

Kaushal Buch

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PROFESSIONAL SUMMARY

I have 19 years of professional experience (five years in industry and fourteen in research) in digital system design, simulation, and implementation of signal processing algorithms. In the initial phase of my career (up to 2009), I worked on System-on-Chip designs, development and verification of Intellectual Property (IP) cores for various digital subsystems and protocols. Subsequently, I have been working on developing and commissioning a radio telescope's signal processing, interference mitigation, and multi-element beamforming systems. I work on algorithms, system-level architecture, implementation and deployment of various systems at the Giant Metrewave Radio Telescope (GMRT). I lead a team of engineers and technical staff members and supervise engineering interns. I have published my professional work in the form of papers in peer-reviewed journals and contributed/invited talks at various national and international conferences.

Professional Experience

Engineer - F, Digital Backend Group, Giant Metrewave Radio Telescope (GMRT), NCRA, Tata Institute of Fundamental Research (TIFR), Khodad, Pune, India December 2009 - till date

The Giant Metrewave Radio Telescope (GMRT) is one of the most sensitive instruments for astronomical observations at low radio frequencies. It is an antenna array with a sensitive receiver system and a high-speed digital signal processing backend system.

Developmental and research activities

Upgraded GMRT Backend System

- Design and implementation of real-time Radio Frequency Interference (RFI) mitigation system for the GMRT Wideband Backend (GWB). This is the first to be implemented on FPGA and released for real-time broadband RFI mitigation during astronomical observations. The system has been implemented on ROACH-1 boards (Xilinx Virtex-5 FPGA). Developed a novel technique for identifying and mitigating longer RFI bursts and an optimized FPGA implementation for 400 MHz bandwidth.
- Developed testing techniques and performance analysis methods for quantifying the effects of RFI filtering on astronomical data. Worked jointly with the GMRT user community to analyze the effects on imaging and time-domain astronomy observations.
- Developed a robust RFI filtering technique for mitigating narrowband RFI for spectrally and spatially confined RFI observed at the GMRT. The technique is implemented to work in real-time or on offline data.
- Currently working on statistical modelling of different types of RFI and understanding the effects of filtering on astronomical data. Also working on non-normality detectors and machine learning-based RFI identification and mitigation methods.
- Porting the FPGA-based real-time RFI filtering algorithm on CPU. Working on algorithm acceleration using data parallelism to achieve real-time performance. Currently, a combination of multi-core processing and algorithm acceleration are being explored for real-time implementation.
- Worked on developing model-based FPGA designs for digital signal processing subsystem blocks for the GWB. Designed and implemented wideband noise generator, correlator, and incoherent and coher-

ent beamformer blocks, a part of the CASPER (Collaboration for Astronomy Signal Processing and Electronics Research) open-source library. Developed an SFP+ adapter for high-speed data transfer between the FPGA boards.

Expanded GMRT project

- Leading the development and commissioning effort for FPGA-based multi-beam Focal Plane Array (FPA) beamformer.
- Involved in the system-level simulation, analysis of RF and analog baseband processing systems, ADC characterization, FPGA architecture optimization, and development of optimal beamforming algorithms.
- The current involvement is testing the beamformer using an aperture array in a free-space test range and implementing a wideband beamformer on Xilinx RF System-on-Chip (RFSoc).
- Supervised the setting up of the FPA beamformer lab and free-space test range equipped with the latest instruments and signal processing platforms.
- Co-investigator in research projects for the next-generation backend systems and the Expanded GMRT.

SKA-LFAA Collaborative Work

- Working on Tile Processing Module (TPM) hardware and firmware design for Square Kilometer Array (SKA)'s Low-Frequency Aperture Array (LFAA) beamformer.
- Development of the RF lab test and low-frequency antenna array set up as part of the test setup for the TPM beamformer.
- Design and optimization of real-time RFI mitigation algorithms and FPGA implementation for the TPM beamformer signal processing chain.

