Application of Fuzzy Clustering for White Blood Cell Subtyping

Introduction

"White blood cell subtyping is essential for comprehending immune system dynamics and diagnosing various diseases. Traditional methods encounter challenges in accurately classifying diverse cell populations. This report explores the innovative application of fuzzy clustering to address uncertainties in white blood cell subtyping."

Nucleus Separation

Algorithm Steps:

Median Filtering:

- Apply a 15 x 15 median filter with parameters C = 10 and m = 2 to create an over segmented image.
- Use a circular structuring element with a radius of 5 pixels for the opening and closing operations.

Oversegmentation:

- Implement the fuzzy clustering algorithm to create an over segmented image.

Patch Combining:

- Combine patches based on the fuzzy clustering results.

Final Touching:

- Perform final touches to refine the segmentation.

Evaluation Formula

$E(Seg) = PE = P(O) * P(B | O) + P(B) * P(O | B)$

- PE = Probability of Error
- P (O) and P (B) is a priori probability of object and background
- P (B|O) is Probability of making a mistake in deciding that the object is a background
- P (P|B) is Probability of making a mistake in deciding that the background is an object

Separate by Professor

Separate by proposed method.

rewrite a formula is:

E(Seg) = ((N1+N2) / Total number of pixels in the Image) * 100%

- N1 = Number of misclassified pixels (proposed method: not nucleus, professor: nucleus)
- N2 = Number of misclassified pixels (proposed method: nucleus, professor: not nucleus)

Cytoplasm Separation:

Algorithm Steps:

Median Filtering:

- Apply a 15 x 15 median filter with parameters C = 10 and m = 2 to create an over-segmented image.
- Use a circular structuring element with a radius of 5 pixels for the opening and closing operations.

Oversegmentation:

- Implement the fuzzy clustering algorithm to create an over-segmented image.

Patch Combining:

- Combine patches based on the fuzzy clustering results.

Final Touching:

- Perform final touches to refine the segmentation.

Evaluation Formula:

E(Seg) = PE = P (O) * P (B | O) + P (B) * P (O | B)

rewrite a formula is:

E(Seg) = ((N1+N2) / Total number of pixels in the Image) * 100%

- N1 = Number of misclassified pixels (proposed method: not cytoplasm, professor: cytoplasm)
- N2 = Number of misclassified pixels (proposed method: cytoplasm, professor: not cytoplasm)

Conclusion:

1.Image Processing Steps:

- Apply median filtering to cell images.
- Utilize the fuzzy clustering algorithm with the modified image.
- Sort results by the center of the algorithm's outcomes in ascending order.

2.Nucleus and Cytoplasm Determination:

- If the center of the group for a patch is < 60% of the average center points of all patches, classify it as a nucleus.
- If 60% <= center of the group for a patch < 150% of the average center points of all patches, classify it as a cytoplasm.

3.Post-Processing:

- Perform opening and closing operations separately for nucleus and cytoplasm.
- Combine the nucleus and cytoplasm into a single image.

Algorithm:

Good:

- Achieves accurate and reliable segmentation of white blood cells.
- Demonstrates robustness across diverse cell populations.
- Performs well under varying conditions.

Method Used:

Good:

- Fuzzy clustering aligns well with the study's objectives.
- Demonstrates adaptability and robustness in handling uncertainties.

Results:

Good:

- Achieves high accuracy and precision in segmentation.
- Qualitative assessments show visually compelling results.

Reference:

[Theera-Umpon and Dhompongsa 2007] N. Theera-Umpon, S. Dhompongsa

"Morphological Granulometric Features of Nucleus in Automatic Bone Marrow White Blood Cell Classification"