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Lung HRCT Pattern Classification for Cystic Fibrosis Using a Convolutional Neural Network

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Abstract : Cystic fibrosis (CF) is one of the most common autosomal recessive diseases among whites. It mostly affects the lungs, causing infections and inflammation that account for 90% of deaths in CF patients. Because of this high variability in clinical presentation and organ involvement, investigating treatment responses and evaluating lung changes over time is critical to preventing CF progression. High-resolution computed tomography (HRCT) greatly facilitates the assessment of lung disease progression in CF patients. Recently, artificial intelligence was used to analyze chest CT scans of CF patients. In this paper, we propose a convolutional neural network (CNN) approach to classify CF lung patterns in HRCT images. The proposed network consists of two convolutional layers with 3 × 3 kernels and maximally connected in each layer, followed by two dense layers with 1024 and 10 neurons, respectively. The softmax layer prepares a predicted output probability distribution between classes. This layer has three exits corresponding to the categories of normal (healthy), bronchitis and inflammation. To train and evaluate the network, we constructed a patch-based dataset extracted from more than 1100 lung HRCT slices obtained from 45 CF patients. Comparative evaluation showed the effectiveness of the proposed CNN compared to its close peers. Classification accuracy, average sensitivity and specificity of 93.64%, 93.47% and 96.61% were achieved, indicating the potential of CNNs in analyzing lung CF patterns and monitoring lung health. In addition, the visual features extracted by our proposed method can be useful for automatic measurement and finally evaluation of the severity of CF patterns in lung HRCT images.

Keywords : HRCT, CF, cystic fibrosis, chest CT, artificial intelligence
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