Collaborative Work with Raman Research Institute (RRI), Bengaluru, India

- Developing an RFSoc-based FPGA board for next-generation wideband correlators and beamformers.
- Working towards implementing CASPER-based tool flow for designing signal processing subsystems using the RFSoc platform.
- SKA-LFAA TPM related firmware and test setup development

Managerial and Administrative duties

- Member of the senior engineering team (GMRT Control Centre) responsible for ensuring the effective operation of the GMRT observatory. Supervise the working of engineering/technical staff members and coordinate activities with the various engineering groups.
- Setting tasks and objectives for the team members and ensuring timely completion of the activities.
- Involved in planning and budgeting for upcoming and ongoing digital backend projects. This includes the technical proposal, cost estimation, indenting and procurement of various instruments and components.
- Serving on the interview panel for recruiting new engineering/technical staff members and reviewing the performance of the existing GMRT staff members.
- Induction and training of fresh recruits and students.
- Member of committees for organizing technical/scientific/public outreach events at the institute level.

ASIC Engineer, ASIC Division, eInfochips Ltd, Ahmedabad, India

April 2005 - August 2009

- Worked on projects related to digital design, RTL coding using Verilog HDL and VHDL, FPGA-based System-on-Chip (SoC) architecture and ASIC IP design, FPGA hardware estimation, functional and design documentation, synthesis and timing closure for FPGA and ASIC designs, functional and gate level verification of FPGA/ASIC/SoC designs. Involved in RTL code and documentation review to ensure compliance with company standards. Used industry-standard EDA tools for project development.
- Projects executed were client projects (offshore and onsite) and IP development for eInfochips. Some of the areas of work are high-speed video data transfer applications, USB mass storage devices, hard disc read channels, video switch matrix and ASIC/FPGA IP cores (SPI 4.2, DDR2 Memory Controller,

I2C bus, BT.656 video interface, NAND Flash memory controller, DMA controller)

Assistant Systems Engineer (Trainee), Tata Consultancy Services Ltd. September 2004 -March 2005

- Undergone training in software engineering, object-oriented programming, database management and operating systems. Worked on software programming and development of software requirement specifications for different projects.

Education

Master of Technology (Research), Electronics
Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat, India March 2013
CGPA 9.58 / 10

Bachelor of Engineering, Electronics and Communication
Nirma Institute of Technology, Gujarat University, Ahmedabad, India June 2004
Percentage 83.5 %
University Rank 2nd

Engineering Diploma, Electronics and Communication
A.V. Parekh Technical Institute, Technical Examinations Board, Gujarat State, India April 2001
Percentage 80.72 %
Institute Rank 2nd

Awards, Grants and Patents

- IETE CDIL best paper award for 2020 by the Institution of Electronics and Telecommunication Engineers (IETE) India. The award is for the paper titled "Implementing and Characterizing Real-Time Broadband RFI Excision System for the GMRT Wideband Backend", published in IETE Technical Review May-June 2019.
- IEEE Geoscience and Remote Sensing Society (GRSS) travel grant (No. 23376) for delivering an invited talk at the IEEE Geoscience and Remote Sensing Symposium (IGARSS) 2019, Yokohama, Japan, July 2019.
- Three-Lead Electrocardiogram (ECG) Monitor Using Mobile Phone with Embedded Electrodes – Indian Patent No. 242547 granted on 31-08-2010.

Professional Recognition

- Fellow, The Institution of Electronics and Telecommunication Engineers (IETE), India
- Senior Member, Institute of Electrical and Electronics Engineers (IEEE), USA
- Senior Member, International Union of Radio Science (URSI), Ghent, Belgium
- Life Member, Astronomical Society of India (ASI)

Publications (Selected)

