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# Near Infrared in Image Segmentation

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***Abstract—*** *Near-infrared (NIR) is a part of the electromagnetic spectrum with an approximate wavelength range of 700 nm to 1100 nm. Mostly all the digital cameras can capture NIR spectrum by doing a slight modifications. To take advantage of both NIR and visible information, it is necessary to simultaneously capture NIR and color images for each scene. RGB and NIR cues have been successfully combined in many applications like dehazing, dark flash photography, and scene categorization. NIR can be widely used in semantic segmentation and many other image processing techniques.*

***Keywords:*** *NIR, RGB, Digital camera, segmentation, haze, 4-channel.*

## 1. INTRODUCTION

Near-infrared (NIR) is a part of the electromagnetic spectrum with an approximate wavelength range of 700 nm to 1100 nm. Sensors of most digital cameras are inherently sensitive to the near infrared (NIR) part of the spectrum (700-1100 nm). However, an interference filter called "hot mirror" is usually used in digital cameras to block the NIR information, which is considered as noise when capturing visible images [1]. Thus, to capture NIR images with current cameras, one needs to remove the hot mirror and mount a visible blocking filter in front of the lens [2]. The extra information offered by NIR images has recently been exploited along with visible (RGB) images in some applications such as illuminant detection [3], dark flash photography [4], video conferencing [5], realistic skin smoothing [6], and object segmentation [7].


**Figure 1:** RGB and NIR image respectively

Fig. 2 shows normalized response of a typical monochrome (photographs in one color or shades of one color) CCD.

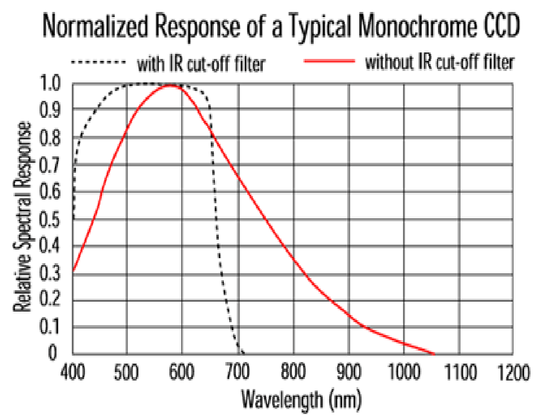


**Figure 2:** Normalized Response of a Typical Monochrome CCD

## 2. PROPERTIES OF NIR

Visible and NIR images of the same scene are, at first regard, very similar. We can easily recognize that they are taken from the same viewpoint and contain the same scene elements as shown in fig.1.

- NIR spectroscopy is based on molecular overtone and combination vibrations.
  a) The molar absorbability in the near IR region is typically quite small.
  b) Light Scattering

Small particles scatter incident light, which can alter the light intensity at specific wavelengths. When the particle size is very small (< λ/10), radiation behaves according to Rayleigh scattering, which states that:

$$I_s/I_o = \text{constant}/\lambda^4 \quad .....(1)$$

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Another effect of Rayleigh scattering can be observed when atmospheric haze or pollution is present. NIR images appear sharper and contain more details in distant objects than the corresponding color photograph.
When the particles are large (> λ/10), spherical, diverse, the dependency between scattering intensity and wavelength disappears and all wavelengths are equally scattered. Thus, clouds wilsl look similar in RGB and NIR images, but the contrast between sky and clouds is enhanced in the NIR image.

### c) Molecular Structure

The interaction of light and particles in the atmosphere is not the sole reason why the intensity content of NIR images differs from those of RGB ones. In general, different molecular structures and complex absorption spectra of natural and man-made materials will result in different intensities in RGB and NIR image.

## 3. NIR IN IMAGE SEGMENTATION

Recent progress in computational photography has shown that we can acquire physical information beyond visible (RGB) image representations. In particular, we can acquire near-infrared (NIR) cues with only slight modification to any standard digital camera. Studies have proved whether this extra channel can improve semantic image segmentation [9]. Based on a state-of-the-art segmentation frame work and a novel manually segmented image database that contains 4-channel images (RGB+NIR), studies shows how to best incorporate the specific characteristics of the NIR response. It leads to improve performances for 7 classes out of 10 in the proposed dataset and discusses the results with respect to the physical properties of the NIR response. Semantically segmenting a scene given an image is one of the eminent goals in computer vision [11]. While we have seen a lot of progress in recent years using sophisticated image descriptors [1, 2] and better machine learning techniques, segmentation still remains challenging. Whereas humans have no difficulties performing semantic image interpretation, machine vision systems still struggle mainly because of the ambiguity of the influence of light and surface reflectance on a given pixel value. For example, a dark pixel can either result from a dark surface reflectance under normal lighting conditions or a light surface reflectance under shadow. Decoding the contributions of light and reflectance from an image is an ill-posed problem [5]. To solve it, we either need to make assumptions about the world, or to capture more information. Semantic segmentation can be studied using the latter approach. Specifically, we propose to use near-infrared (NIR) images in addition to visible (RGB) images as input. Silicon sensors of digital cameras are naturally sensitive in the NIR wavelengths range (750-1100nm). By removing the NIR blocking filter affixed to the sensor, digital cameras can capture both RGB and NIR images RGB and NIR cues have been successfully combined in many applications like dehazing [7], dark flash photography [8], and scene categorization [9, 10]. We believe that the intrinsic properties of NIR images make them relevant for semantic segmentation. First, due to the NIR radiation being adjacent to the visible spectrum, NIR images share many characteristics with visible images [12]. In particular, the shapes of objects in the scene are preserved, i.e., borders of physical objects in the visible images match the borders in the NIR image, which is necessary for segmentation. Second, the intensity values in the NIR images are more consistent across a single material, and consequently across a given class region, due to the unique reflectance of certain natural and man-made composites to NIR radiation [11]. For instance, vegetation is consistently "bright", and sky and water are "dark". Third, texture in NIR images is more intrinsic to the material. This is partly due to the transparency of most colorants and dyes in NIR; texture introduced by (color) patterns on a surface is less dominant in NIR Additionally, there is generally less haze present in NIR images [7]. Consequently in landscape images, distant regions appear sharper. These properties of NIR images have been used by the remote sensing devices [10].

