Supplementary Information

Supplementary Table S1. description of radiomics features

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Classes of texture features** | **Based methods** | **Parameter** | **Formula** | **Description** |
| **Statistical based** | **1st order features** (Histogram based features) | Maximum | Where denote the 3d image matrix | Measures maximum intensity value of a histogram |
| Minimum | Where denote the 3d image matrix | Measures minimum intensity value of a histogram |
| Median | Where denote the 3d image matrix | Measures median intensity value of a histogram |
| Mean | Where denote the 3d image matrix with voxel. | Measures mean intensity value of a histogram |
| Variance |  | Measures squared distances of each value of a histogram from the mean  |
| *Energy* | Where denote the 3d image matrix with voxel. | Measures squared magnitude value of a histogram |
| Standard deviation | Where denote the 3d image matrix with voxel. | Measures amount of variation of a histogram. |
| Skewness | Where is the mean of , is the standard deviation of , is the expectation operator. | Measures asymmetry of a histogram. |
| Kurtosis | Where is the mean of, is the standard deviation of , is the expectation operator. | Measures “peakedeness” of a histogram (flatness of histogram) |
| Root mean square (RMS) | Where denote the 3d image matrix with voxel. | Measures the square-root of the mean of the squares of the values of the histogram. This feature is another measure of the magnitude of a histogram |
| Inter quartile range | Where denote the 3rd quartile of histogram, denote the 1st quartile of histogram | Measures of variability, based on dividing a histogram into quartiles |
| Range |  | Measures difference between the highest and lowest voxel values of a histogram |
| Entropy | Where denote the first order histogram with discrete intensity levels. | Measures irregularity of a histogram. |
| Uniformity | Where denote the first order histogram with discrete intensity levels. | Measures uniformity of a histogram. |
| Percentile |  | Measures intensity value at the 2.5th , 25th ,50th ,75th , and 97.5th percentile on histogram |
| **Higher order features**(GLCM based features) | Autocorrelation |  | Measures of the magnitude of the fineness and coarseness of texture |
| Cluster tendency |  | Measures of the homogeneity of GLCM |
| Maximum probability |  | Measures maximum value of GLCM matrix |
| Contrast |  | Measures of the local intensity variation of GLCM |
| Difference entropy |  | Measures entropy of processed GLCM matrix Px-y |
| Dissimilarity |  | Measures differences of entries in GLCM |
| Energy |  | Measures of the homogeneity of GLCM |
| Entropy |  | Measures irregularity of GLCM |
| Homogeneity1 |  | Measures closeness of GLCM |
| Informational measure of correlation 1 (IMC1) |  | Secondary measure of Homogeneity1 |
| Variance |  | Measures dispersion of the parameter values around the mean of the combinations of reference and neighborhood pixels |
| Sum average |  | Measures the relationship between occurrences of pairs with lower and higher intensity values |
| Sum entropy |  | Sum of neighborhood intensity value differences |
| Sum variance |  |  |
| Inverse variance |  |  |
| Inverse Difference Moment Normalized (IDMN) |  | Measures the local homogeneity of an image |
| Where is the gray level co-occurrence matrix for (,is the number of discrete intensity value in the image, is the number of voxels in the ROI, is the mean of  is the marginal row probabilities, is the marginal column probabilities, is the expected value of marginal row probability, is the expected value of marginal column probability, is the standard deviation of , is the standard deviation of ,,, is the entropy of , is the entropy of ,is the entropy of . |
| **Higher order features**(ISZ based features) | Size-zone variability |  | Variability in the size |
| Intensity variability |  | Variability in the intensity |
| Where is the intensity size zone matrix  represents the number of homogeneous areas in tumor, is the number of distinct intensity values, is the size of homogeneous area in the matrix  |
| **Morphological features** | **Shape and Size based features** | Compactness | Where denote the volume and denote the surface area of the volume of interest (VOI) | Quantifies how close an object to the smoothest shape, the circle |
| Surface area | Where is the total number triangle (coved surface area) and are edge vectors | The surface area of the ROI  |
| Convexity | Where denote tumor volume and denote convex hull volume | Measures ratio of the ROI volume contained within the tumor to the calculated convex hull volume |
| Sphericity | Where denote area and denote tumor volume | Measures of the roundness of the ROI |
| Maximum 3D diameter | See description in the next column | Measures of the maximum 3D ROI diameter. It is measured as the largest pairwise Euclidean distance, between surface voxels of the ROI |
| Spherical disproportion | Where is the radius of a sphere with the same volume as the ROI | The ratio of the surface area of the ROI to the surface area of a sphere with the same volume as the ROI |
| Surface to volume ratio (SVR) | Where is area and is volume | Surface to volume ratio  |
| **Physical based features** | Volume | Where denote the 3d image resolution | Volume of tumor (ROI) |