

In theory, data points that are in the same group should have similar properties and/or features, while data points in different groups should have highly dissimilar properties and/or features. Clustering is a method of unsupervised learning and is a common technique for statistical data analysis used in many fields.

Reliable intraoperative [delineation](#) of [tumor](#) from healthy [brain tissue](#) is essentially based on the neurosurgeon's visual aspect and [tactile](#) impression of the considered [tissue](#), which is due to inherent low brain consistency contrast-a challenging task. Development of an intelligent [artificial](#) intraoperative tactile perception will be a relevant task to improve the safety during surgery, especially when-as for neuroendoscopy-tactile perception will be damped or-as for surgical robotic applications-will not be a priori existent.

Stroop et al. presented the enhancements and the evaluation of a tactile sensor based on the use of a piezoelectric tactile sensor.

A robotic-driven piezoelectric bimorph sensor was excited using multisine to obtain the frequency response function of the contact between the sensor and fresh ex vivo porcine tissue probes. Based on load-depth, relaxation and creep response tests, viscoelastic parameters E1 and E2 for the elastic moduli and η for the viscosity coefficient have been obtained allowing tissue classification. Data analysis was performed by a multivariate cluster algorithm.

Cluster algorithm assigned five clusters for the assignment of white matter, basal ganglia and thalamus probes. Basal ganglia and white matter have been assigned to a common cluster, revealing a less discriminatory power for these tissue types, whereas thalamus was exclusively delineated; gray matter could even be separated in subclusters.

Bimorph-based, multisine-excited tactile sensors reveal a high sensitivity in ex vivo tissue-type differentiation. Although, the sensor principle has to be further evaluated, these data are promising ¹⁾.

1)

Stroop R, Nakamura M, Schoukens J, Oliva Uribe D. Tactile sensor-based real-time [clustering](#) for tissue differentiation. Int J Comput Assist Radiol Surg. 2018 Oct 6. doi: 10.1007/s11548-018-1869-5. [Epub ahead of print] PubMed PMID: 30293172.

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