Automatic Image Quality Assessment

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**Significance**
Obtaining the highest possible image quality is critically important when photographing a patient’s retina in a clinic, or collecting images of a subject for a study or clinical trial. In telemedicine, transmitting an unacceptable quality image may mean, at worse, a missed diagnosis, or, at best, the need to retake the image or images at an inconvenience to a patient who will have to return to the clinic for re-imaging. High-quality images are a prerequisite for automatic screening systems, such as those for diabetic retinopathy. Studies have shown that 12 to 29% of data collected in non-mydriatic (no pupil dilation) retinal screening environments were ungradable². An automatic quality evaluation system would have an impact, not only by rejecting the images with poor quality, but also by improving the overall quality of retinal images where the cause of the poor image was due to a technical issue, and not a physiological limitation (e.g., poor dilation or lens opacities), by prompting the photographer to reimage the patient.

**Technical Details**
Depending on the application and the hardware specifications of the imaging system, image quality criteria will vary. However, human visual perception is at the heart of quantitative and automatic image quality evaluation system. The core of the system detects retinal landmarks to determine right/left eye and the image alignment (field 1- optic disc centered, field 2, macula centered), and performs a top-down image quality classification based on a multitude of image features. A flow chart of the system is shown below.

![Flow Chart of the Automatic Image Quality Assessment System](image.png)

Fig.1 Flow Chart of the Automatic Image Quality Assessment System
Image Quality

We have developed an automated retinal image assessment system that can automatically determine whether the quality of a retinal image is sufficient for computer-based diabetic retinopathy (DR) screening. The system integrates the extraction of global and local features that correlate with the human perception of retinal image quality as assessed by eye care specialists. The overall image content, such as lightness, homogeneity (detect crescents, etc.), brightness, and contrast are measured by global histogram and textural features. The sharpness of local structures, such as optic disc and vasculature network, is measured by a local non-reference perceptual sharpness metric (CPBD) and vessel density. A partial least square (PLS) classifier is trained to distinguish low quality images from normal quality images. Technical details and results have been presented in an international conference paper\(^2\).

Landmark Detection and Alignment

Methods have been previously developed for the detection and segmentation of the optic disc\(^3\). The segmented disc is halved and the vessel count in each hemisphere determines whether the image is a right or left eye. The field detection is based on the location of the optic disc along with general definitions of a field 1 and field 2 image. To detect the macula, the optic disc and field information are used along with geometric properties of the retina. To narrow the search region for the macula, the main vessel arcades are detected using a vessel segmentation algorithm\(^4\). The combined information of this system allows us to determine if an image is aligned properly and can be used for further processing.

![Figure 2](image-url)

**Figure 2:** a) Rules based on the location of the optic disc and right/left eye determine the field of the image. b) Vessel segmentation showing the search area of the macula based on the location of the main arcades.

**Future Work**

After undergoing rigorous clinical testing, the automatic image quality system will be the first step in our automatic eye disease screening system: EYESTAR™. It will allow photographers to reimage patients whose images are improperly aligned and determine which images are of high enough quality to be screened by EYESTAR™.