BOOK REVIEW

Fractal Image Compression

Michael F. Barnsley and Lyman P. Hurd, 244 pages, ISBN 1-56881-000-8, AK Peters, Ltd., Wellesley, Massachusetts (1993) \$49.95.

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I have been hearing for nearly a decade about how tremendous fractals are for image compression. I can remember those marvelous claims of 10,000:1 compression when I was struggling to have good compression in the range of 20:1. Now the originator of fractal compression decides to tell all. Well, almost.

This text is organized into six chapters. The first chapter is a brief introduction that includes a description of the other chapters, as well as the patents that protect the material in the book and the address of where to obtain more information regarding the legal aspects enshrouding fractal compression. The second chapter is dedicated to establishing the formal mathematical model in which fractal compression is described. The majority of the material here is found in countless other texts on image processing. The third chapter discusses the mathematical foundations of fractal compression. The fourth chapter describes the application of this mathematical framework to fractal compression. The fifth chapter revisits mathematical constructs with a focus on concepts from information theory. The sixth and final chapter applies the higher mathematical formalisms of the fifth chapter to develop what is referred to as the *fractal transform*. As the culmination of the previous chapters, the textual content of Chapter 6 is surprisingly small.

When I first began reading this book I had trouble deciding whether I had picked up a book on metric spaces or a book on compression. As a book on metric spaces it is lacking, and there are a great number of better references available. As a book on data compression, there are also serious flaws, such as the lack of any mention of the trade-offs between compression ratios and image quality or any mention of the limitations of the method.

This book contains mathematics that any

undergraduate mathematics major is required to take, namely, real analysis. Unfortunately, this rendition is not rigorous and there are some blunders. For example, the authors claim that a set is open if it is not closed; however, the set $(0, 1]$ is not closed in the real line, but then it is not open either. There are also other places where the mathematics is just plainly wrong (e.g., Example ii on p. 73 is in error). In fact, one of the functions claimed to be a metric is not! The problem is that the authors have adopted a definition of a metric that is not consistent with the generally accepted definition. The standard definition includes the property that the distance between two elements is zero if and only if they are equal. The author's definition of a metric did not include this property. Of course, the implication is that one has to be quite careful in adopting the vast body of mathematics of metric spaces without first developing the theory without the benefit of this axiom. I believe that the mathematics of this book should be approached with some skepticism.

However, since the book is about compression, one should consider the contribution made on that topic and assume the mathematical problems can be resolved. The basic idea is to consider the space of images as a metric space according to some metric, and then develop a special set of transformations, referred to as *affine transforms*. These transformations have the property of being contractive according to the metric, and as such, have a unique fixed point. Determining the fixed point is a trivial affair; simply pick any point and apply the transformation to the point iteratively, and convergence is guaranteed. If the fixed point is the image we wish to compress, then one begins with any image and iterates with the affine transforms to produce the desired image. Great idea! The only trick is to determine the collection of affine transforms. This turns out to be quite labor intensive and requires significant amounts of human intervention. There is a section on making the compression scheme automatic, but the discussion is rather confusing and inconclusive. Most of the sample images are bitonal, but there is sufficient information to extend the results to gray scale and color.

The inclusion of C source code to implement some of the compression ideas is welcome. It is intended to run on a PC with a Targa board, but with some minor modifications it

can be converted to other platforms. However, the authors warn the reader that a license is truly needed to use the software. The notice of patent protection was probably encouraged by the authors' attorneys, but it does seem to be in bad taste. Moreover, the software is also a reduced set of what is really needed and, of course, the full set can be purchased elsewhere. I got the same feeling reading the material as I do from "infomercials" on late-night television. If the authors wish to describe their work, then the description should not be a cloaked advertisement for a product that the unsuspecting customer has to purchase. This book should be distributed free of charge, since it is really a marketing tool.

In summary, this book has mathematical errors, the original technical content is small, and it is largely an advertisement for the author's company. There are much better treatments of metric spaces and much better expositions on image compression. In my opinion, the book *Fractal Image Compression* will not stand the test of time to become part of the electronic imaging literature. Someday, a text will be published that gives the topic of fractal image compression the treatment it deserves. I will have to wait for that day to arrive.

Lawrence A. Ray received his BS degree in mathematics from Union College in Schenectady, New York, in 1971. He received MS and PhD degrees in mathematics from the University of Rochester, New York, in 1974 and 1978, respectively. Between 1986 and 1990, Ray was the senior on-site representative from Eastman Kodak at the National Center for Supercomputing Applications at the University of Illinois. Currently, he is a research associate at the Imaging Science Division of the Eastman Kodak Research Laboratories.

Publisher's note: Please note that in the book review of *Vision: Coding and Efficiency*, which appeared in the July issue (Vol. 2, No. 3, p. 272), the statement concerning the high price of the book was made with reference to the hardcover edition, whose ISBN number was listed. The price listed in the review, however, is for the softcover edition (ISBN 0-521-44769-0), which, at a price of \$34.95, is felt by the reviewer to be appropriately priced for a student buyer. We regret any inconvenience this may have caused.