- **Kaushal Buch** et al., "Real-time RFI Filtering for uGMRT: Overview of the Released System and Relevance to the SKA", *Journal of Astronomy and Astrophysics (JoAA)*, Vol. 44, April 2023.
- **Kaushal Buch** et al., "Performance Analysis Techniques for Real-time Broadband RFI Filtering System of uGMRT", *Journal of Astronomical Instrumentation*, Vol. 11, No. 2, June 2022.
- **Kaushal Buch**, "RFI Excision in Radiometers: A Radio Astronomy Perspective", Invited paper for FARS session, IEEE International Symposium on Geoscience and Remote Sensing 2019 (IGARSS 2019), July 28-Aug 2, 2019, Yokohama, Japan.
- **Kaushal Buch** et al., "Real-time MAD-based RFI Excision on FPGA", *Journal of Astronomical Instrumentation*, Special issue on Interference Mitigation in Radio Astronomy, World Scientific Publishing Inc., Vol. 8, No. 1, March 2019.
- **Kaushal Buch** et al., "Implementing and Characterizing Real-time Broadband RFI Excision for the GMRT Wideband Backend", *IETE Technical Review (Taylor and Francis)*, Vol. 36, Issue 3, 2019.
- **Kaushal Buch** et al., "Towards Real-Time Impulsive RFI Mitigation for Radio Telescopes", *Journal of Astronomical Instrumentation*, Vol. 5, Issue 4, 2016, World Scientific Publishing Inc.
- **Kaushal Buch**, Yashwant Gupta and Ajithkumar B., "Variable Correlation Digital Noise Source on FPGA – A Versatile Tool for Debugging Radio Telescope Backends", Vol. 3, No. 3 (2014), *Journal of Astronomical Instrumentation*, World Scientific Publishing Inc.
- John Ford, **Kaushal Buch**, "RFI Mitigation Techniques in Radio Astronomy", presented at the IEEE International Symposium on Geoscience and Remote Sensing 2014 (IGARSS 2014), July 13-18, 2014, Quebec, Canada.
- **Kaushal Buch**, Anand Darji, "Interpolated Histogram Method for Area Optimized Median Computation", *International Journal of Electronics (Taylor and Francis)*, Vol. 100, No. 4, 468-472, 2013
- B. Ajithkumar, S.C. Choudhari, **K.D. Buch**, M.V. Muley, G.J. Shelton, S.H. Reddy, S. Kudale, J. Roy and Y. Gupta, "Next Generation Digital Backends for the GMRT", *Radio and Antenna Days of the Indian Ocean (RADIO2012)*, IOP Conf. Series: Materials Science and Engineering, 44 (2013) 012024.

Publications (Collaborative work)

- Santra et al., "A Deep uGMRT view of the ultra-steep spectrum radio halo in Abell 521", accepted for publication in the *Astrophysical Journal (ApJ)*, November 2023.
- B.S. Girish et al., "Progression of Digital-Receiver Architecture: from MWA to SKA1-Low, and beyond", *Journal of Astronomy and Astrophysics (JoAA)*, Vol. 44, March 2023.
- Patra et al., "The Expanded Giant Metrewave Radio Telescope", *Monthly Notices of the Royal Astronomical Society (MNRAS)*, 483, 3007-3021 (2019)
- Hickish et al., "A decade of developing radio-astronomy instrumentation using CASPER open-source technology", *Journal of Astronomical Instrumentation*, Vol. 5, Issue 4, 2016, World Scientific Publishing Inc.

Book Chapter

- **Kaushal Buch**, Rahul Dubey, Saket Buch, "Low Power Techniques for Greener Hardware", *Handbook of Research on Green ICT – Technology, Business and Social Perspectives*, IGI Global, 2011.

