Modular Neural Network with a Topological Data Analysis channel from inertial data for dyskinesia crises detection and Activity Recognition.

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Among the common age-related neurodegenerative disorders, Parkinson's disease is currently ranked second. Treatments are being developed but the quantification of their efficiency remains a real challenge, inherently due to the complexity of the symptoms. Nowadays, the most commonly prescribed treatment is based on Levodopa, a drug known to ease the symptoms of the sufferers while having a main drawback: dyskinesia crises. Those side effects are totally unpredictable and unintended movements, and do seemingly not follow obvious patterns. Other parkinsonian symptoms also exist, such as tremors, dyskinesia, bradykinesia or freezing of gait. Our aim is to develop an automated home detection of such symptoms, thanks to wearable inertial sensors worn on the wrist and the ankle of patients.
Multiple techniques have been tested, including electromyography or electroencephalogram signals, along with the use of vision, or even audio sensors. However, most these methods were restrained to a controlled environment. Nonetheless, some papers [1] implemented a way of doing automatic detection in everyday life environments by learning patterns. To the best of our knowledge, none did really extend their detection out of controlled areas, to test their robustness and generalization ability.
To deal with this issue, we oriented our work towards a deep-learning approach on the inertial data recorded by a wearable device. We built an innovative model based on multi-channels convolutional networks with the use of a fast-evolving geometric theory to improve our results: Topological Data Analysis. We validated our algorithm on the problem of activity recognition with an open-source dataset (HAPT) that has the same characteristics as our Parkinson database. We finally reached interesting results on dyskinesia crises detection and overtaked the best results of the literature for the HAPT dataset.

Références

[1] Sam A., Prez-Lopez C., Romagosa J., Rodriguez-Martin D., Catal A., Cabestany J., Prez-Martinez D.A., Rodriguez-Molinero A., *Dyskinesia and motor state detection in Parkinson's Disease patients with a single movement sensor*, 34th International IEEE EMBS, 2012.

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