Software-Based Method for Acquiring Enhanced, Panoramic Images from Video Indirect Ophthalmoscopy for Evaluation of Retinopathy of Prematurity (ROP)

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Abstract

Purpose: Indirect ophthalmoscope is the standard of care for evaluation of the neonatal retina. However, images obtained during video indirect ophthalmoscopy (VIO) have inferior quality and small field of view (FOV). Alternative imaging systems have higher quality but are more expensive. We have developed a user-friendly software program for generating reliable, digitally-enhanced, wide-FOV images of the retina from a head-mounted VIO taken during neonatal retinal examinations.

Methods: Retinal video recordings were taken by head-mounted VIO during usual ROP screening examinations using a 28 diopter condensing lens. We developed a hue-based filtering algorithm to automatically identify the video frames featuring the retina in high quality and to filter out non-diagnostically relevant frames. From the set of relevant frames, we selected groups of 5-10 partially-overlapping frames using a graphical user interface. We registered each set of frames using linear conformal mapping by identifying a small number (6) of common visual landmarks. We fused the registered frames in the wavelet domain to form an initial wide FOV mosaic. We then removed the following artifacts arising from the lens, the video camera, or the processing algorithm: 1. Light source reflections appearing as saturated white speckles, 2. over-saturated or shifted retinal colors near the lens' border, 3. inter-frame color imbalances, and 4. intra-mosaic frame borders.

Results: Hue-based filtering adequately distinguished high-quality retinal frames from irrelevant or low-quality frames. The resulting mosaics of registered video frames extended the video camera's intrinsic FOV by over 75%. Our automatic techniques removed or significantly reduced the VIO artifacts.

Conclusions: Our software tool allows VIO to capture neonatal retinal images with high quality and large field of view. These images can be used for computer-assisted analysis of vessel width and tortuosity or for assessment by an ROP specialist, thus expanding the potential application of VIO to ROP clinical care and ongoing research efforts.

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