EFFECTS OF OPTICAL ABERRATIONS ON AUTOMATED CLASSIFICATION OF HISTOPATHOLOGICAL IMAGES

Lydia Neary-Zajiczek[1,2], Michael Shaw[2,3], Delmiro Fernandez-Reyes[2], Vijay Pawar[2], and Danail Stoyanov[1]
[1]Wellcome/EPSRC Centre for Interventional and Surgical Sciences and [2]UCL TouchLab, Department of Computer Science, University College London, London, UK
[3]Biometrology Group, National Physical Laboratory, Teddington, UK
Email: lydia.zajiczek.17@ucl.ac.uk

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In a recent census of UK histopathology departments carried out by the Royal College of Pathologists, only 3% of respondents reported sufficient staff levels, with particular concern for the future given the increased demand for histopathology services expected due to an aging population [1]. The use of digital pathology, whereby a physical sample is converted to a "digital slide" by means of a whole slide imager (WSI), could alleviate some of these issues, for example by allowing for remote consultation in areas without sufficient pathologist cover. A more radical possibility lies in automating diagnoses of more routine cases using machine learning, alleviating significant strain on pathologist workforces while maintaining a high quality of service. The implementation of fully digital histopathology workflows faces some serious barriers, particularly the challenge of secure data storage and high equipment costs.

The main contributions to the cost of a typical WSI are the microscope objective(s) and the image sensor, both necessary for generating sufficiently high resolution, true colour images of stained tissue for pathologists to make a confident diagnosis. The recent development of deep learning techniques has resulted in neural network classifiers capable of achieving accuracies that rival human classifiers [2]. Given the success of deep learning in improving resolution of microscopy images [3], it is not strictly necessary that images of the same quality required by human pathologists are needed to make an accurate automated classification; some aspects of image quality could potentially be sacrificed while maintaining acceptable accuracy levels, requiring less expensive equipment to capture.

To study the sensitivity of a neural network classifier's performance both to training and input image quality, an annotated histopathological image dataset was systematically degraded to simulate the presence of optical aberrations typically present in lower-quality clinical imaging systems. Breast cancer biopsy images from a publicly available database [4] were systematically degraded with aberrations of increasing severity. The classification accuracy of a simple neural network trained on the original high-quality images reached 93%. Introducing a wavefront error of 0.1 λ (rms) due to first-order spherical aberration resulted in a classification accuracy of 90%, while re-training the network on the degraded images achieved similar performance to the original dataset (93%).

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