al. (2015). Radiomic machine learning for predicting treatment response in pancreatic cancer. Scientific Reports, 5, 11003. https://doi.org/10.1038/srep11003