**Table S1-1 Description and equation of the first-order features**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Features name** | **Description** | **Equation** |
| 1 | Minimum | the minimum susceptibility in the VOI | min(X) |
| 2 | 10Percentile | the 10th percentile of the sorted susceptibility in the VOI | 10th\_percentile(X) |
| 3 | Kurtosis | the ‘peakedness’ of the susceptibility in the VOI, A higher kurtosis implies that the mass of the distribution is concentrated towards the tails rather than towards the mean |  |
| 4 | Skewness | asymmetry of the distribution of the susceptibility about the Mean value |  |
| 5 | RootMeanSquared  (RMS) | square-root of the mean of all the squared intensity values |  |
| 6 | Median | median of the sorted susceptibility in the VOI | Median(X) |
| 7 | Entropy | randomness of the susceptibility |  |
| 8 | Energy | the magnitude of susceptibility in the VOI |  |
| 9 | TotalEnergy | Energy feature scaled by the volume of the voxel in VOI |  |
| 10 | 90Percentile | the 90th percentile of the sorted susceptibility in the VOI | 90th\_percentile(X) |
| **Index** | **Features name** | **Description** | **Equation** |
| 11 | Mean | the average susceptibility within the VOI. |  |
| 12 | MeanAbsolute  Deviation (MAD) | the mean distance of all susceptibilities from the Mean Value in the VOI |  |
| 13 | RobustMeanAbsolute  Deviation (RMAD) | the mean distance of all intensity values from the Mean Value calculated between 10th and 90th percentile. |  |
| 14 | Range | The range of susceptibility in the VOI |  |
| 15 | InterquartileRange | the difference between 25th and 75th percentile within the VOI |  |
| 16 | Maximum | the maximum susceptibility in the VOI | max(X) |
| 17 | Variance | the amount of dispersion from the Mean Value |  |
| 18 | Uniformity | the homogeneity of the image |  |

The first-order features describe how the individual susceptibilities distribute statistically.

*X* is a set of *Np* voxels included in the VOI; *P(i)* is the first order histogram with *Ng* discrete intensity levels.

**Table S1-2 Description and equation of the texture features based on gray level co-occurrence matrices (GLCM)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Features name** | **Description** | **Equation** |
| 1 | Correlation | the image complexity. the linear dependency of gray level values to their respective voxels in the GLCM |  |
| 2 | Informational Measure of Correlation 1 (IMC1) | the complexity of the texture |  |
| 3 | Inverse Difference Normalized (IDN) | the local homogeneity of an image |  |
| 4 | Informational Measure of Correlation 2 (IMC2) | the correlation between the probability distributions of i and j |  |
| 5 | DifferenceVariance | the heterogeneity that places higher weights on differing intensity level pairs that deviate more from the mean |  |
| 6 | InverseVariance | a measure of the local homogeneity in an image |  |
| 7 | DifferenceEntropy | the randomness in neighborhood intensity value differences |  |
| 8 | Contrast | the local intensity variation |  |
| 9 | MaximumProbability | occurrences of the most predominant pair of neighboring intensity values |  |
| **Index** | **Features name** | **Description** | **Equation** |
| 10 | SumEntropy | the sum of neighborhood intensity value differences |  |
| 11 | Inverse Difference Moment (IDM) | the local homogeneity of an image |  |
| 12 | DifferenceAverage | the relationship between occurrences of pairs with similar intensity values and occurrences of pairs with differing intensity values |  |
| 13 | Autocorrelation | the magnitude of the fineness and coarseness of texture |  |
| 14 | JointAverage | the mean gray level intensity of the intensity distribution |  |
| 15 | SumAverage | the relationship between occurrences of pairs with lower intensity values and occurrences of pairs with higher intensity values |  |
| 16 | SumSquares | a measure in the distribution of neigboring intensity level pairs about the mean intensity level in the GLCM |  |
| 17 | ClusterShade | a measure of the skewness and uniformity of the GLCM |  |
| **Index** | **Features name** | **Description** | **Equation** |
| 18 | ClusterProminence | the skewness of the GLCM |  |
| 19 | JointEnergy | homogeneous patterns in the image |  |
| 20 | JointEntropy | the randomness in neighborhood intensity values |  |
| 21 | Inverse Difference (ID) | the local homogeneity of an image |  |
| 22 | Inverse Difference Moment Normalized (IDMN) | the normalized IDM, a measure of the local homogeneity of an image |  |
| 23 | ClusterTendency | a measure of groupings of voxels with similar gray-level values |  |

