

Deep learning for automatic diabetic retinopathy detection under multiple image quality levels

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PURPOSE

Using deep learning techniques is showing promising results for automatic diabetic retinopathy (DR) screening in fundus images. We analyze the **effect of image quality of a handheld fundus camera** on the performance of an automatic DR screening algorithm.

METHODS

- This retrospective study used 257 fovea-centered fundus images from 93 subjects using VISUSCOUT® 100 (ZEISS, Jena, Germany) handheld fundus camera.
- The images are annotated positive for DR if signs of DR are visible. Image quality is assessed using a subjective 1-5 scale (1-very poor; 2-Poor; 3-Fair; 4-Good; 5-Excellent). Figure 1. Shows an example of each quality level.
- We used our Diabetic Retinopathy Deep Network grading model (DRDN) [1] that is trained on ~35k publicly available fundus images for grading the severity of DR.
- DRDN is used to classify VISUSCOUT images for Healthy vs DR by considering any mild or more prediction result as DR.
- Sensitivity (Sn), Specificity (Sp), and Area Under the Curve (AUC) of receiver operating characteristics curve are reported.

CONCLUSION

A high number of false positives (specificity=0.8, 95% CI [0.656, 0.943]) occurred in images rated as very poor quality. For images with a poor and above quality, we observe a consistent performance of the algorithm with less effect of image quality on the specificity. Using samples from fair quality and above gives the highest results with specificity=0.926, 95% CI [0.886, 0.966] which suggests that **using images of above-poor quality would decrease the number of false positives in the DR screening**

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[1] M.H. Sarhan, S. Albarqouni, M. Yigitsoy, N. Navab, A. Eslami: Multi-scale Microaneurysms Segmentation Using Embedding Triplet Loss arXiv preprint (2019)

RESULTS

DRDN shows **good prediction power for unseen images** from a handheld camera (not used in training the model) reaching AUC of 0.98 on images from all quality profiles. No false negatives were triggered, hence, sensitivity=1. The model gave 22 false positives with specificity=0.905, 95% CI [0.866, 0.943]. The results are shown in Fig 2.

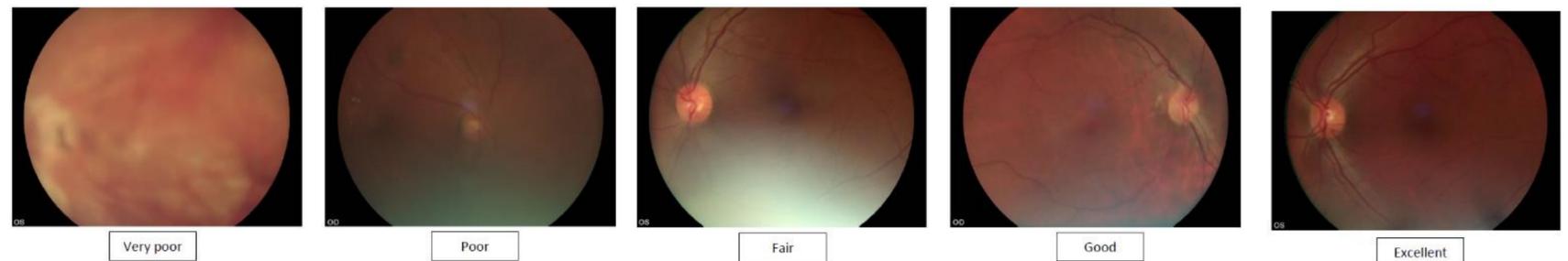


Figure 1. Examples of fundus images for each quality level

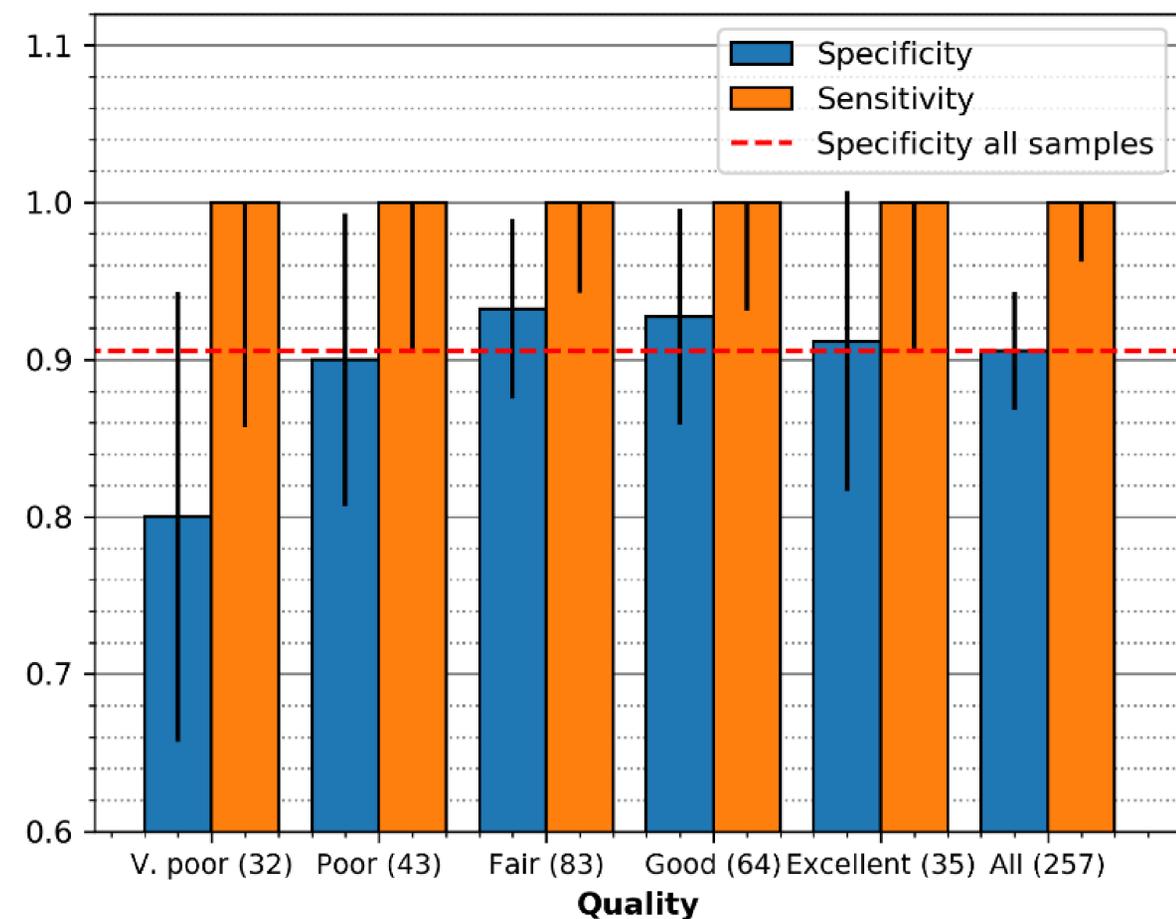


Figure 2. 2 Sensitivity and Specificity of 5 quality levels and all levels combined; vertical black lines show 95% CI; in parentheses are the number of available images for each quality level; red dotted horizontal line shows Sp over all the images.