Medical image analysis

Medical image analysis is the process of using computer algorithms and software to extract meaningful information from medical images, such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Positron Emission Tomography (PET), and ultrasound images. The goal of medical image analysis is to support diagnostic and therapeutic decision-making by providing accurate and reliable information about the structure and function of the human body. Medical image analysis techniques include image segmentation, registration, and visualization, as well as quantitative analysis of images to extract specific features and measurements. These techniques can be applied to a wide range of medical applications, including the detection and diagnosis of diseases, the planning and monitoring of treatments, and the development of personalized medicine. The field of medical image analysis is rapidly evolving, with advances in machine learning and computer vision contributing to the development of new and improved methods for image analysis.

Deep learning algorithms are playing an increasing role in automatic medical image analysis.

Yeo et al. evaluated the performance of a DL model for the automatic detection of intracranial hemorrhage and its subtypes on non-contrast CT (NCCT) head studies and compared the effects of various preprocessing and model design implementations.

The DL algorithm was trained and externally validated on open-source, multi-center retrospective data containing radiologist-annotated NCCT head studies. The training dataset was sourced from four research institutions across Canada, the USA, and Brazil. The test dataset was sourced from a research center in India. A convolutional neural network (CNN) was used, with its performance compared against similar models with additional implementations: (1) a recurrent neural network (RNN) attached to the CNN, (2) preprocessed CT image-windowed inputs and (3) preprocessed CT image-concatenated inputs. The area under the receiver operating characteristic curve (AUC-ROC) and micro-averaged precision (mAP) score were used to evaluate and compare model performances.

The training and test datasets contained 21,744 and 491 NCCT head studies, respectively, with 8,882 (40.8%) and 205 (41.8%) positive for intracranial hemorrhage. Implementation of preprocessing techniques and the CNN-RNN framework increased mAP from 0.77 to 0.93 and increased AUC-ROC [95% confidence intervals] from 0.854 [0.816-0.889] to 0.966 [0.951-0.980] (p-value = 3.91 × 10-12).

The deep learning model accurately detected intracranial hemorrhage and improved in performance following specific implementation techniques, demonstrating clinical potential as a decision support tool and an automated system to improve radiologist workflow efficiency [1)]

[1)]
Yeo M, Tahayori B, Kok HK, Maingard J, Kutaiba N, Russell J, Thijs V, Jhamb A, Chandra RV, Brooks M, Barras CD, Asadi H. Evaluation of techniques to improve a deep learning algorithm for the automatic detection of intracranial haemorrhage on CT head imaging. Eur Radiol Exp. 2023 Apr 10;7(1):17. doi: 10.1186/s41747-023-00330-3. PMID: 37032417.