The (i,j)th element of GLCM represents the frequency of the combination of levels *i* and *j* of two pixels occurring in the image, which are separated by a distance of *δ* pixels along angle *θ.*

*p(i,j)* is the normalized GLCM; *px(i)*, *py(i)* are the marginal row and column probability respectively; *μx, μy* and *σx, σy* denote the mean and standard deviations of the row and column sums of the GLCM respectively; HX and HY are the entropy of *px* and*py* respectively; HXY is be the entropy of *p(i,j).*

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**Table S1-3 Description and equation of the texture features based on Gray Level Dependence Matrix (GLDM)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Features name** | **Description** | **Equation** |
| 1 | DependenceEntropy | the randomness of GLDM. bigger Dependence Entropy implies more complex textural |  |
| 2 | DependenceVariance | the variance in dependence size in the image |  |
| 3 | GrayLevelNonUniformity  (GLN) | the similarity of gray-level intensity values in the image, where a lower GLN value correlates with a greater similarity in intensity values |  |
| 4 | LargeDependenceEmphasis  (LDE) | the distribution of large dependencies, with a greater value indicative of larger dependence and more homogeneous textures |  |
| 5 | DependenceNonUniformity  Normalized(DNN) | the similarity of dependence throughout the image, with a lower value indicating more homogeneity among dependencies in the image. |  |
| 6 | LargeDependenceLowGray  LevelEmphasis(LDLGLE) | the joint distribution of large dependence with lower gray-level values |  |
| 7 | LowGrayLevelEmphasis  (LGLE) | the distribution of low gray-level values, with a higher value indicating a greater concentration of low gray-level values in the image |  |
| 8 | DependenceNonUniformity  (DN) | the similarity of dependence throughout the image, with a lower value indicating more homogeneity among dependencies in the image |  |
| **Index** | **Features name** | **Description** | **Equation** |
| 9 | SmallDependenceHighGray  LevelEmphasis(SDHGLE) | the joint distribution of small dependence with higher gray-level values |  |
| 10 | SmallDependenceLowGray  LevelEmphasis(SDLGLE) | the joint distribution of small dependence with lower gray-level values |  |
| 11 | SmallDependenceEmphasis  (SDE) | the distribution of small dependencies, with a greater value indicative of smaller dependence and less homogeneous textures |  |
| 12 | LargeDependenceHighGray  LevelEmphasis(LDHGLE) | the joint distribution of large dependence with higher gray-level values |  |
| 13 | GrayLevelVariance  (GLV) | the variance in grey level in the image |  |
| 14 | HighGrayLevelEmphasis  (HGLE) | the distribution of the higher gray-level values, with a higher value indicating a greater concentration of high gray-level values in the image |  |

GLDM quantifies gray level dependencies in an image. A gray level dependency is defined as the number of connected voxels within distance *δ* that are dependent on the center voxel.

*Ng* is the number of discreet intensity values in the image; *Nd* is the number of discreet dependency sizes in the image; *Nz* is the number of dependency zones in the image.

