FAREY SEQUENCES AND VARIABLE PROCESSING ARCHITECTURE FOR MEDICAL IMAGE PROCESSING

Poornima M[1], S. Jagannathan[2], R Chandrasekhar[3]
[1]Department of Mathematics, SJB Institute of Technology, Bangalore
[2]Department of Computer Science Engineering, Jain University, Bangalore
[3]Department of MCA, PESIT Research, Bangalore

Abstract
This paper brings out Farey sequence and its applications to medical image processing. This paper gives the architecture for farey approximation for a given fraction, reduction in computational calculations and floating point operations.
Keywords: Farey sequence, Compressing the Farey table, Image Processing Floating point reduction, Floating point error, DSP.

1 Introduction

This paper is an exploration of the Farey sequence and its applications to image processing. In the year 1816, John Farey invented an amazing procedure to generate proper fractions lying in the interval [0, 1], called the Farey sequence. Formally defined, the Farey sequence Fn of order n is the sequence of simple/irreducible, proper, and less than or equal to n, and are arranged in increasing order of their qualities. There are a few studies and research works related with Farey sequences [1-4].

Image processing algorithms involves a variety of operations on large arrays and Compute-intensive floating point operations. Business altered point DSPs (Digital Signal processors) have particular cost, power and frame element points of interest. Be that as it may, the process of converting a floating-point algorithm to fixed-point is time-consuming and prone to subtle errors.

This paper is in Section 2 gives the properties [3-4] and Section 3 which gives Farey approximation and image segmentation for medical images using Farey sequence and proposes architecture

2. Farey Sequence

The Farey sequence of any order n is a sequence of or simple or irreducible fractions in [0, 1], which have denominators less than again equivalent to n, organized in climbing request. Every grouping starts with the value 0 (0/ 1) and ends with the value 1 (1 /1). Interestingly, each sequence Fn can be generated from its preceding sequence Fn-1 by inserting the fraction (a + a') esteem (1/1). Strikingly, every arrangement Fn can be produced pair of consecutive fractions a b and a' b' of Fn-1, disposing of the divisions whose denominators surpass n, as appeared in Fig. 1.

F_1 = {0/1,1/1}
F_2 = {0/1,1/2,1/1}
F_3 = {0/1,1/3,1/2,2/3,1/1}

F_7={0/1,1/7,1/6,1/5,1/4,2/7,1/3,2/5,
3/7,1/2.4/7,3/5,2/3,5/7,3/4,4/6.5/6,6/7.1/1}

Fig. 1. Generation of Farey sequences up to order 7 in an iterative way

3.Farey Sequence and Medical Image Processing of Brain Images

In the signal processing and image coding, some of the operations are of multiplications and some are of fractional arithmetic. It involves usage of more power and floating point operations for applications such as the medical image processing. By having only fixed point implementation and less searching will save the power and reduces the complexity in implementation..

By using the farey Trees, the computation can be reduced more than traditional methods [15] which are in vogue. It involves only few searches in the table which is a small table of size 1k bytes. It avoids the floating point arithmetic. First using the farey sequence approximation encoder Tree table is created and the table size is of less than 256 entries and of 2-3% of image size.

An image frame of a Brain image is considered. All the pixel values are divided by 255 or 65536 depending on the pixel size value for normalization or thresh holding. By normal division it involves more floating arithmetic and computation. It also consumes more power. As per the Fig 2 the farey approximation can be obtained. The approximation is reduced approximation. The numerator and denominator of the (irreducible) fraction like 159/255 is reduced to 15/17 or 8/9 which is a reduced fraction. Similarly any value like 255/65536 can be reduced to 1/257 reduced fraction. The numerator and denominator of the (irreducible) fraction like 146/255 is reduced to 47/82 or 19/37 which is a reduced fraction. Similarly any value like 246/255 can be reduced to 82/85 reduced fraction.

The Fig 3 gives the farey approximation of reduced numerator is tor of the reduced fraction when pixel value is divided by 255 value. The Fig 4 gives the farey approximation of reduced denominator of the reduced fraction when pixel value is divided by 255 value.

Fig 5 and Fig 6 gives further reduction of numerator and denominator by applying farey approximation as per the Fig 1 repeatedly till the gcd(Numerator, denominator) is 1. One can stop for particular approximation.

A farey approximation of reduced fraction cab be created for a image of suitable size can be created . By look up for particular fraction, the computation and calculations involving divisions can be reduced.

Fig 7 gives proposed architecture which can implemented in hardware as co-processor in traditional or custom specific embedded architecture for fast processing with less number of clock cycles for medical image or video coding processing applications. In conventional image processing architecture all the mathematical computation will be performed on fixed bit formatted raw data. In proposed image processing architecture we receive variable bit data from farrey sequence generator, which in turn fed to modified variable processing blocks as shown in the figure.

