Sanjoy Pratihar, Ph.D.

Present affiliation
Assistant Professor
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Research and Teaching

Areas of research
Computer Vision, Document Image Processing, Digital Geometry, Pattern Recognition, Biometrics.

Ph.D. Thesis
On Farey Sequence and Farey Table with Digital-geometric Applications to Image Analysis, Indian Institute of Technology Kharagpur, 2015.

Abstract *Farey sequences*, introduced by the renowned mathematicians like John Farey, Charles Haros, and Augustin-Louis Cauchy over 200 years ago, is quite well-known by today in *theory of fractions*, but its computational perspectives are possibly not yet explored up to its merit. In this thesis, we present some new theoretical findings, efficient algorithms, and computational aspects related with a Farey sequence along with its digital-geometric applications to image analysis. From an original Farey sequence that contains only simple and proper fractions in ascending order, we obtain an *augmented Farey sequence* (AFS) for its applicability to 2D image analysis. The *ranks* of the AFS fractions are stored in an *augmented Farey table* (AFT), proposed by us, which provides an efficient solution to the *rank problem*, thereby aiding in and speeding up different digital-geometric techniques. As the size of an AFT increases quadratically with the order of the Farey sequence, we have also designed an efficient algorithm for finding the *closest rank* of any fraction in an AFT of a lower order. For the reverse problem on *order statistics*, an AFT is not efficient for finding the fraction of a given rank. Hence, as an improvement, we have proposed the *rank-based Farey table* (RFT), which not only requires less storage space but also solves both the rank and the order statistics problems quite efficiently. For space reduction and with a focus on the rank problem only, we have also proposed two (lossy) compression schemes to obtain a *compressed Farey table* (CFT) from an AFT. Necessary analysis has been done to derive the error bound in a CFT. The idea of CFT comes up with the notion of *approximate rank*, which could be useful in practical scenarios where *maximum errors* are pre-specified. To demonstrate the applicability of AFT, two well-known image-analytic problems have been revisited, one involving *polygonization* in digital images and the

other related to *skew correction* in digitized documents. Experimental results have been furnished to demonstrate the usefulness, efficiency, and robustness of the proposed techniques based on AFT.

Publications

Journals

1. S. Pratihar and P. Bhowmick, **On Farey Sequence and its Augmentation for Applications to Image Analysis**, International Journal of Applied Mathematics and Computer Science (AMCS), Vol. 27(3), pp. 637-658, 2017.

2. Sanjoy Pratihar and Partha Bhowmick, **Fast and Direct Polygonization for Gray-scale Images Using Digital Straightness and Exponential Averaging**, International Journal of Image and Graphics, Vol. 16(2), Art. 1650007 (36 pages), 2016.

3. B. Paria, S. Pratihar and P. Bhowmick, **On Farey table and its compression for space optimization with guaranteed error bounds**, Mathematics for Applications (published by the Institute of Mathematics, Brno University of Technology, Czech Republic), Vol. 5(2), pp. 123-145, 2016.

4. Sanjoy Pratihar, Partha Bhowmick, Shamik Sural, and Jayanta Mukhopadhyay, **Skew Correction of Document Images by Rank Analysis in Farey Sequence**, International Journal of Pattern Recognition and Artificial Intelligence, Vol. 27(7), Art. 1353004 (35 pages), 2013.

Book Chapter

1. Sanjoy Pratihar and Partha Bhowmick, **On Applying the Farey Sequence for Shape Representation in Z^2**, Speech, Image and Language Processing for HCI: Multi-modal enhancements, Chapter 9, Pages 172-190, U.S. Tiwary and T.J. Siddiqui (Ed.), IGI Global, 2012.

Conference Proceedings

1. Md. Ajij and Sanjoy Pratihar, **Quasi-straightness based Features for Off-line Verification of Signatures**, *Proc. International Conference on Identity, Security and Behavior Analysis (ISBA 2017)*, IIIT New Delhi, India, IEEE Press, pp. 1-7, 2017.

2. Md. Ajij, Sanjoy Pratihar and Kanishka Ganguly, **Detection and Retargeting of Emphasized Text for Content Summarization**, *Proc. ICACCI-2016*, LNMIIT, Jaipur, India, IEEE Press, pp. 15–21, 2016.

3. Sanjoy Pratihar and Najima Begum, **Understanding Shape Context by Analysis of Farey Ranks**, *Proc. 5th Internatioal Conference on Informatics, Electronics and Vision, The University of Dhaka*, Dhaka, IEEE Press, pp. 580–585, 2016.

4. Sanjoy Pratihar, Partha Bhowmick, Shamik Sural, and Jayanta Mukhopadhyay, **Removal of Hand-drawn Annotation Lines from Document Images by Digital-geometric Analysis and Inpainting**, *Proc. NCVPRIPG, IIT Jodhpur*, Jodhpur, India, IEEE Press, pp. 1–4, 2013.

5. Sanjoy Pratihar, Partha Bhowmick, Shamik Sural, and Jayanta Mukhopadhyay, **Detection and Removal of Hand-drawn Underlines in a Document Image using Approximate Digital Straightness**, *Proc. workshop on Document Analysis and Recognition (workshop with ICVGIP 2012), IIT Bombay*, India, ACM, pp. 124–131, 2012.

