ioM-HDR: A High Dynamic Range adapted model of visual salience

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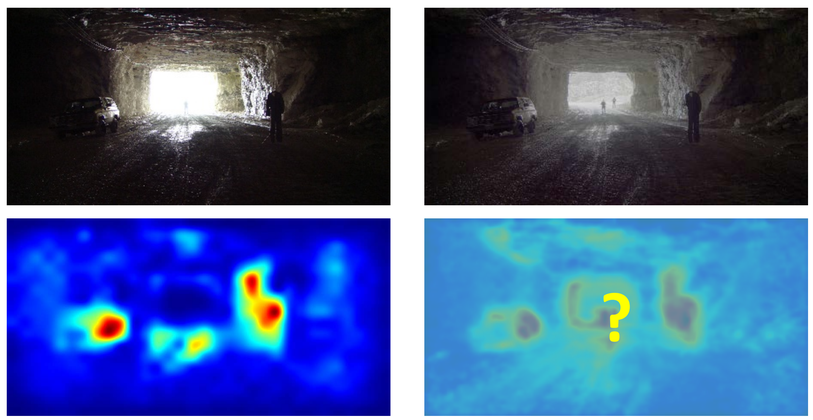
Motivation

- Develop a computational model of visual salience, visual search, for high dynamic range (HDR) stimuli
  - HDR image: in-scene luminance change >10^3:1



