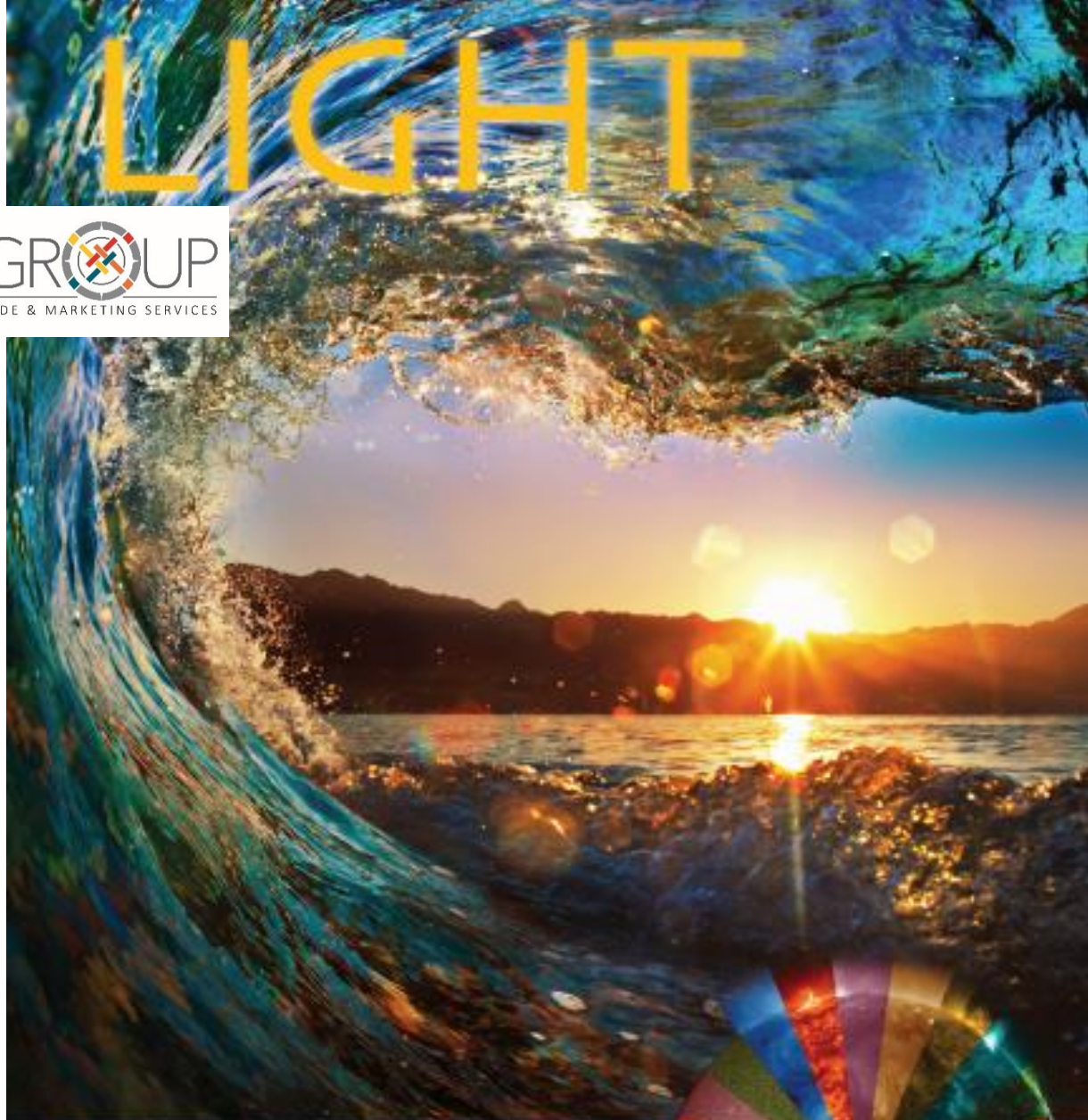




What is Light?

Light plays a vital role in our daily lives and has become an important tool in meeting the needs of our 21st-century world. Light-based technologies protect health and safety, provide sustainable energy, enable space exploration, advance lighting options in rural areas, enable communication via the Internet, and hold the promise of limitless possibilities to improve the human condition and protect the earth.

