MIDDLE EAST TECHNICAL UNIVERSITY

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Outline of the proposed method

Preprocessing:
Determining lymph node sections on Layer 7 images

Classification:
CNN on sliding windows on Layer 2 images

Post Processing:
Decision fusion for metastasis regions and slides
Preprocessing of Whole Slide Images

To eliminate background (Layer 7)

- OTSU thresholding
- Median filtering
- Connected component analysis
- Elimination of small noisy parts
- Converting to binary

Output: Mask of lymph node sections in the WSIs
Effects of preprocessing operations

a  Original image
b  Otsu thresholding
c  Median filtering
d  Small connected component elimination (mask)
e  Final output of preprocessing stage (masked image)
f  Metastasis region boundaries shown on original image
g  Metastasis region boundaries shown on masked image
Dataset for training CNN

- 480,000 randomly selected 64x64x3 RGB sub-images (Layer 2)
- Half from slides with label NORMAL
- Half from metastasis regions of slides with label TUMOR
- Images with more than 75% background eliminated
Example dataset images

First row: Samples with label NORMAL
Second row: Samples with label TUMOR
Convolutional Neural Network architecture

**INPUT**
- Input 64x64x3
- Cropped Input 48x48x3

**FEATURE EXTRACTION**
- C1: 64@48x48
- P1: 64@24x24
- C2: 64@24x24
- P2: 64@12x12

**CLASSIFICATION**
- L1: 9216
- L2: 384
- L3: 192
- Softmax

- Random cropping and dynamic range normalization
- Convolution with 64 kernels of 5x5x3
- Normalization and max-pooling with stride 2
- Convolution with 64 kernels of 5x5x64
- Normalization and max-pooling with stride 2
- Fully connected layers and softmax
Metastasis detection and localization

Postprocessing consists of:
- Elimination of small regions
- Confidence Filtering (Gaussian-like) on CNN output
- Extraction of metastasis region representatives by connected component analysis for Evaluation 2
- Whole slide probabilities for Evaluation 1
Effects of post processing operations

a Final output of preprocessing stage (masked image)
b Metastasis Region Boundaries shown on masked Image
c Binary image showing metastasis regions constructed from CNN output labels,
d Eroded binary image eliminating small regions
e Probability image obtained after Confidence Filtering (green area)
f Metastasis representatative points shown on probability image
g Metastasis representatives shown on evaluation mask image
Results on training set:

Evaluation I
AUC ROC : 0.920087

Evaluation II
Average FROC : 0.5349