Preface

Color is one of the most fascinating areas to study. Color forms an integral part of nature, and we humans are exposed to it every day. We all have an intuitive understanding of what color is, but by studying the underlying physics, chemistry, optics, and human visual perception, the true beauty and complexity of color can be appreciated—at least to some extent. Such understanding is not just important in these areas of research, but also for fields such as color reproduction, vision science, atmospheric modeling, image archiving, art, photography, and the like.

Many of these application areas are served very well by several specifically targeted books. These books do an excellent job of explaining in detail some aspect of color that happens to be most important for the target audience. This is understandable as our knowledge of color spans many disciplines and can therefore be difficult to fathom.

It is our opinion that in application areas of computer science and computer engineering, including such exciting fields as computer graphics, computer vision, high dynamic range imaging, image processing and game development, the role of color is not yet fully appreciated. We have come across several applications as well as research papers where color is added as an afterthought, and frequently wrongly too. The dreaded RGB color space, which is really a collection of loosely similar color spaces, is one of the culprits.

With this book, we hope to give a deep understanding of what color is, and where color comes from. We also aim to show how color can be used correctly in many different applications. Where appropriate, we include at the end of each chapter sections on applications that exploit the material covered. While the book is primarily aimed at computer-science and computer-engineering related areas, as mentioned above, it is suitable for any technically minded reader with an interest in color. In addition, the book can also be used as a text book serving a graduate-level course on color theory. In any case, we believe that to be useful in any engineering-related discipline, the theories should be presented in an intuitive manner, while also presenting all of the mathematics in a form that allows both a deeper understanding, as well as its implementation.

Most of the behavior of light and color can be demonstrated with simple experiments that can be replicated at home. To add to the appeal of this book, where possible, we show how to set-up such experiments that frequently require no more than ordinary household objects. For instance, the wave-like behavior of light is easily demonstrated with a laser pointer and a knife. Also, several visual illusions can be replicated at home. We have shied away from such simple experiments only when unavoidable.

The life cycle of images starts with either photography or rendering, and involves image processing, storage, and display. After the introduction of digital imaging, the imaging pipeline has remained essentially the same for more than two decades. The phosphors of conventional CRT devices are such that in the operating range of the human visual system only a small number of discernible intensity levels can be reproduced. As a result, there was never a need to capture and store images with a fidelity greater than can be displayed. Hence the immense legacy of eight-bit images.

High dynamic range display devices have effectively lifted this restriction, and this has caused a rethinking of the imaging pipeline. Image capturing techniques can and should record the full dynamic range of the scene, rather than just the restricted range that can be reproduced on older display devices. In this book, the vast majority of the photography was done in high dynamic range (HDR), with each photograph tone-mapped for reproduction on paper. In addition, high dynamic range imaging (HDRI) is integral to the writing of the text, with exceptions only made in specific places to highlight the differences between conventional imaging and HDRI. Thus, the book is as future-proof as we could possibly make it.

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