# A Histogram Approach for the Screening of Age-Related Macular Degeneration

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## ABSTRACT

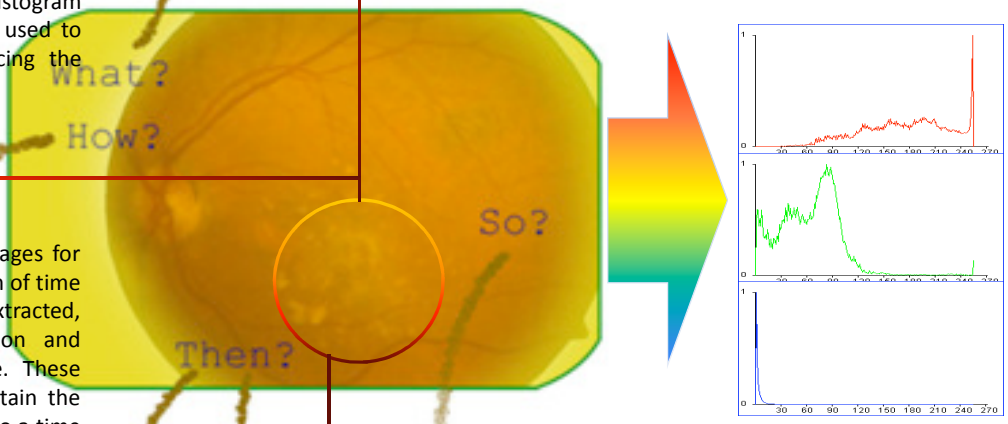
The identification of retinal drusen is important in the diagnosis of Age-Related Macular Degeneration (AMD). Visual inspection of retinal colour images is a time consuming and resource intensive process. In this paper an automated approach is proposed to support AMD screening. The fundamental idea is that instead of detecting the physical existence of drusen in the retina, representative patterns of retinal images are extracted in the form of histograms. Labelled exemplar histograms are then stored in a "case based". New, "unseen" examples are then classified by comparing with this case base and analysed for drusen using a Dynamic Time Warping (DTW) comparison process. Evaluation using the proposed approach has produced results that are both interesting and promising.

## BACKGROUND

AMD, the main cause of elderly blindness in developed countries, is diagnosed by mainly identifying one if its hallmark feature known as drusen, yellowish–white deposits, through examining retinal images. The identification of drusen is not a straightforward process due to: (i) non-uniform illumination of the captured images, and (ii) indistinct separation between drusen's boundaries and retina background [1]. Image processing techniques have been widely applied to AMD, such as background levelling [1] and multilevel histogram equalisation (MLE) [2]. These techniques were used to normalise the illumination as well as enhancing the drusen visibility on the images.

## METHOD

The proposed approach of screening retinal images for AMD diagnosis represents the images in the form of time series data. Histograms of each image are first extracted, each brings red, green, blue, hue, saturation and intensity information of the respective image. These histograms are then plotted onto graphs to attain the histograms curves, which are later transformed to a time series data. Dynamic time warping [3], a technique for measuring the similarity between two time series sequences, is applied to find the best pre-labelled (classified) histogram that match the new (unclassified) one.




## EXPERIMENTAL SETUP

144 retinal images collected by the ARIA [4] project, of which 86 are AMD images and the rest are control images, are separated into ten equally distributed datasets. Each set has approximately 9 AMD and 6 control images. Ten-fold cross validation was used for performance evaluation. Three evaluation metrics are used: sensitivity, specificity and accuracy to assess the classification performance.

## RESULTS

Performances of red (R), green (G) and blue (B) channels and hue (H), saturation (S) and Intensity (I) components in AMD classification is shown in Table 1.

**Table 1**. Results of using red (R), green (G), blue (B), hue (H), saturation (S) and intensity (I) for classification of retinal images

| Dataset | Specificity (%) | | | | | | Sensitivity (%) | | | | | | Accuracy (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | G | B | H | S | I | R | G | B | H | S | I | R | G | B | H | S | I |
| 1 | 100 | 80 | 40 | 60 | 60 | 100 | 100 | 56 | 100 | 67 | 100 | 89 | 100 | 64 | 79 | 64 | 86 | 93 |
| 2 | 33 | 100 | 50 | 83 | 83 | 50 | 88 | 56 | 100 | 75 | 88 | 88 | 64 | 79 | 79 | 79 | 86 | 71 |
| 3 | 50 | 67 | 67 | 33 | 50 | 50 | 67 | 56 | 100 | 100 | 89 | 67 | 60 | 60 | 87 | 73 | 73 | 60 |
| 4 | 33 | 50 | 33 | 50 | 67 | 17 | 67 | 44 | 67 | 78 | 56 | 67 | 53 | 47 | 53 | 67 | 60 | 47 |
| 5 | 50 | 50 | 50 | 50 | 50 | 83 | 78 | 78 | 67 | 56 | 67 | 56 | 67 | 67 | 60 | 53 | 60 | 67 |
| 6 | 33 | 83 | 50 | 50 | 83 | 33 | 78 | 78 | 100 | 100 | 100 | 78 | 60 | 80 | 80 | 80 | 93 | 60 |
| 7 | 67 | 83 | 33 | 100 | 67 | 67 | 88 | 63 | 75 | 63 | 88 | 88 | 79 | 71 | 57 | 79 | 79 | 79 |
| 8 | 20 | 40 | 40 | 20 | 60 | 20 | 78 | 80 | 78 | 89 | 78 | 78 | 57 | 71 | 64 | 64 | 71 | 57 |
| 9 | 33 | 50 | 67 | 100 | 50 | 33 | 75 | 63 | 75 | 100 | 75 | 75 | 57 | 57 | 71 | 100 | 64 | 57 |
| 10 | 33 | 50 | 33 | 67 | 17 | 17 | 63 | 50 | 88 | 63 | 100 | 50 | 50 | 50 | 64 | 64 | 64 | 36 |
| Mean | **47** | ***62**** | **46** | **57** | **60** | **49** | **76** | **65** | ***83**** | **81** | **82** | **76** | **65** | **65** | **69** | **72** | ***74**** | **63** |

## DISCUSSION

Results demonstrate the potential of using histograms and time series data in AMD screening. Blue channel posed the most surprising outcome as compared to others. The lack of consistent patterns of the curves representing each class adversely affect the classification performance. Results indicate the necessity of advanced image pre-processing to be done before any classification process takes place, with more standard curves pattern distinguishes both classes is expected.

## CONCLUSION

We found that histograms (particularly RGB) has potential in AMD screening, and thus warranting further investigation.

## References

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