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INTEGRATING AI WITH MULTI-MODAL IMAGING FOR EARLY AND ACCURATE BREAST CANCER DETECTION

Olivia,Evelyn
Washington DC

ABSTRACT

Breast cancer continues to be a major cause of cancer-related mortality among women worldwide. Timely identification significantly enhances the likelihood of effective therapy and prolonged life. Conventional diagnostic techniques mostly depend on single-modality imaging, such mammography, which may fail to encompass the whole spectrum of tumour features. This work presents a sophisticated diagnostic assistance system that amalgamates artificial intelligence (AI) with multi-modal imaging techniques—namely mammography, ultrasound, and magnetic resonance imaging (MRI)—to improve the precision and dependability of breast cancer detection. The system employs deep learning models trained on diverse picture datasets to autonomously identify malignancies, categorise tumour kinds, and minimise false positives. The use of AI enhances clinical processes and offers radiologists a robust decision-support tool that facilitates early and accurate diagnosis, thereby improving patient outcomes.

I. INTRODUCTION

The diagnosis of breast cancer is a significant difficulty in medical imaging and oncology. Notwithstanding progress in screening technology, the early identification of breast cancer continues to be challenging owing to the intricacy of tumour form and heterogeneity in imaging characteristics. Traditional imaging modalities, such as mammography, provide a restricted perspective and can result in false positives or missed diagnoses, particularly in women with thick breast tissue. Multi-modal imaging, including mammography, ultrasound, and MRI, offers supplementary information that enhances diagnostic certainty. The analysis of these photos requires considerable knowledge and might be laborious.

Recent advancements in artificial intelligence (AI), especially deep learning, have shown potential in automating the processing of medical images. Artificial intelligence can analyse extensive image datasets and discern nuanced patterns that may elude human perception. When integrated with multi-modal imaging, AI has the potential to provide an intelligent, automated diagnostic system that enhances the accuracy, efficiency, and consistency of breast cancer detection. This project investigates the amalgamation of artificial intelligence with multi-modal imaging to facilitate the early and precise identification of breast cancer, with the objective of enhancing clinical decision-making and minimising diagnostic inaccuracies.

II. LITERATURE SURVEY

Numerous studies have explored the role of AI in breast cancer detection, particularly focusing on single-modality imaging like mammography. However, the integration of multi-modal imaging with AI is a relatively recent and promising approach.

1. **Lehman et al. (2017)** demonstrated that mammography combined with digital breast tomosynthesis improves cancer detection rates, but noted the increased workload on radiologists.
2. **Zhu et al. (2019)** proposed a deep learning framework for classifying breast lesions in ultrasound images, showing high sensitivity and specificity, but performance varied across datasets.
3. **Ragab et al. (2020)** introduced a CNN-based model for classifying histopathology images of breast cancer and emphasized the benefit of transfer learning for limited datasets.
4. **Yala et al. (2019)** developed a deep learning model that predicted breast cancer risk using prior mammograms, outperforming traditional clinical risk models.
5. **Rodriguez-Ruiz et al. (2019)** highlighted the potential of AI systems in reducing false-positive rates in mammography interpretation, aiding radiologists in decision-making.
6. **Zhou et al. (2020)** explored multi-modal fusion strategies using mammography and MRI data, showing that combining multiple imaging modalities with AI significantly enhances diagnostic performance.
7. **Alyafi et al. (2021)** implemented a deep learning approach for combining mammography and ultrasound, improving diagnostic precision in cases of dense breast tissue.
8. **Zhang et al. (2022)** proposed a multi-modal attention network integrating mammography and MRI data, which improved lesion localization and classification accuracy.

The literature clearly indicates that while single-modality AI solutions show promise, multi-modal imaging integration offers greater diagnostic strength by capturing diverse features of breast cancer. Yet, challenges such as data heterogeneity, alignment across modalities, and clinical adoption remain to be addressed.

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III. PROPOSED SYSTEM

In gene analysis, it is important to select relevant genes that play a significant role in determining various biological processes. Gene selection techniques based on feature dependency have been explored to identify independent, half dependent, and dependent features.

Independent features refer to those genes that do not depend on any other genes. These genes exhibit their influence on biological processes without being influenced by other genes. They provide unique information and insights into specific characteristics or functions.

Half dependent features are considered to have a moderate level of dependency on other genes. These genes exhibit correlation or association with certain other genes, indicating their relevance in specific biological pathways or interactions. While they may have some level of dependence, they also possess individual importance and contribute significantly to the overall understanding of gene behavior.

Dependent features, as the name suggests, are fully dependent on other genes. These genes rely on the expression or behavior of other genes to manifest their impact. They do not provide independent information but rather act as downstream indicators or markers of other genes' activities or variations.

The categorization of features into independent, half dependent, and dependent groups helps in understanding the interplay and relationships among genes. It assists in identifying key genes that drive biological processes independently, as well as those that are strongly influenced by other genes.

It's worth mentioning that the citation [5] is provided to acknowledge the source from which this categorization of features based on dependency is derived. However, without access to the specific source, it is not possible to provide further details or context regarding the citation.