**Table S1-4 Description and equation of the texture features based on Gray Level Run Length Matrix (GLRLM)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Features name** | **Description** | **Equation** |
| 1 | RunEntropy  (RE) | the randomness of the distribution of run lengths and gray levels. A higher value indicates more heterogeneity in the texture patterns |  |
| 2 | LongRunEmphasis  (LRE) | the distribution of long run lengths, with a greater value indicative of longer run lengths and more coarse  structural textures |  |
| 3 | RunLengthNonUniformity  Normalized(RLNN) | the similarity of run lengths throughout the image, with a lower value indicating more homogeneity among run lengths  in the image |  |
| 4 | RunVariance  (RV) | the variance in runs for the run lengths |  |
| 5 | GrayLevelNonUniformity  (GLN) | the similarity of gray-level intensity values in the image, a lower GLN value correlates with a greater similarity  in intensity values |  |
| 6 | LongRunLowGrayLevel  Emphasis(LRLGLE) | the joint distribution of long run lengths with lower  gray-level values |  |
| **Index** | **Features name** | **Description** | **Equation** |
| 7 | ShortRunLowGrayLevelEmphasis  (SRLGLE) | measures the joint distribution of shorter run lengths with lower gray-level values |  |
| 8 | ShortRunEmphasis  (SRE) | the distribution of short run lengths, a greater value indicates shorter run lengths and more fine textural textures |  |
| 9 | LowGrayLevelRunEmphasis  (LGLRE) | the distribution of low gray-level values, with a higher value indicating a greater concentration of low gray-level values  in the image |  |
| 10 | RunLengthNonUniformity  (RLN) | the similarity of run lengths throughout the image, with a lower value indicating more homogeneity among run lengths  in the image |  |
| 11 | RunPercentage  (RP) | the coarseness of the texture by considering the ratio of number of runs and number of voxels in the VOI |  |
| 12 | LongRunHighGrayLevel  Emphasis(LRHGLE) | the joint distribution of long run lengths with higher  gray-level values |  |
| 13 | HighGrayLevelRun  Emphasis (HGLRE) | the distribution of the higher gray-level values, with a higher value indicating a greater concentration of high gray-level values |  |
| **Index** | **Features name** | **Description** | **Equation** |
| 14 | ShortRunHighGrayLevel  Emphasis(SRHGLE) | the joint distribution of shorter run lengths with  higher gray-level values |  |
| 15 | GrayLevelVariance  (GLV) | the variance in grey level in the image |  |
| 16 | GrayLevelNonUniformity  Normalized (GLNN) | the homogeneity of the image array, a greater uniformity implies a greater homogeneity or a smaller range of discrete intensity values |  |

GLRLM quantifies gray level runs, which are defined as the length in number of pixels, of consecutive pixels that have the same gray level value. In a gray level run length matrix *P(i,j)*, the (i,j)th element describes the number of runs with gray level *i* and length *j* along angle *θ*

*p(i,j)* be the normalized run length matrix; *Ng* be the number of discreet intensity values in the image; *Nr* be the number of discreet run lengths in the image; *Np* be the number of voxels in the image.

**Table S1-5 Description and equation of the texture features based on Gray Level Size Zone Matrix (GLSZM)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Features name** | **Description** | **Equation** |
| 1 | ZoneEntropy  (ZE) | the randomness in the distribution of zone sizes and gray levels. A higher value indicates more heterogeneity in the texture patterns |  |
| 2 | GrayLevelNonUniformity  (GLN) | the variability of gray-level intensity values in the image, with a lower value indicating more homogeneity in intensity values |  |
| 3 | GrayLevelNonUniformity  Normalized(GLNN) | the variability of gray-level intensity values in the image, with a lower value indicating a greater similarity in intensity values.The normalized version of the GLN |  |
| 4 | SmallAreaEmphasis  (SAE) | the distribution of small size zones, with a greater value indicative of more smaller size zones and more fine textures |  |
| 5 | SizeZoneNonUniformity  (SZN) | the variability of size zone volumes in the image, with a lower value indicating more homogeneity in  size zone volumes |  |
| 6 | SizeZoneNonUniformity  Normalized (SZNN) | the variability of size zone volumes throughout the image, with a lower value indicating more homogeneity among zone size volumes in the image, the normalized  version of the SZN |  |
| **Index** | **Features name** | **Description** | **Equation** |
| 7 | SmallAreaLowGrayLevelEmphasis(SALGLE) | the proportion in the image of the joint distribution of smaller size zones with lower gray-level values |  |
| 8 | LargeAreaHighGrayLevelEmphasis(LAHGLE) | the proportion in the image of the joint distribution of larger size zones with higher gray-level values |  |
| 9 | ZoneVariance(ZV) | the variance in zone size volumes for the zones |  |
| 10 | LowGrayLevelZoneEmphasis(LGLZE) | the distribution of lower gray-level size zones, with a higher value indicating a greater proportion of lower gray-level values and size zones in the image |  |
| 11 | GrayLevelVariance(GLV) | the variance in gray level intensities for the zones |  |
| 12 | HighGrayLevelZoneEmphasis (HGLZE) | the distribution of the higher gray-level values, with a higher value indicating a greater proportion of higher gray-level values and size zones in the image |  |
| 13 | LargeAreaEmphasis (LAE) | the distribution of large area size zones, with a greater value indicative of more larger size zones and more coarse textures |  |
| 14 | LargeAreaLowGrayLevelEmphasis (LALGLE) | the proportion in the image of the joint distribution of larger size zones with lower gray-level values |  |
| **Index** | **Features name** | **Description** | **Equation** |
| 15 | SmallAreaHighGrayLevelEmphasis (SAHGLE) | the proportion in the image of the joint distribution of smaller size zones with higher gray-level values |  |
| 16 | ZonePercentage(ZP) | the coarseness of the texture by taking the ratio of number of zones and number of voxels in the VOI |  |

