EE367 Project Proposal: Application of biomimetically inspired algorithms to noise reduction in low light and night vision device captured images and video.

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Motivation

The use of low light imagery and night vision devices (NVD) has long been ubiquitous in commercial, private, and military contexts. Many applications rely on these to provide or augment visual acuity in situations where lives are at stake. While technology has advanced significantly in recent decades allowing greater amplification of signals collected under low light level conditions, the issue of resultant noise is one that deserves continued attention. Noise levels, as applied in signal-to-noise-ratios (SNR), diminish the observer's ability to distinguish colors and contrast, and perceive depth. Thus, in applications such as night flying, reducing noise levels in displayed images is vital to safety.

Related Work

The body of work concerned with nocturnal night vision among animals is extensive. Warrant et al. [1], give a detailed review of such work as it pertains to their development of algorithms. Insects in particular have been successful at adapting their visual organs to low light levels [2]. Warrant et al. propose modeling noise reduction on an inherent ability of some invertebrates to neurally sum collected visual signals in both time and space. Noise is thus reduced by extending the collection time period and integrating signals over that time, [3]. This spatio-temporal smoothing technique has been described numerous times and is used by Warrant et al. in developing a noise reducing algorithm [4].

Project Overview

The main goal of this project is to investigate the applicability of the algorithm described in Warrant et al. to NVDs. The first step will be to understand the algorithm's effect on images captured under low light level conditions. Next, the algorithm will be applied to images captured by an NVD under low light conditions. This is representative of the noisy scenes pilots and aircrew experience during flight operations under these conditions. If time allows, an application of the algorithm to a full motion video captured by NVDs under low light conditions will be made. Ultimately, any benefit of such an algorithm to improving contrast and depth perception during NVD use would be identified.

Milestones, Timelines, Goals

By 2/24: Have images and video captured under low light conditions and with NVDs.

By 3/3: Implement and/or modify the Warrant et al. algorithm. Might also experiment with the BM3D algorithm.

By 3/10: Successfully apply algorithm to images and/or video.

By 3/15: Create poster presentation.

By 3/17: Project report and related code turned in for evaluation.

References

[1] E. J. Warrant, O. Magnus, H. Malm, "The remarkable visual abilities of nocturnal insects: neural princilples and bioinspired night-vision algorithms." Proc. of the IEEE, vol. 102, no. 10, pp. 1411-1426, 2014.

[2] E. J. Warrant, ''Seeing better at night: Life style, eye design and the optimum strategy of spatial and temporal summation,'' Vis. Res., vol. 39, pp. 1611–1630, 1999.

[3] J. H. van Hateren, ''Spatiotemporal contrast sensitivity of early vision,'' Vis. Res., vol. 33, pp. 257–267, 1993.

[4] G. Z. Yang, P. Burger, D. N. Firmin, and S. R. Underwood, ''Structure adaptive anisotropic image filtering,'' Image Vis. Comput., vol. 14, pp. 135–145, 1996.