Respiratory Rate Monitoring Using Multimode Fibre Specklegram Sensor

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Significance: Respiratory rate is a vital sign that can provide important information about patients' overall health condition. Measuring respiratory rate in a noninvasive way is desirable when the patient's condition (e.g. skin irritation or breakdown) limit them to wear a capnography monitor or when the patient removes them for being uncomfortable.

Aim: Demonstration of a multimode fibre based specklegram sensor for noninvasive respiratory rate monitoring on a hospital mattress using deep learning.

Approach: Specklegram sensors can be highly sensitive to bending and movement [1]. This can be used for breathing recognition where the chest cavity inflates and deflates during a breathing cycle and creates movement on the multimode fibre. A single multimode optical fibre is laid on a hospital bed shown in Fig. 1a. A convolutional neural network based deep learning model was trained using speckle images captured from the sensor's CCD camera during a breathing cycle of inhale and exhale. Speckle images were also fed into the model to identify when there was no one on the bed. The trained model was then used to identify the breathing cycle.

Results: High accuracy of the model was achieved which can be seen from the confusion matrix as shown in Fig. 1b. In future work we will increase the data size and distribution to allow us to build a live model. Figure 1c shows a snapshot of live breathing cycle captured with the current model.
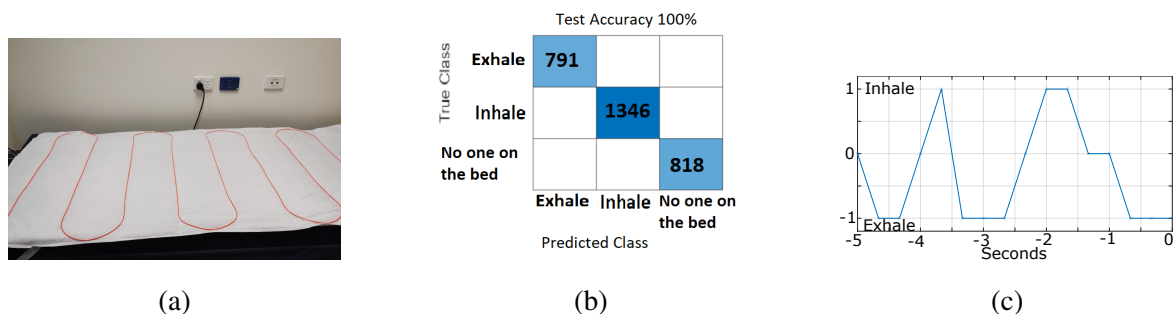

Figure 1: (a) Hospital mattress with specklegram sensor installed (b) Confusion matrix (c) Snapshot of breathing cycle

[1] S. C. Warren-Smith et al., "Multimode optical fiber specklegram smart bed sensor array," *Journal of Biomedical Optics*, vol. **27**, no. 6, p. 067002, 2022.