GLSZM quantifies gray level zones in an image. A gray level zone is defined as the number of connected voxels that share the same gray level intensity. In a gray level size zone matrix P(i,j), the (i,j)th element equals the number of zones with gray level *i* and size *j* appear in image.

*p(i,j)* is the normalized size zone matrix; *Ng* be the number of discreet intensity values in the image; *Ns* be the number of discreet zone sizes in the image; *Np* be the number of voxels in the image; *Nz* be the number of zones.

**Table S1-6 Description and equation of the texture features based on Neighbouring Gray Tone Difference Matrix (NGTDM)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Features name** | **Description** | **Equation** |
| 1 | Complexity | bigger value means that the image is non-uniform and there are many rapid changes in gray level intensity |  |
| 2 | Busyness | A high value for busyness indicates the image is with rapid changes of intensity between pixels and its neighbourhood |  |
| 3 | Contrast | high value means that an image is with a large range of gray levels, with large changes between voxels and their neighbourhood |  |
| 4 | Coarseness | average difference between the center voxel and its neighbourhood and is an indication of the spatial rate of change. A higher value indicates a lower spatial change rate and a locally more uniform texture |  |
| 5 | Strength | high value menas that an image is with slow change in intensity but more large coarse differences in gray level intensities |  |

A NGTDM quantifies the difference between a gray value and the average gray value of its neighbours within distance δ.

**Table S1-7 Description of the shape-based features**

|  |  |  |
| --- | --- | --- |
| **Index** | **Features name** | **Description** |
| 1 | SurfaceArea | The total surface area in the VOI |
| 2 | Volume | the volume of the VOI |
| 3 | SurfaceVolumeRatio | a lower value indicates a more compact (sphere-like) shape |
| 4 | Maximum2DDiameterColumn | the largest pairwise Euclidean distance between surface mesh vertices in the coronal plane |
| 5 | Maximum2DDiameterRow | the largest pairwise Euclidean distance between surface mesh vertices in the sagittal plane |
| 6 | Maximum2DDiameterSlice | the largest pairwise Euclidean distance between surface mesh vertices in the axial plane |
| 7 | Maximum3DDiameter | largest pairwise Euclidean distance between surface mesh vertices |
| 8 | LeastAxis | smallest axis length of the VOI-enclosing ellipsoid |
| 9 | MajorAxis | the largest axis length of the VOI-enclosing ellipsoid |
| 10 | MinorAxis | the second-largest axis length of the VOI-enclosing ellipsoid |
| 11 | Elongation | the root square value of ration of Minor Axis to Major axis, and bigger value means the shape is more circle-like |
| 12 | Flatness | the root square value of ration of Least Axis to Major axis. bigger value means the shape is more non-flat |
| 13 | Sphericity | the roundness of the shape of the VOI relative to a sphere |