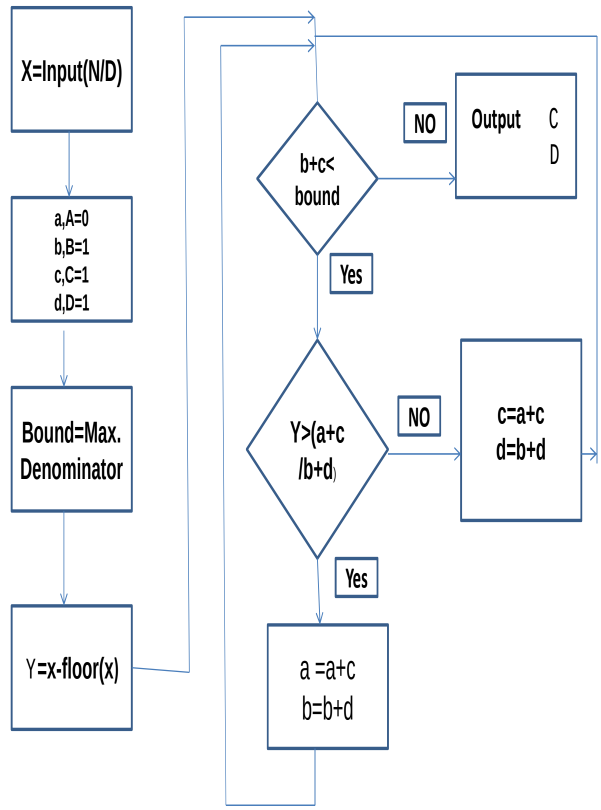

Fig 2

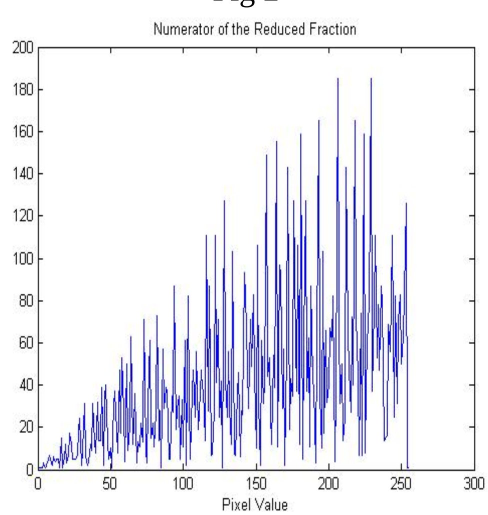

Fig 3 Numerator of the Reduced Fractions

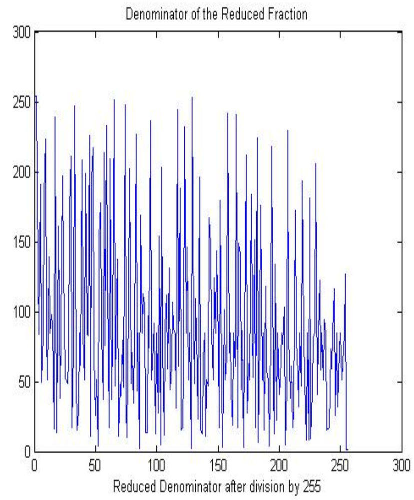

Fig 4 Denominator of the Reduced Fractions

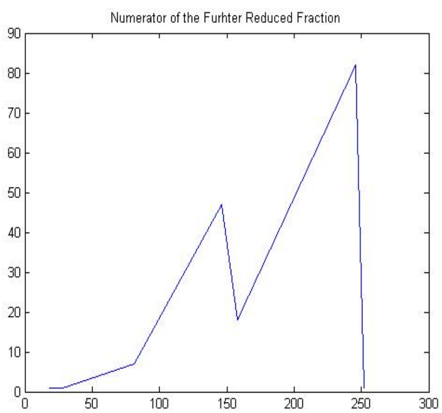

Fig 5 Numerator of the Further Reduced Fractions

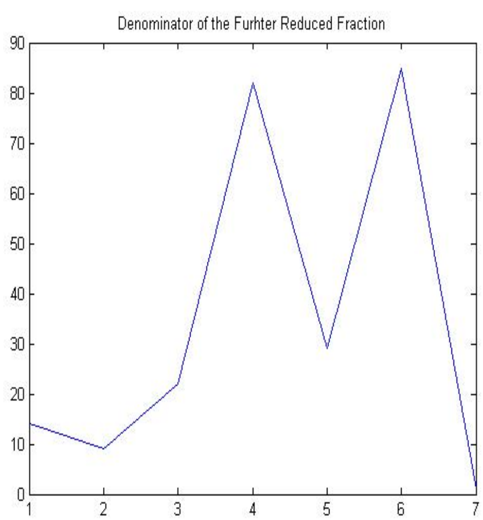

Fig 6 Denominator of the Further Reduced Fractions

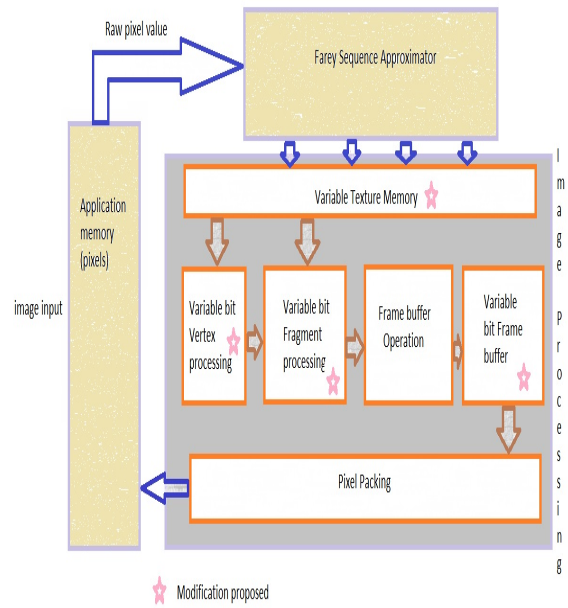

Fig 7 Proposed Farey Architecture

Acknowledgment

This paper shows searching a fraction in the Farey sequence has been improved by using the Farey approximation approach and proposed variable processing architecture. Algorithms to find a fraction closest to any arbitrary fraction in a given Farey sequence are also presented. All the algorithms are devoid of floating-point operations, and thus save time, power and computing. Also shows that the ranks of fractions in the Farey sequence can be used to provide a useful estimation of their relative values.

References

1. R. Graham etc., Addison-Wesley, 1994. 2. C. E. Patrascu and M.Patrascu. Computing Order Statistics in the Farey Sequence, ANTS 2004: 358-366.

2. J. Pawlewicz, Order statistics in the Farey sequences in sublinear time and counting primitive lattice points in polygons. Algorithmica 55(2): 271-282, 2009.

3. S. Das, K. Halder, S. Pratihar, and P. Bhowmick, Properties of Farey Sequence and their Applications to Digital Image Processing, 4th Intl. Conf. on Information Processing, 6-8 August, Bangalore University, Bangalore, pp. 71-81, 2010, (IK International Publishing House Pvt. Ltd. New Delhi, 2010, ISBN 978-93-80578-46-0).

