Classification of Diabetic Retinopathy Images Using Multi-Class Multiple-Instance Learning Based on Color Correlogram Features

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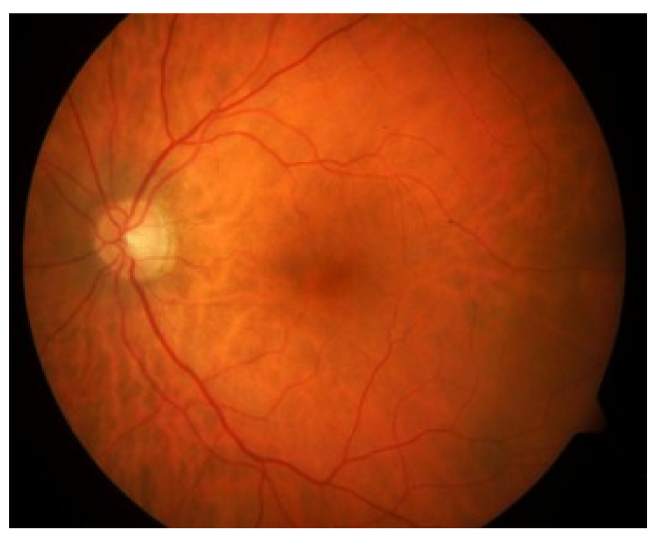
OBJECTIVE

To automatically classify diabetic retinopathy (DR) images into three classes based on their severity, using multi-class multiple-instance classification framework and modified color correlogram features.

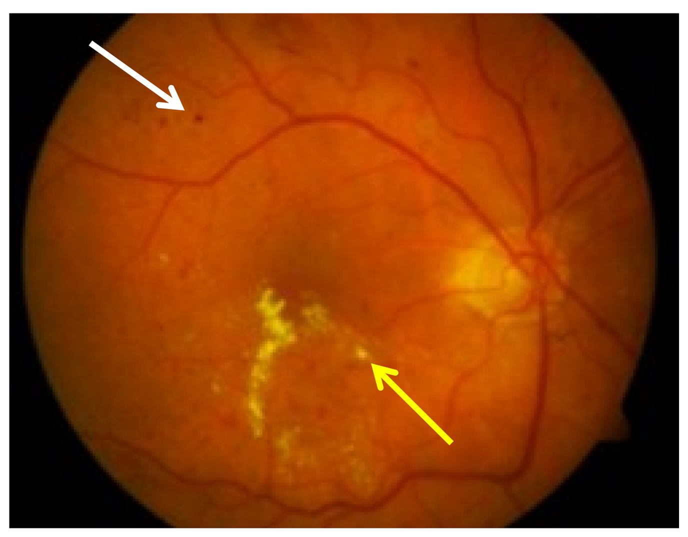
MOTIVATION

- DR is a common cause of blindness among diabetic people. Despite the advancement in diabetic care, vision loss is still a devastating complication.
- Timely diagnosis and treatment of DR can significantly reduce the risk of vision loss.
- DR diagnosis is a laborious process and is prone to human error. It is very costly in monetary and personnel terms.
- Lack of a unified DR grading system.

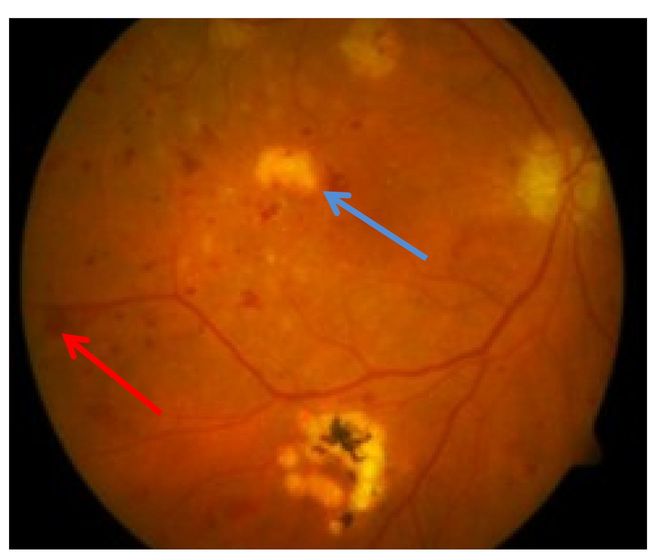
BACKGROUND



Normal



Non-prolifearative DR



Proliferative DR

Fig. 1. Red and blue arrow indicate hemorrhages and cotton wool spots respectively. White and yellow arrow indicate microaneurysms and yellow, waxy exudates.