Light is part of the electromagnetic radiation spectrum and is a form of energy. Light is usually considered to be the visible part of the spectrum. However, in physics, light can be defined as all portions of the electromagnetic scale, including invisible forms such as infrared, ultraviolet, X-rays, radio waves, and more.

Electromagnetic waves can be described by their wavelength, energy, and frequency.

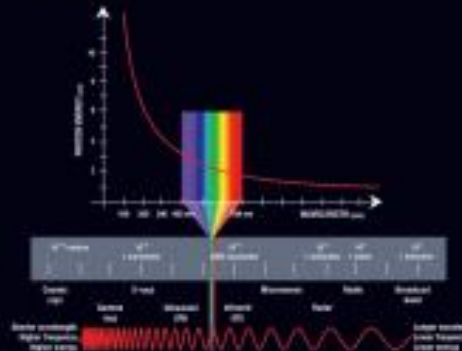
Wavelength (λ)—Light waves are vibrations in the electromagnetic field. The wavelength of a light wave is measured as the distance between two wave crests. Light wavelengths can vary greatly; for example, radio waves can be about the size of small buildings, while gamma rays are subatomic size.

Frequency (ν)—The number of wave crests passing by a fixed point in a given time period—usually one second—is called frequency. Frequency is measured in hertz (Hz). Higher-frequency waves have shorter wavelengths.

Energy (E)—The greater the energy, the higher the frequency and the shorter (smaller) the wavelength. Given the relationship between wavelength and frequency—the higher the frequency, the shorter the wavelength—it follows that short wavelengths are more energetic than long wavelengths.



This still image was taken from a new NASA movie of the southeast on data from NASA's Solar Dynamics Observatory, or SDO, showing the wide range of wavelengths—visible to the naked eye—but the infrared can also be seen. The swirling patterns of the sun in a variety of wavelengths, including visible light, have problems and features through the sun's atmosphere. In this image, the visible wavelengths are most prominent, although it shows the range of components on the sun's surface, helping scientists to build a complete picture of our star.



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FONTES DE LUZ E ILUMINAÇÃO	Cristais líquidos, LEDs e OLEDs, colorimetria
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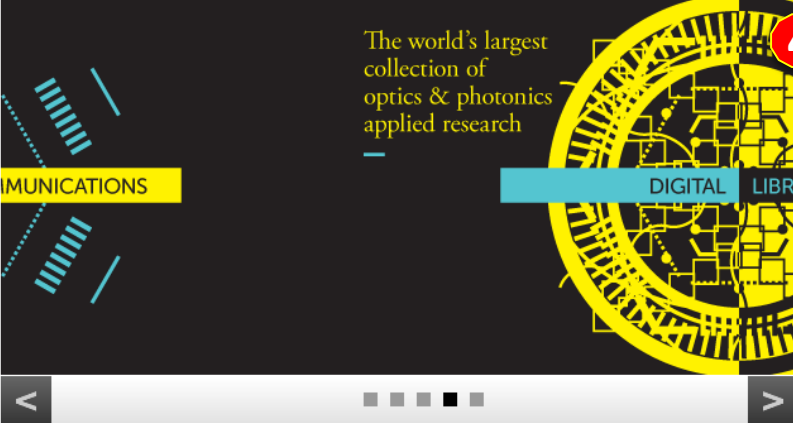
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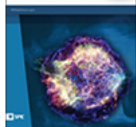
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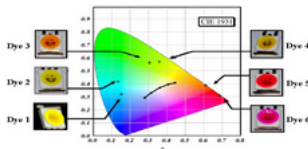


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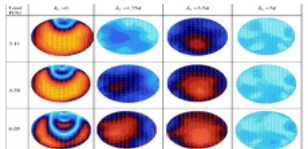
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1 Content-based image retrieval in radiology: analysis of variability in human perception of similarity

Jessica Faruque ; Christopher F. Beaulieu ; Jarrett Rosenberg ; Daniel L. Rubin ; Dorcas Yao ; Sandy Napel

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J. Med. Imag. 2(2), 025501 (Apr 03, 2015). doi:10.1117/1.JMI.2.2.025501