4., Jonathan Ainsworth, etc., The Farey Sequence , School of Mathematics, University of Edinburgh, March 15, 2012

5. G. H. Hardy and E. M. Wright. An Introduction to the Theory of Numbers. OxfordUniversity Press, New York, 1968.

6. E. H. Neville. The Farey Series of Order 1025. Cambridge University Press, 1950.

7. P. L. Rosin. Techniques for assessing polygonal approximation of curves. IEEE Trans.PAMI, 19(6): 659-666, 1997.

8. M. Schroeder. Fractions: Continued, Egyptian and Farey (Chapter 5). Number Theory inSc. & Communication, vol. 7, Springer Series in Information Sciences, 2006.

9. C.-H. Teh and R. T. Chin. On the detection of dominant points on digital curves. IEEE Trans. PAMI, 2(8):859-872, 1989.

10. P. Y. Yin. Ant colony search algorithms for optimal polygonal approximation of planecurves. Pattern Recognition, 36:1783-1797, 2003.

11. K. Wall and P.-E. Danielsson, A fast sequential method for polygonal approximation of digitized curves, Computer Vision, Graphics, and Image Processing, 28:220-227, 1984.

12. Narkhede H P , Review of Image Segmentation Techniques, International Journal of Science and Modern Engineering (IJISME) ISSN: 2319-6386, Volume-1, Issue-8, July 2013 54

13. Digital Image Processing, Rafael C. Gonzalez & Richard E. Woods, Second Edition 2002, Prentice Hall.

14. K. K. Singh, A. Singh,“A Study of Image Segmentation Algorithms for Different Types of Images”, International Journal of Computer Science Issues, Vol. 7, Issue 5, 2010

15 . Chunming Li, Rui Huang, Zhaohua Ding, J. Chris Gatenby, Dimitris N. Metaxas, A Level Set Method for Image Segmentation, in the Presence of Intensity nhomogeneities, With Application to MRI, IEEE Transactions on Image processing, Vol. 20, NO. 7, July 2011