RELATED WORK

- Boundary detection is performed using morphological operations to detect exudates. Distribution of exudates was used to determine the severity of DR in [1].
- Naïve Bayes classifier was used to classify DR images using the size foveal avascular zone [2].
- STARE project was aimed at automatic diagnosis and comparisons of retinal fundus images. The approach segments the image into 11 predefined regions and then uses primitives like color features to perform automated diagnosis [3].

PROPOSED APPROACH

- Color correlogram (CC) is a well-studied feature for image retrieval. A quantization scheme for CC, modeled after HVS was proposed in [4].
- CC features are unsuitable for DR images due to the unique color spectrum of DR images.

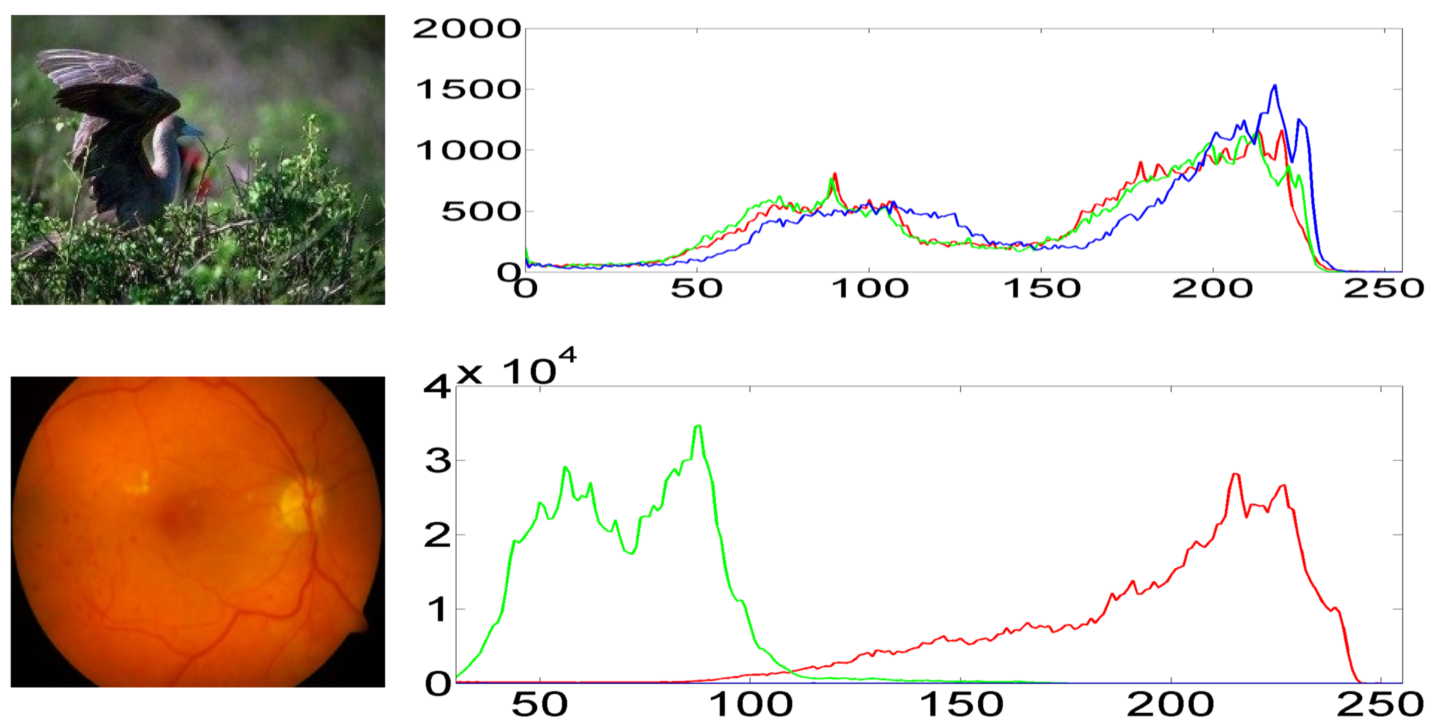


Fig. 2. Color spectrum of a natural and a DR image.

- Design of a quantization scheme for DR images:
  - ➢ Equalize red channels of all images.
  - ➢ Extract all the unique shades in the training set.
  - ➢ Group the color space into 64 clusters.
  - ➢ Build codebook out of centroids.

