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Content Based Image Retrieval in Digital Pathology

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Overview

The proposed CBIR system works in the following way:

i) An end-user is able to select a region of interest/concern from a candidate digital slide
ii) A robust set of textural and spectral features are calculated on the selected region
iii) This feature vector derived from the user-given image region is then trained to form a Support Vector using one-class Support Vector Machine (SVM) classification
iv) A large set of virtual slides from a database is then queried
v) Corresponding feature vectors for every region of the digital slides stored in the database are calculated
vi) Pattern recognition is performed using the previous trained Support Vector and SVM for all feature vectors
vii) The result from SVM, the so-called decision value is then used as indication regarding how similar a region of an image in the database is to the candidate user selected region
viii) Using the similarity metric, the top most similar images are retrieved from the archive.

Features

Texture Measurements

\[ m = \frac{1}{N} \sum_{i=1}^{N} x_i \]

\[ s = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2 \]

\[ \phi_1 = \frac{\bar{x}}{N} \]

\[ \phi_2 = (\bar{x} - s)^2 + 4s^2 \]

\[ \phi_3 = (\bar{x} - 3s)^2 + 9s^2 \]

\[ \phi_4 = (\bar{x} - 2s)^2 + (2s)^2 \]

\[ \phi_5 = (\bar{x} - s)^2 + 4s^2 \]

\[ \phi_6 = (\bar{x} - 3s)^2 + 16s^2 \]

\[ \phi_7 = (\bar{x} - 2s)^2 + (2s)^2 \]

\[ \phi_8 = (\bar{x} - s)^2 + 4s^2 \]

\[ \phi_9 = (\bar{x} - 3s)^2 + 9s^2 \]

\[ \phi_{10} = (\bar{x} - 2s)^2 + (2s)^2 \]

Spectral Measurements of Texture

\[ 2D Fourier Spectrum \rightarrow F(u,v) = \int \int f(x,y) e^{-2\pi i (ux + vy)} dx dy \]

\[ 2D Spectral Measure of Texture = S(r,\theta), \text{where } r \text{ is a radial direction and } \theta \text{ a curve centred around the DC channel} \]

System Architecture

Conclusions

CBIR has been shown to be feasible for WSI using texture and spectral feature measurements with a One Class SVM used as a classifier.

Further work needs to be developed to support high throughput analysis and evaluation on large image libraries. The computational complexity of working with such large imagery as well as the associated feature calculation is substantial.

It is clear the massively parallel nature of the problem can be exploited to provide a fast, real-time manageable CBIR system.