Predictive accuracy of gaze in HDR imagery is poor without adaption

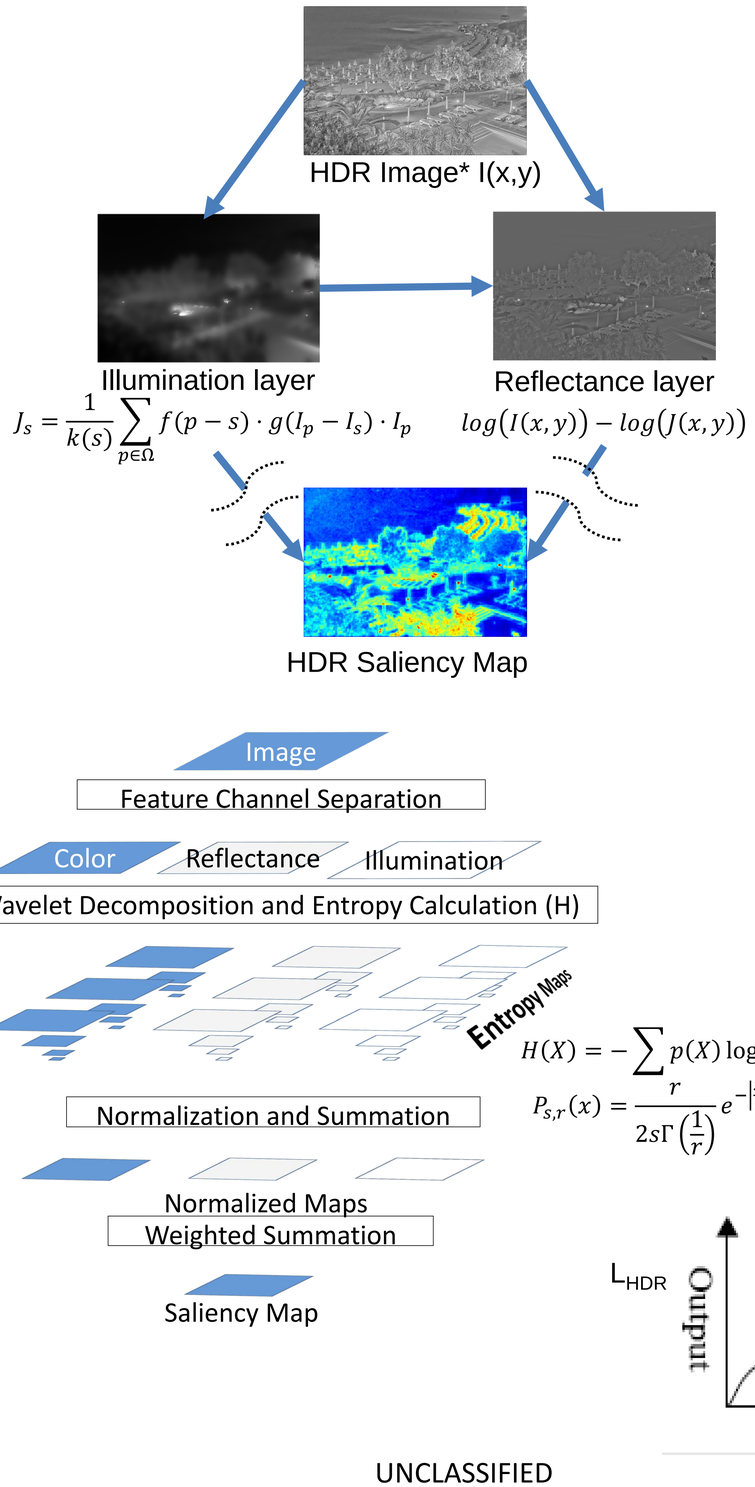
Challenge

- Existing visual-salience models primarily tested on standard dynamic range (SDR) imagery rarely tested on HDR stimuli
- Few studies of eye tracking datasets of visual search under HDR imagery (Nemoto et al. 2015; Narwaria et al. 2012)
- Visual search pattern may be due to improved visibility or changes in how features interact with high luminance within the human visual system

Approach

- Leverage work from tone mapping (HDR image compression) to adapt saliency models to HDR stimuli
  - Use Bilateral filtering (J) to separate reflectance and illumination from an image
- Modify ideal observer model (ioM) of visual salience to use tone mapping inspired adaptation (Harrison & Etienne-Cumming 2012)
  - Estimates of entropy(H) within an image are used to predict likelihood of eye gaze

ioM-HDR Model



Results

- Reflectance is almost as useful an adaption as taking the logarithm of the image
- The appropriate combination of reflectance and illumination is the best adaptation method for the ioM

ioM estimate	ROC (AUC)	NSS
HDR Image	0.7524	0.9999
Log(HDR Image)	0.7651	1.0714
Log(Illumination)	0.7561	1.0088
Log(Reflectance)	0.7651	1.0673
Log(Combination)	0.7660	1.0795
Effective Chance	0.7486	0.9358

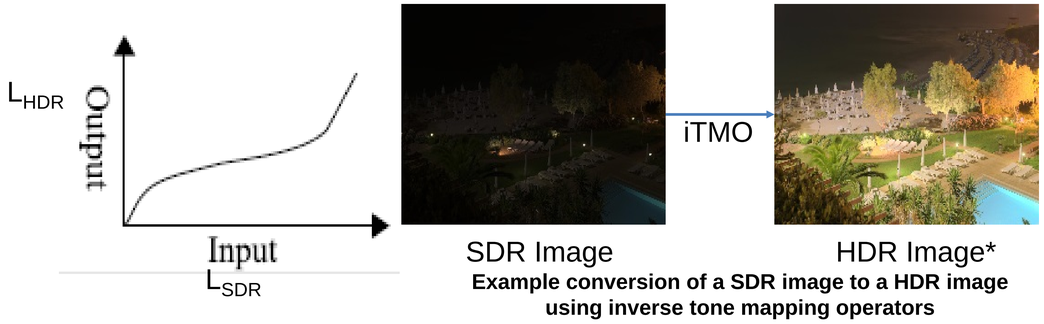
Performance results of the ideal observer model (ioM) on different HDR image channels using the area under the curve of the receiver operating characteristic (ROC-AUC) and the normalized scanpath saliency (NSS) measures. Human performance is approximately 0.7800 and 1.2811, respectively.

Discussion & Conclusion

- Integrating reflectance and illumination processing directly into the ioM may provide further benefits
- An HDR adapted model of visual saliency will enable vision models to operate better on real world scenes
- Visual search models that are consistent with human vision allow autonomous systems to operate predictably and cooperatively with people by estimating human behavior

Path Forward

- Learn weight between reflectance and illumination layers
- Train Deep Learning saliency models on existing SDR datasets through inverse tone mapping (iTMO)/expansion operators (EO)



Example conversion of a SDR image to a HDR image using inverse tone mapping operators