

Lucien Vuille¹

W. Sakata², Y. S. Leong, Y. Kumamoto², J-E. Clément¹

¹University of Lille, Cité Scientifique, Villeneuve d'Ascq, France, ²University of Osaka, Suita, Osaka, Japan

lucien.vuille@univ-lille.fr

Accelerating Raman Measurement Using a Convolutional Neural Network

Raman imaging enables the non-destructive, label-free chemical characterization of biological specimens with submicrometer spatial resolution. It allows the visualization of biochemical heterogeneity at the single-cell level, revealing subtle variations in cellular composition, metabolic state, and responses to environmental changes, which makes it particularly attractive for developing disease-diagnostic tools. Nevertheless, Raman measurements remain relatively slow compared with other imaging techniques, such as fluorescence microscopy, limiting their throughput and applicability to image large biological samples. In this contribution, we present a computational approach that restores high-quality Raman spectra from short-exposure, low-signal-to-noise-ratio measurements.

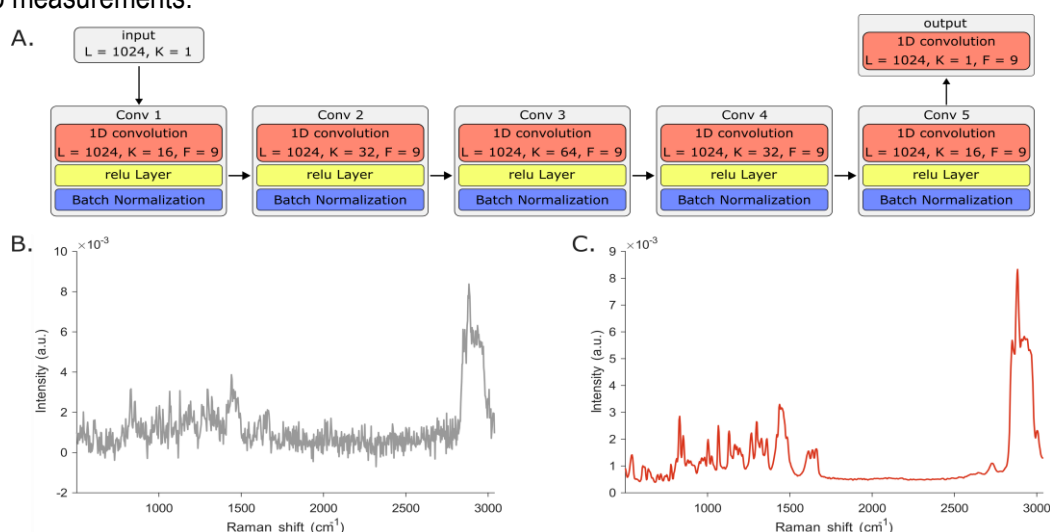


Figure 1 : Raman spectrum denoising. **A.** 1D-CNN architecture. **B.** Representative noisy Raman spectrum given as input to the network. **C.** Corresponding denoised spectrum predicted by the network.

The model is a convolutional neural network built from convolution–ReLU–batch normalization blocks, in which the number of feature channels increases over three blocks before returning to its initial value (Fig. 1). It was evaluated on three distinct Raman imaging platforms: point-scanning microscopy, line-scanning microscopy, and a fiber-based spatially multiplexed random-access system [1]. On the fiber-based platform, the required acquisition time was reduced from 5s to 1s while restoring the relevant spectral information. By enabling measurements with shorter exposure times and potentially lower laser power, this approach will facilitate the translation of Raman imaging towards intraoperative applications, where fast acquisition and limited tissue irradiation are critical.

References

[1] W. Sakata, A. Fujihara, T. Ota, Y. Harada, N. I. Smith, T. Ueda, T. Takamatsu, O. Ukimura, K. Fujita, Y. Kumamoto, *Biomed. Opt. Express*, 17(6) (2026) 3072-3088.