6. Sanjoy Pratihar and Partha Bhowmick, **Skew Correction of Engineering Drawings by Digital-geometric Analysis of Farey Ranks**, *Proc. ICIIP, Jaypee University of Information Technology, Shimla*, India, IEEE Press, pp. 1–6, 2011.

7. Sanjoy Pratihar and Partha Bhowmick, **Vectorization of Thick Digital Lines Using Farey Sequence and Geometric Refinement**, *Proc. ICVGIP-2010, IIT Madras*, Chennai, India, ACM, pp. 518–525, 2010.

8. Sanjoy Pratihar and Partha Bhowmick, *Proc. ICVGIP-2010, IIT Madras*, Chennai, India, ACM, pp. 77–84, 2010.

9. Sanjoy Pratihar, Shyamosree Pal, Partha Bhowmick, Arindam Biswas, and Bhargab B. Bhattacharya, **Recognition of Hand-drawn Graphs Using Digital-geometric Techniques**, *12th International Conference on Frontiers in Handwriting Recognition (ICFHR), ISI Kolkata*, India, IEEE CS Press, pp. 89–94, 2010.

10. Soham Das, Kishaloy Halder, Sanjoy Pratihar, and Partha Bhowmick, **Properties of Farey Sequence and their Applications to Digital Image Processing**, *Proc. 4th International Conference on Information Processing, Bangalore University*, Bangalore, India, pp. 71–81, 2010.

11. Sanjoy Pratihar and Partha Bhowmick, **A Thinning-free Algorithm for Straight Edge Detection in a Gray-scale Image**, *Proc. 7th International Conference on Advances in Pattern Recognition (ICAPR), ISI Kolkata*, India, IEEE CS Press, pp. 341–344, 2009.

Teaching Interest

I shall prefer to teach Computer Graphics, Algorithm Analysis and Design, Theory of Computation, Computational Geometry, Computer Vision.
Earlier Courses taught: Computational Geometry, Computer Graphics, Theory of Computation, Compiler Design, Algorithm Analysis and Design, Graph Theory, Discrete Mathematics, Data Structure, Principles of Programming Languages, Computer Programming.

Education

Ph.D. in Computer Science and Engineering
Thesis Title: On Farey Sequence and Farey Table with Digital-geometric Applications to Image Analysis
Specialization: Digital Geometry, Computer Vision, and Document Image Processing
Institute: Indian Institute of Technology Kharagpur, India
Year: June, 2015

M.E. in Computer Science and Engineering
Subject: Computer Science and Engineering

INSTITUTE: Bengal Engineering and Science University, Shibpur, Howrah, India
(Presently, Indian Institute of Engineering Science and Technology, Shibpur)
YEAR: 2007

B.Tech. in Computer Science and Engineering
INSTITUTE: North Eastern Regional Institute of Science and Technology (NERIST)
UNIVERSITY: North Eastern Hill University, Shillong, India
YEAR: 2002

Conference Participation

1. **Seventh International Conference on Advancement in Pattern Recognition (ICAPR), 2009** *Indian Statistical Institute Kolkata, India*, February, 2009.
   TITLE OF PAPER PRESENTED: A Thinning-free Algorithm for Straight Edge Detection in a Gray-scale Image.

2. **The Twelfth International Conference on Frontiers of Handwriting Recognition (ICFHR)** *Indian Statistical Institute Kolkata, India*, November, 2010.
   TITLE OF PAPER PRESENTED: Recognition of Hand-drawn Graphs Using Digital-geometric Techniques.

3. **International Conference on Information Processing (ICIP)** *Bangalore University, Bangalore, India*, August, 2010.
   TITLE OF PAPER PRESENTED: Properties of Farey Sequence and their Applications to Digital Image Processing.

4. **International Conference on Image Information Processing (ICIIP)** *Jaypee University of Information Technology, Shimla, India*, November, 2011.
   TITLE OF PAPER PRESENTED: Skew Correction of Engineering Drawings by Digital-geometric Analysis of Farey Ranks.

5. **Workshop DAR with The Eighth Indian Conference on Vision, Graphics and Image Processing (ICVGIP)** *Indian Institute of Technology Bombay, India*, December, 2012.
   TITLE OF PAPER PRESENTED: Detection and Removal of Hand-drawn Underlines in a Document Image using Approximate Digital Straightness.

6. **National Conference on Computer Vision, Pattern Recognition, Image Processing and Graphics (NCVPRIPG)** *Indian Institute of Technology Jodhpur, India*, December, 2013.
   TITLE OF PAPER PRESENTED: Removal of Hand-drawn Annotation Lines from Document Images by Digital-geometric Analysis and Inpainting.

7. **Internatioal Conference on Informatics, Electronics and Vision (ICIEV)** *The University of Dhaka, Dhaka*, 13–14 May, 2016.
   TITLE OF PAPER PRESENTED: Understanding Shape Context by Analysis of Farey Ranks.

8. **International Conference on Identity, Security and Behavior Analysis (ISBA 2017)** *India Habitat Centre, New Delhi*, 22 – 24 February, 2017.
   TITLE OF PAPER PRESENTED: Quasi-straightness based Features for Off-line Verification of Signatures.

Personal Details

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