## 4. PURPOSE BEHIND USING NIR

The interest of using NIR information is that it effectively doubles the wavelength range over which the illuminant can be estimated [13]. Practically speaking, usual illuminant detection and estimation is performed by comparing fairly correlated information (cameras color filters have peak sensitivities that are only about 100nm apart) [14]. Because of its greater distance to the visible spectrum (400nm on average), NIR is less correlated and can therefore provide more relevant information for illuminant estimation.

The main advantage of NIR is that for common multiple lighting conditions, it has very large response variation with respect to the type of incident light: incandescent light bulbs have their emission peak in the NIR, while scattered skylight (which is the color of outdoor shadows) and florescent lighting have virtually no emission in that part of the spectrum [15]. This actually enables us to distinguish between different light bulbs that have an identical white point, but different metameric properties.

## 5. FOUR CHANNEL IMAGES

Any kind of applications need RGB (red, green, and blue) and NIR channels of the scene. There are Four-channel

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images RGBN. Without the hot-mirror filter, a mixture of one color channel and NIR is captured at each spatial position on the sensor [16]. Hence, to have full resolution NIR and RGB images, we first need to separate the NIR and color channels in different pixels of the mosaiced image. There are algorithms that separate these signals by exploiting their spatial and spectral correlations. Once the color and NIR channels are successfully separated, the NIR intensities are known in all pixels, but the intensities of two color channels are missing in each pixel [17].

## 6. CONCLUSION

While digital imaging sensors are inherently sensitive to both visible and near-infrared wavelengths, combining this information for meaningful image processing is studied. We observed the benefit of NIR in the presence of haze. As stated by Rayleigh's law, the light scattered from small particles ($< \lambda/10$) is inversely proportional to the wavelength $\lambda$ ($1/\lambda 4$). The use of this potentially free additional information is a promising direction to improve semantic segmentation, which we plan to test on a broader range of classes. Integrating NIR along with conventional RGB images improves the segmentation results.

## REFERENCES

**[1] Shotton,J., Winn, J., Rother, C., Criminisi, A.:Textonboost: Joint appearance,shape and context modeling for multi-class object recognition and segmentation.In: ECCV. (2006)**

**[2] Csurka, G., Perronnin, F.: An efficient approach to semantic segmentation. IJCV95 (2011)**

**[3] Verbeek, J., Triggs, B.: Region classification with markov field aspects models. In:CVPR. (2007)**

**[4] Ladicky, L., Russell, C., Kohli, P., Torr, P.H.S., Brookes, O.: Graph cut based inference with co-occurrence statistics. In: ECCV. (2010)**

**[5] Finlayson, G.D., Drew, M.S., Funt, B.V.: Color constancy:generalized diagonal transforms suffice. Journal of the Optical Society of America 11 (1994) 3011–3019**

**[6] Fredembach, C., S¨usstrunk, S.: Colouring the Near-infrared. In: CIC. (2008)**

**[7] Schaul, L., Fredembach, C., S¨usstrunk, S.: Color image dehazing using the Nearinfrared. In: ICIP. (2009)**

**[8] Krishnan, D., Fergus, F.: Dark flash photography. In: SIGGRAPH. (2009)**

**[9] Brown, M., S¨usstrunk, S.: Multispectral SIFT for scene category recognition. In: CVPR. (2011)**

**[10] Salamati, N., Larlus, D., Csurka, G.: Combining visible and Near-infrared cues for image categorisation. In: BMVC. (2011)**

**[11] Salamati, N., Fredembach, C., S¨usstrunk, S.: Material classification using color and NIR images. In: CIC. (2009)**

**[12] Zhou, W., Huang, G., Troy, A., Cadenasso, M.L.: Object-based land cover classification of shaded areas in high spatial resolution imagery of urban areas: A comparison study. Remote Sensing of Environment 113 (2009) 1769–1777**

**[13] Zhang, X., Sim, T., Miao, X.: Enhancing photographs with NIR images. In: CVPR. (2008)**

**[14] Kermani, Z., Lu, Y., S¨usstrunk, S.: Correlation-based joint acquisition and demosaicing of visible and Near-infrared images. In: ICIP. (2011)**

**[15] Lafferty, J., McCallum, A., Pereira, F.: Conditional random fields: probabilistic models for segmenting and labeling sequence data. In: ICML. (2001)**

**[16] Lowe, D.: Distinctive image features from scale-invariant keypoints. IJCV (2004)**

**[17] Csurka, G., Dance, C., Fan, L., Willamowski, J., Bray, C.: Visual categorization with bags of keypoints. In: ECCV SLCV Workshop. (2004)**