Analysis of the relationship between DAT-SPECT and motor symptoms using machine learning

Parkinson's disease is a neurodegenerative disorder that causes various motor and non-motor symptoms. Patients with Parkinson's disease show degeneration and loss of dopamine neurons in the substantia nigra of the brain. DAT-SPECT is often used to obtain information on the amount of dopamine in the brain; it indirectly measures dopamine levels by capturing DAT, which regulates dopamine uptake. The evaluation using DAT-SPECT is mainly done visually or by SBR, which is a scalar evaluation value. However, in this case, the influence of the evaluator's subjectivity and the loss of three-dimensional information are inevitable.

Therefore, we are developing a system to investigate the relationship between DAT-SPECT and motor symptoms by capturing 3D DAT-SPECT features of Parkinson's disease patients. The system uses 3D DAT-SPECT images as input and outputs several scores calculated from UPDRS, an index to evaluate motor function. Convolutional neural networks were used for regression analysis. To understand how the system learned, Grad-CAM was used to visualize the areas that significantly affected the results.

As a result, it was confirmed that the estimation accuracy was better when 3D DAT-SPECT images were used as input than when only SBR was used as input. The visualization results showed that the area around the striatum, especially around the putamen, significantly affected the estimation results. This is consistent with the finding that the putamen is related to motor function within the striatum.

At present, there are predictions for improvement in estimation accuracy, so we are aiming for better estimation by taking into account the heterogeneity of data distribution and the amount of data. In addition, although this analysis was conducted only for motor symptoms, patients with Parkinson's disease often present non-motor symptoms from the early stage of the disease. In the future, we will conduct the same analysis for non-motor symptoms to clarify the relationship between motor and non-motor symptoms.

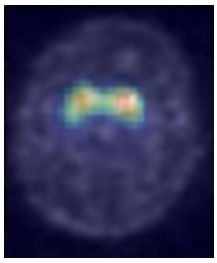

Figure 1. An example of using Grad-CAM to visualize the areas that significantly affected the results. The closer the color is to red, the greater the influence.

Keywords: DAT-SPECT, Parkinson’s disease, Machine learning

References

[1] 石川 茂一, 上西 康平, 長谷川 哲也, 千葉 龍介, 四津 有人, 高草木 薫,太田 順. パーキンソン病患者の DAT-SPECT と運動症状：説明可能 AI を用いた予測と分析. 2023 年度精密工学会春季大会学術講演会講演論文集, G19, (pp.716-717). 東京, 2023 年 3 月 14 日～16 日.