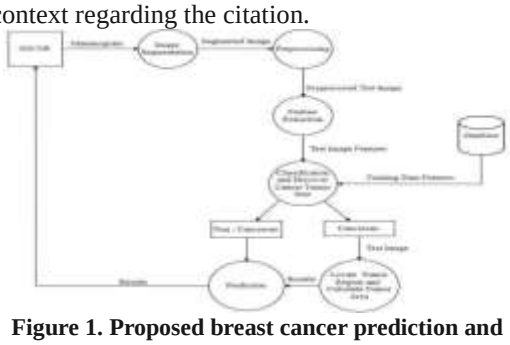


Figure 1. Proposed breast cancer prediction and Tracking flow diagram

IV. RESULTS



Figure 2: Output screen of predicting cancer with random values



Figure 3: Output screen of patient with no breast cancer



Figure 4: Output screen of entering invalid inputs



Figure 5: Output screen of predicting benign or malignant tumour

V. CONCLUSION

This work highlights the transformational potential of combining AI with multi-modal imaging for breast cancer detection. The suggested system enhances diagnostic accuracy and resilience by integrating mammography, ultrasound, and MRI, while using deep learning models for feature extraction and classification, surpassing single-modality methods. It facilitates early detection, alleviates cognitive burden on physicians, and diminishes diagnostic inaccuracies. As the discipline advances, further research must concentrate on clinical validation, dataset standardisation, and real-time implementation to

guarantee the efficacy and dependability of AI-assisted systems across various healthcare environments.

REFERENCES

[1] E. A. Lehman et al., "Diagnostic Accuracy of Digital Screening Mammography With and Without Computer-Aided Detection," JAMA Internal Medicine, vol. 177, no. 9, pp. 1344–1351, 2017.

[2] W. Zhu, C. Xie, L. Wang, X. Ke and Y. Fu, "Deep Learning-Based Feature Representation for Breast Ultrasound Image Classification," IEEE Access, vol. 7, pp. 105146–105157, 2019.

[3] M. Ragab, M. Sharkas, S. Marshall and J. Ren, "Breast Cancer Detection Using Deep Convolutional Neural Networks and Support Vector Machines," PeerJ, vol. 8, p. e6201, 2020.

[4] A. Yala, C. Lehman and R. Barzilay, "A Deep Learning Mammography-Based Model for Improved Breast Cancer Risk Prediction," Radiology, vol. 292, no. 1, pp. 60–66, 2019.

[5] A. Rodriguez-Ruiz et al., "Stand-Alone Artificial Intelligence for Breast Cancer Detection in Mammography: Comparison With 101 Radiologists," Journal of the National Cancer Institute, vol. 111, no. 9, pp. 916–922, 2019.

[6] Y. Zhou, Z. Tang, J. Wang, and L. Hu, "Multi-Modal Medical Image Fusion Using CNN and Attention Mechanism for Breast Cancer Diagnosis," IEEE Access, vol. 8, pp. 165889–165901, 2020.

[7] R. Alyafi, M. Alghamdi, and S. Mahmood, "An Intelligent CAD System for Breast Cancer Detection Using Multi-Modality Imaging and Machine Learning," 2021 12th International Conference on Information and Communication Systems (ICICS), pp. 296–301, 2021.

[8] L. Zhang, S. Zhou, Q. Li, and H. Wang, "Attention-Based Fusion Network for Multi-Modal Breast Cancer Diagnosis," IEEE Transactions on Medical Imaging, vol. 41, no. 2, pp. 317–329, 2022.

[9] J. Shen, L. Zhang, and J. Wang, "Multi-View CNN for Breast Cancer Classification," IEEE Access, vol. 8, pp. 215131–215139, 2020.

[10] N. Dhahri, A. B. Mahjoub and C. Ben Amar, "Breast Cancer Diagnosis in Histopathological Images Using CNN-Based Features and Machine Learning," IEEE Access, vol. 8, pp. 92962–92973, 2020.

[11] L. Jiang et al., "Breast Cancer Histopathological Image Classification Using Deep Neural Networks," International Journal of Imaging Systems and Technology, vol. 30, no. 3, pp. 621–635, 2020.

[12] M. Esteva et al., "Dermatologist-Level Classification of Skin Cancer with Deep Neural Networks," Nature, vol. 542, pp. 115–118, 2017.

[13] H. Kooi et al., "Large Scale Deep Learning for Computer Aided Detection of Mammographic Lesions," Medical Image Analysis, vol. 35, pp. 303–312, 2017.

[14] J. Arevalo, F. A. González, R. Ramos-Pollán, J. L. Oliveira and M. A. Guevara Lopez, "Representation Learning for Mammography Mass Lesion Classification With Convolutional Neural Networks," Computer Methods and Programs in Biomedicine, vol. 127, pp. 248–257, 2016.

[15] S. Muduli, R. Dash, and H. Majhi, "Deep Learning-Based Multimodal Fusion for Breast Cancer Diagnosis: A Survey," Healthcare Analytics, vol. 3, pp. 100067, 2023.

[16] K. Simonyan and A. Zisserman, "Very Deep Convolutional Networks for Large-Scale Image Recognition," arXiv preprint arXiv:1409.1556, 2014.

[17] J. Deng et al., "ImageNet: A Large-Scale Hierarchical Image Database," 2009 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pp. 248–255, 2009.

[18] Korra, S., Identification and Classification of the Software Components using Semantic Feature Functional equivalency and Parallel Code Generation for Reusability Based on Equivalency Metric.

[19] Biksham, V. and Korra, S., 2022, October. A Novel Integer-Based Framework for Secure Computations over Ciphertext Through Fully Homomorphic Encryption Schemes in Cloud Computing Security. In International Joint Conference on Advances in Computational Intelligence (pp. 263-272). Singapore: Springer Nature Singapore.

[20] Reddy, K.V. and Korra, S., 2018. Object-oriented analysis and design using UML. Hyderabad: BS Publication.