A real-time method for infrared (IR) reflectance image focus assessment

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PURPOSE

Many optical coherence tomography (OCT) systems incorporate IR fundus imaging for retinal preview and tracking. The acquisition reliability of OCT data depends on the quality of the IR fundus images' focus. This technique demonstrates a real-time image focus measurement using a fast method which can aid an operator during patient alignment. The real-time focus measurement is also essential for an automated acquisition system.

METHODS

- First, stripe artifacts are removed from IR images using a real-time algorithm (Ambrecht et al., *IOVS*, 2020; 61(9):PB0096).
- The method computes a focus value for each IR image by calculating the sum of the gradient magnitude above the 95th percentile of the gradient image as the focus value.
- Prototype software was used to collect a series of IR images (768x624 pixels over 11.52×9.36 mm^2 with a pixel size of 15 µm/pixel) from a CLARUS™ 500 (ZEISS, Dublin, CA) at a frame rate of 50 Hz, using normal and small pupil modes.
- Sequences of roughly 700-800 images each were collected from 10 subjects (some of which had multiple sequences). Images with artifacts, such as blinks, were removed from the database, leaving 5005 total images. The database contains images with different degree of focus [Fig 1].
- The focus values are mapped to probabilities using a cumulative distribution function (CDF) [Fig 2] determined from 5,005 IR images. This plot shows the probability that image focus as a real-valued random variable takes a value less than or equal to the focus value calculated by the algorithm.

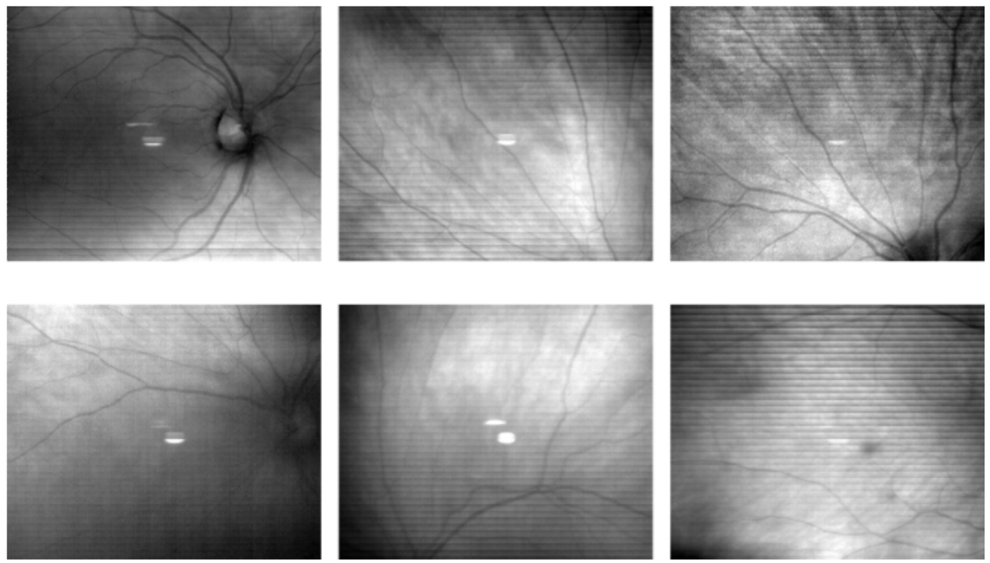

Figure 1: Top: IR images in-focus, Bottom: IR images out-of-focus

RESULTS

- Approximately 100 images were randomly selected from each of the 10 sequences for evaluation.
- 1,016 independent images (486 out of focus and 530 in-focus) were evaluated subjectively by an expert grader using large vessel sharpness as a measure of focus using two grades (in-focus vs out-of-focus).
- We used the grader's evaluation and the focus measurement calculated by the algorithm to compute receiver operating characteristic (ROC) curves [Fig 3].
- The area under the ROC curve (AUC = 0.97) showed great performance of the algorithm with the test data.

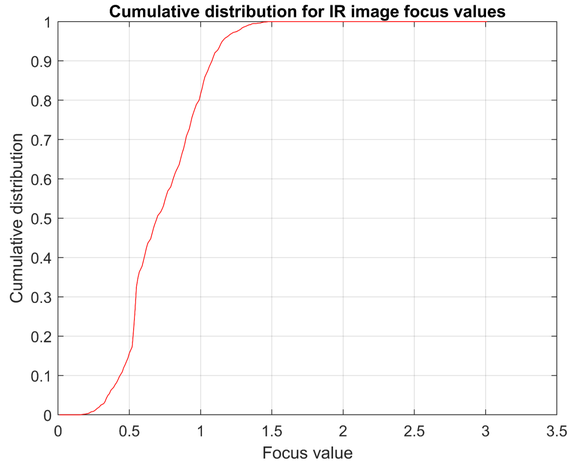

Figure 2: CDF for image focus assessment

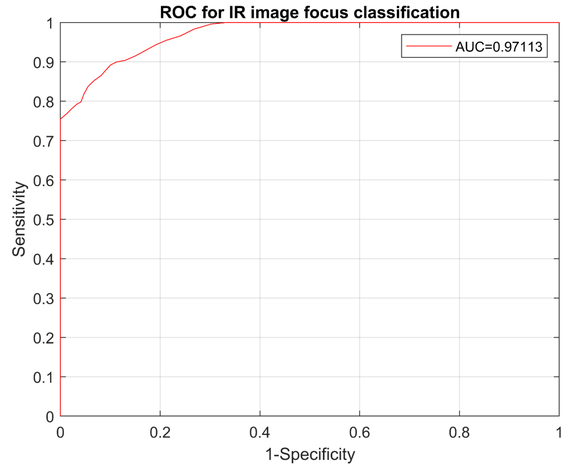

Figure 3: ROC depicts sensitivity and specificity of the algorithm

CONCLUSIONS

We demonstrated a functional real-time IR image focus assessment algorithm that can help operators with patient alignment and automated acquisition, leading to more successful alignment and more efficient workflow.

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Disclosures: RM (E), HB (E), KR (E), HS (E), PS (E), SS (E) – Carl Zeiss Meditec, Inc.