A Rapid and Accurate Diagnostic System Based On Label-free Multimodal Multiphoton Microscopy (MPM) and Deep Learning

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BACKGROUND

Despite the significant growth of computational pathology (CPATH) as a promising solution to improve cancer diagnosis in the past years, limited generalizability due to the technical variabilities introduced during slide preparation and digitization processes is still the single most important obstacle for its implementation into the clinic.

METHODS

To overcome this issue, we develop the first highly generalizable auxiliary diagnostic system integrating slide-free, stain-free femtosecond multimodal multiphoton microscopy (MPM) imaging with specially designed deep learning algorithm.

RESULTS

By virtue of standardized information-rich images as input data, a small training set of 130 specimens is sufficient to achieve an area under the curve (AUC) of 0.9934 for breast cancer detection, when tested on 500 independent patient specimens. More importantly, such performance is well maintained in various external tests with less than 1% drop in AUCs. We also demonstrate our system's great potential for molecular subtyping that traditionally requires immunohistochemical evaluation.

CONCLUSIONS

Collectively, high generalizability and small training set size needed warrant this system to significantly improve the applicability of deep learning-based diagnostic systems into the clinic, and help enable precision oncology which relies heavily on rapid, accurate and robust diagnosis.

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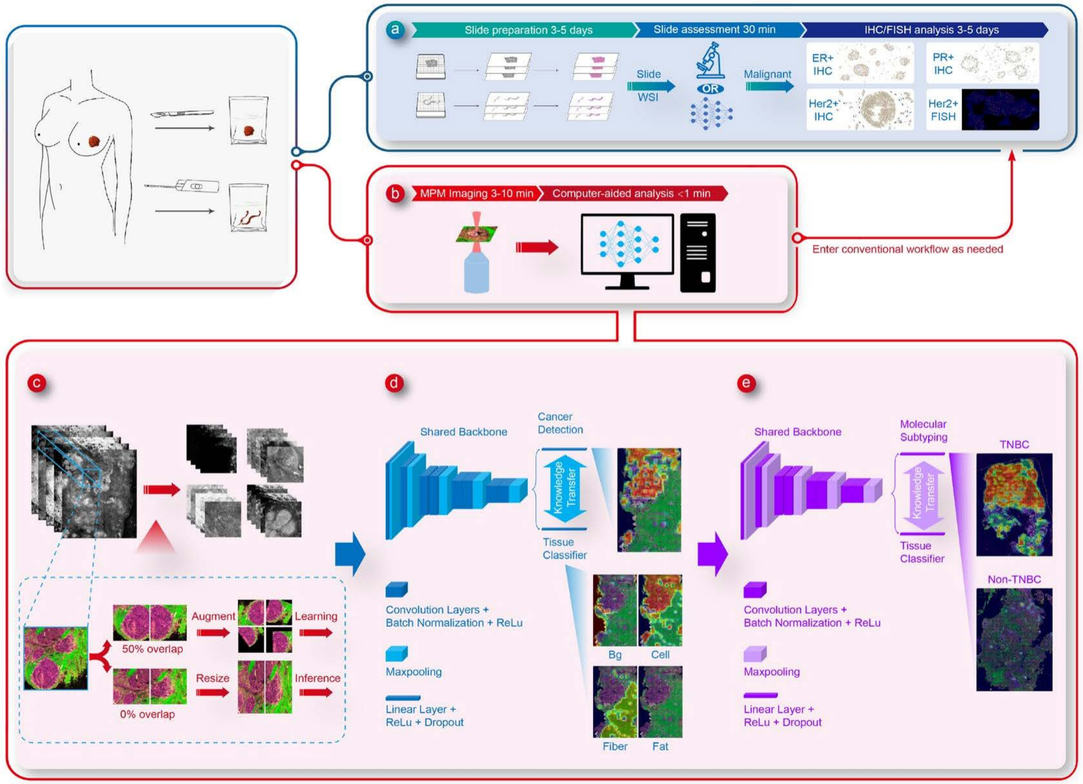


Figure 1. An auxiliary diagnostic system integrating multimodal MPM with deep learning

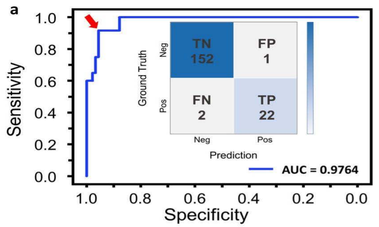


Figure 4. Performance of the classification model for distinguishing TNBC and non-TNBC whole MPM images

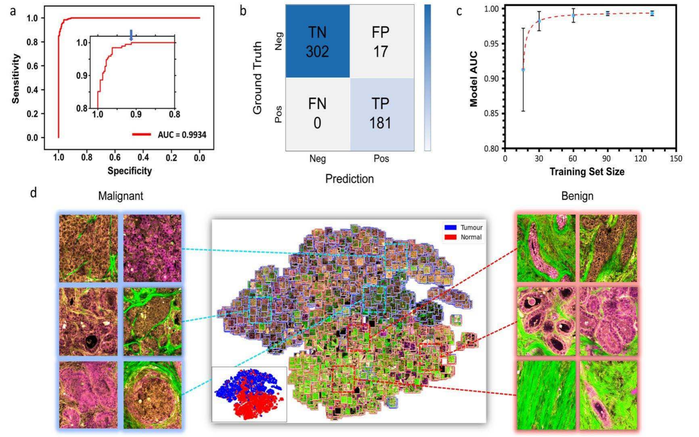


Figure 2. Model performance and visualization

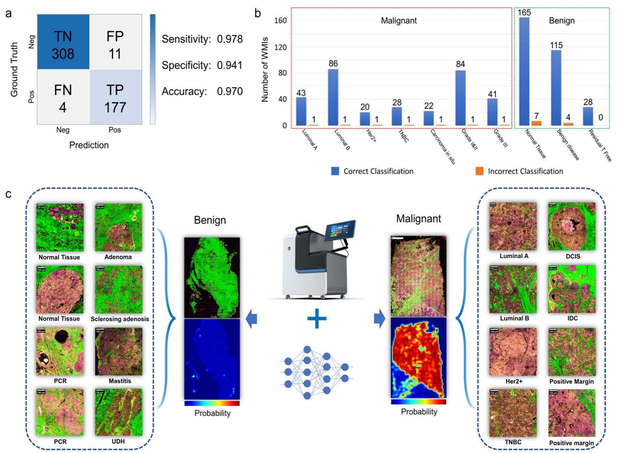


Figure 3. Evaluation of the universality of the auxiliary diagnosis system for different types of breast tissues