Professional Activities

- Member, Collaboration for Astronomical Signal Processing and Electronics Research (CASPER) Advisory Board. (since September 2022)
- Member, Technical Evaluation Committee (TEC) for Wideband Solar Radio Spectrograph (WBSRS) at Udaipur Solar Observatory, PRL. (since October 2022)
- Member, P4006 RFI in Remote Sensing Working Group, IEEE Standards Association, IEEE, USA.
- Lead Issue Editor, Special issue on "Interference Mitigation Techniques in Radio Astronomy", Journal of Astronomical Instrumentation (JAI), World Scientific Publishing Co., March 2019.
- Referee, Radio Science, published by Wiley-Blackwell on behalf of the American Geophysical Union and URSI.
- Referee, Experimental Astronomy, Springer
- Organizing Committee Member (Sponsorship Co-chair), IEEE International India Geoscience and Remote Sensing Symposium (InGARSS 2020 and 2021), Virtual Symposium.
- Convener, Commission-E (Electromagnetic Environment and Interference), International Union of Radio Science (URSI) APRASC 2019, RCRS 2020, RCRS 2022, GASS 2023 conferences
- Co-convener, Invited Special Session on "Radio Frequency Interference in Radio Astronomy, Remote Sensing, and Navigation", IEEE-InGARSS 2023 conference.

Contributed Talks (Selected)

- "Plans for Automated Powerline RFI Identification for the Upgraded GMRT", Modern Engineering Trends in Astronomy (META) 2023, Raman Research Institute, Bangalore, 1-4 November 2023.
- "Experimental Focal Plane Array Beamforming for the Expanded GMRT", Phased Array Feed and Advanced Receiver (PAFAR) 2022 workshop, CSIRO, Sydney, Australia, November 2022.
- "System-level Simulation and Testing of an Aperture Array Beamformer", selected for presentation at Mathworks' MATLAB EXPO 2022 (Global online event), May 2022.
- "Real-time RFI Filtering for uGMRT Observations: Shared-risk Release and Optimal System Configuration", RFI 2022 Workshop (virtual), February 2022.
- "Recent Updates from the Real-time RFI Mitigation System of uGMRT", CASPER 2021 workshop (virtual), May 2021.
- "Array Simulation and Beamforming for the Expanded GMRT", stage presentation at Mathworks MATLAB EXPO 2019, Pune, India, 2 May 2019.
- "Robust Real-time Power-line RFI Filtering for Radio Telescopes", Asia-Pacific Regional Conference on Radio Science (APRASC-2019), New Delhi, India, 9-15 March 2019
- "Mitigating RFI through real-time excision for the uGMRT", CASPER-2017 workshop, California Institute of Technology, Pasadena, USA, August 14-18 2017.
- "Focal Plane Array Beamformer for the Expanded GMRT: Initial Implementation on ROACH", CASPER-2017 workshop, California Institute of Technology, Pasadena, USA, August 14-18 2017
- "Real-time RFI Filtering for the uGMRT Wideband Correlator", RFI-2016 conference, Socorro, NM, USA, October 16-20, 2016
- "Real Time RFI Mitigation Technique For Wide-Band Digital Backend at GMRT", CASPER 2013 Workshop, Jodrell Bank Observatory, Cheshire, U.K., August 2013

Invited Talks

- "Current Status and Plans for the eGMRT Focal Plane Array Beamformer", 2021 IEEE AP-S/URSI Radio Science Symposium, Singapore, 6 December 2021 (Online).
- "Upgraded GMRT: Real-time RFI mitigation in the back-end system", Celebrating 20 years of the Giant Metrewave Radio Telescope, October 2021 (Online event)
- "Giant Metrewave Radio Telescope (GMRT) - A System Overview", NCRA-IUCAA Graduate School (as part of the Astronomical Techniques II course), June 2021 (delivered online)
- "RFI Excision in Radiometers: A Radio Astronomy Perspective", IEEE Geoscience and Remote Sensing Symposium (IGARSS) 2019, Yokohama, Japan, July 28 - August 2 2019.
- "Real-time RFI Excision for the uGMRT and its relevance to SETI", Radio Astronomy Laboratory and SETI group, University of California, Berkeley, CA, USA, 23 August 2017
- "RFI Mitigation Techniques in Radio Astronomy", IEEE International Symposium on Geoscience and Remote Sensing 2014 (IGARSS 2014), Quebec, Canada, July 13 - 18, 2014.