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PathoPy2.0: Application of Fractal Geometry for Early Detection and Histopathological Analysis of Lung Cancer

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Abstract : Fractal dimension provides a way to characterize non-geometric shapes like those found in nature. The purpose of this research is to estimate Minkowski fractal dimension of human lung images for early detection of lung cancer. Lung cancer is the leading cause of death among all types of cancer and an early histopathological analysis will help reduce deaths primarily due to late diagnosis. A Python application program, PathoPy2.0, was developed for analyzing medical images in pixelated format and estimating Minkowski fractal dimension using a new box-counting algorithm that allows windowing of images for more accurate calculation in the suspected areas of cancerous growth. Benchmark geometric fractals were used to validate the accuracy of the program and changes in fractal dimension of lung images to indicate the presence of issues in the lung. The accuracy of the program for the benchmark examples was between 93-99% of known values of the fractal dimensions. Fractal dimension values were then calculated for lung images, from National Cancer Institute, taken over time to correctly detect the presence of cancerous growth. For example, as the fractal dimension for a given lung increased from 1.19 to 1.27 due to cancerous growth, it represents a significant change in fractal dimension which lies between 1 and 2 for 2-D images. Based on the results obtained on many lung test cases, it was concluded that fractal dimension of human lungs can be used to diagnose lung cancer early. The ideas behind PathoPy2.0 can also be applied to study patterns in the electrical activity of the human brain and DNA matching.

Keywords : fractals, histopathological analysis, image processing, lung cancer, Minkowski dimension
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