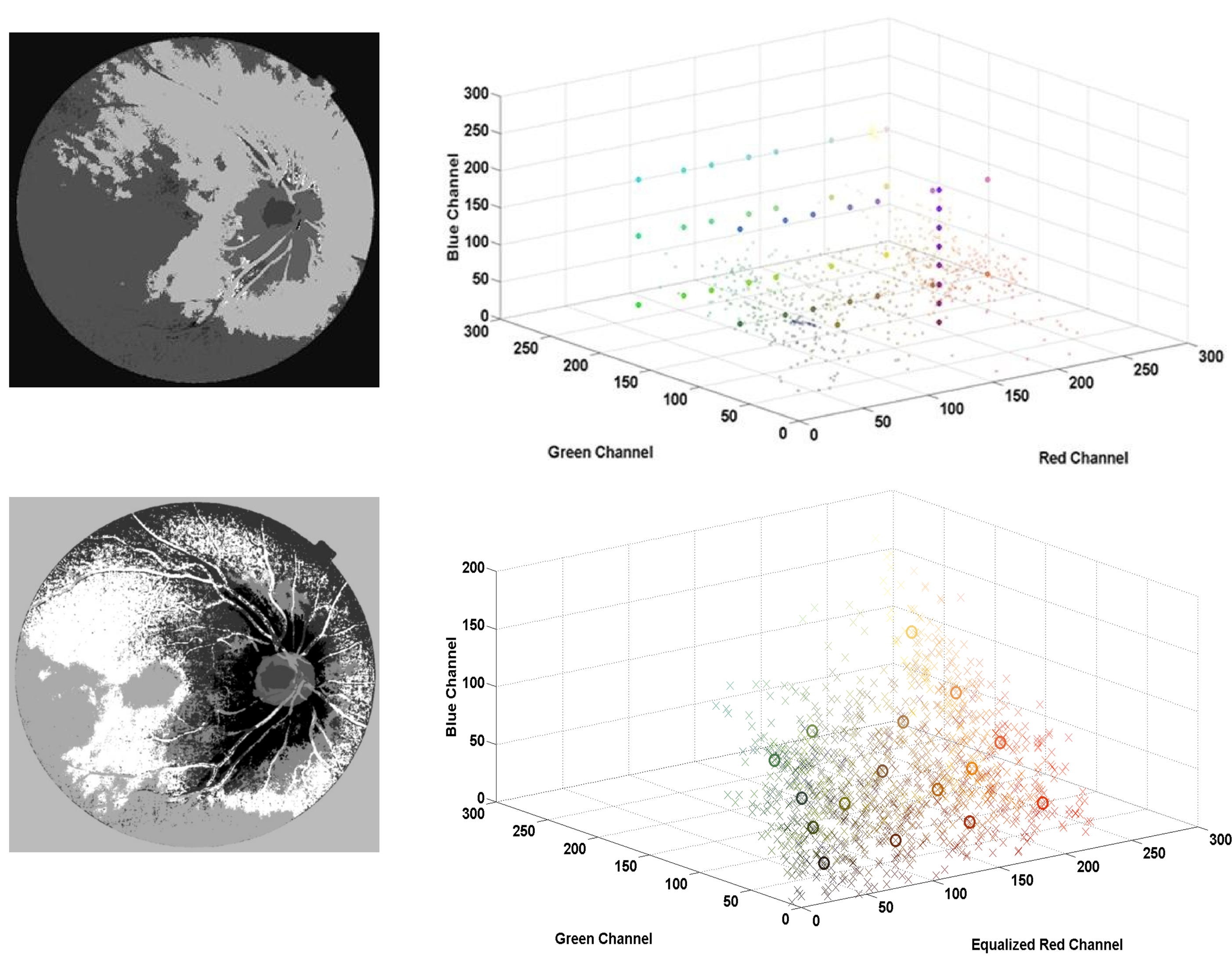


Fig. 3. Visualization of quantization schemes.

- *Algorithm for computing CC features:*
  - ➢ The 64-bin histogram for the instance is recorded
  - ➢ For any pixel, a neighborhood of 3*X*3 is considered. The pixel value of the center pixel is compared with the pixel value of all the 8 pixels in the neighborhood. A count is made of the number pixels that hold the same value as the pixel under consideration. This count gives us the local spatial distribution of the pixels.
  - ➢ This count is added to that bin of a spatial distribution histogram to which the pixel under consideration belongs. This process is repeated for all the pixels in the instance.
  - ➢ The vector thus formed is divided by the count of global distribution of pixels to get the color auto-correlogram of the instance. This results in a 64 dimensional feature vector for every instance.

Fig. 4. Necessity for MIL Framework.

- For classification using MCMIL, a Citation-KNN approach is used [5].

EXPERIMENTAL RESULTS

Approach	Mean Accuracy
SIFT+BoW+SVM	51.14 %
Gabor features+SVM	64.71 %
HNM + SVM	75.76 %
Original AutoCC+MIL	78.01 %
Proposed Algorithm	87.61 %

Experiments were performed and the said results were obtained from a database containing 425 images with 160 Normal, 181 MA and 84 NV images.

KEY REFERENCES

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[5] J. Wang and J.-D. Zucker, "Solving the multiple-instance problem: A lazy learning approach," in 17th International conference of Machine Learning, 2000.