A wireless camera-based optical elastography probe towards intraoperative breast cancer detection

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Optical coherence tomography (OCT)-based optical elastography has the capability to assess breast tumour margins with high accuracy [1, 2] and more recently has been implemented in a probe for intraoperative tumour assessment [3]. However, OCT-based optical elastography requires bulky, complex and expensive optical imaging systems which may hinder the uptake of this technique in a broad range of applications and clinical scenarios. In this work, we present the development of a compact, wireless imaging probe using a camera-based optical elastography technique, stereoscopic optical palpation (SOP), to achieve cost-effective breast tumour assessment. SOP combines stereoscopic imaging from two parallel cameras and a custom silicone layer with embedded phosphorescent microparticles to generate 2-D maps of the layer strain when it is compressed against the tissue [4]. As the elasticity of the layer is pre-characterised, 2-D stress maps of the layer and tissue surface can be directly derived from the strain maps, assuming uniaxial stress distribution at the tissue surface. Here, we demonstrate the working principle of SOP and present results of the SOP probe on silicone phantoms and freshly excised breast tissue, demonstrating a high stress sensitivity and robust mechanical contrast between regions of tumour and benign tissue. With further improvement and development, our probe has the potential to be used as a real-time cancer imaging tool that can help surgeons to more accurately remove cancer during the operation, potentially reducing the need for additional surgery. Due to its portability, affordability and reliability, this wireless probe holds promise to be widely used not only in large metropolitan hospitals but also in rural and remote areas all around the world.

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[2] K. Y. Foo, K. M. Kennedy, R. Zilkens, W. M. Allen, Q. Fang, R. W. Sanderson, *et al.*, "Optical palpation for tumor margin assessment in breast-conserving surgery," *Biomedical Optics Express,* vol. 12, pp. 1666-1682, 2021.

[3] P. Gong, S. L. Chin, W. M. Allen, J. D. Anstie, L. Chin, H. M. Ismail, *et al.*, "In vivo quantitative micro-elastography can detect residual tumor during breast-conserving surgery," *In revision,* 2022.

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