History: Received January 27, 2015; Accepted March 10, 2015

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Abstract

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Abstract. We aim to develop a better understanding of perception of similarity in focal computed tomography (CT) liver images to determine the feasibility of techniques for developing reference sets for training and validating content-based image retrieval systems. In an observer study, four radiologists and six nonradiologists assessed overall similarity and similarity in 5 image features in 136 pairs of focal CT liver lesions. We computed intra- and inter-reader agreements in these similarity ratings and viewed the distributions of the ratings. The readers' ratings of overall similarity and similarity in each feature primarily appeared to be bimodally distributed. Median Kappa scores for intra-reader agreement ranged from 0.57 to 0.86 in the five features and from 0.72 to 0.82 for overall similarity. Median Kappa scores for inter-reader agreement ranged from 0.24 to 0.58 in the five features and were 0.39 for overall similarity. There was no significant difference in agreement for radiologists and nonradiologists. Our results show that developing perceptual similarity reference standards is a complex task. Moderate to high inter-reader variability precludes ease of dividing up the workload of rating perceptual similarity among many readers, while low intra-reader variability may make it possible to acquire large volumes of data by asking readers to view image pairs over many sessions.

3

4 Introduction

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Liver cancer is a leading cause of cancer mortality, and early detection of cancer using radiological images plays a crucial role in improving survival rates.¹ However, early detection is challenging due to inter-reader variability in image interpretation and the need for more efficiency in interpreting large volumes of imaging data resulting from increased screening rates.²⁻⁴

Predictive and learning techniques for assisting in radiological decision making are becoming increasingly sophisticated and may improve the accuracy and efficiency of cancer diagnosis.^{5,6} One technique, content-based image retrieval (CBIR), involves the presentation of images containing visually similar lesions alongside images requiring diagnosis in order to improve diagnostic accuracy and efficiency.⁷⁻⁹ Studies involving CBIR systems for clinical decision support demonstrate that they may be useful in assisting diagnosis.¹⁰⁻¹²

A recurring challenge in building a robust CBIR system is obtaining an accurate reference set (or "gold standard") for training and validating the system. Even though major strides have made in image feature analysis and prediction algorithms, obtaining training and testing data that accurately reflect the higher-level perceptual judgments necessary for diagnosis remains a major obstacle to progress.¹³⁻²¹

The study of medical image perception is an ongoing task.²²⁻²⁵ Recent publications about medical image similarity have focused on mammograms. Many of these studies showed that asking several radiologists and nonradiologists to rate similarity in pairs of mammograms may be a feasible way to acquire similarity data, particularly when readers' ratings are averaged.^{26,27} Recent work also involves using artificial neural networks to impute similarity ratings, showing that the neural networks produced ratings with variability that may be comparable with variability between radiologist readers.^{28,29} Similar

5

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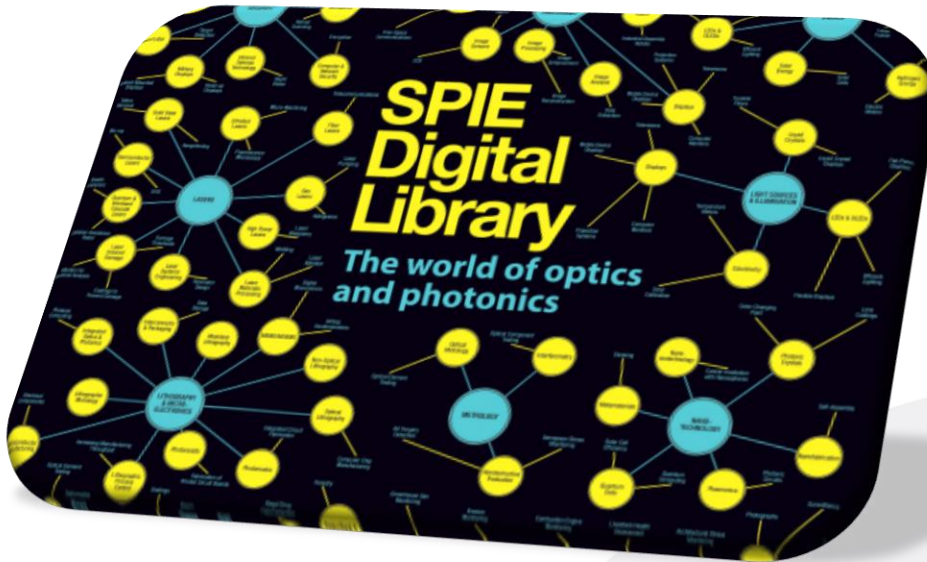
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