Zubair Khalid

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Highlights

- **73 Publications – 23 Journals and 47 Conference proceedings**
- **247 million PKR R&D Funding since June 2015 from HEC, Industries and LUMS**
- **Associate Editor, IEEE Signal Processing Letters and Senior Member, IEEE**
- **Vice Chancellor's Teaching Excellence Award, 2021**
- **Research supervision of 7 Ph.D. students (6 graduated)**
- **Research collaboration with researchers from UCL, ANU, Princeton and EPFL**
- **Active collaborations with leading industries**

Research Interests

- **Design and development of novel algorithms for machine/deep learning, data analysis, optimization, machine vision and information processing**
- **Development of data-driven policies for sustainable urban development**
- **Digital transformation of industries**
- **Convex optimization applications**
- **Spatio-spectral signal processing**
- **Spherical signal processing applications in Acoustics, Medical Imaging, Cosmology**
- **Connectivity of wireless sensor and ad-hoc networks**

Education

Australian National University (ANU), Canberra, Australia

Ph. D. Engineering, Apr. 2013

– Thesis Topic: *Spatio-spectral Analysis on the Unit Sphere*

University of Engineering and Technology, Lahore, Pakistan

B. Sc. (Hons.) Electrical Engineering, Aug. 2008

– **Rank: 1/300 in Electrical Engineering (Awarded 5 Gold medals)**

Experience

Lahore University of Management Sciences Jul. 2015-Current

Assistant Professor of Electrical Engineering

Australian National University Apr. 2013-Feb. 2015, May 2016-Aug-2016

Research Fellow with Research School of Engineering

Tetra Pak Pakistan Jun. 2008-Feb. 2010

Project Engineer

Funded Projects and Awards

- HEC Grand Challenge Fund 2020 **"Creating Technological Foundations of Data-Driven Policy Making for Sustainable Urban Development" (co-PI, PKR 210.2 million)**
- National Centre for Robotics and Automation (NCRA) grant on **"Catalysing Industry 4.0: Development of Framework and IIoT and Machine Vision Test-beds for Providing Automation Roadmap to the Industries" (PKR 10.3 million)**
- Bulleh Shah Packaging funding for the development of machine vision based surface quality inspection system (PKR 5.3 million)
- HEC Technology Development Fund (TDF) for project titled **"Motorway to Safety: Design and Development of an Intelligent System for Active Traffic Management and Efficient Law enforcement on National Highways and Motorways" (PKR 13 million)**
- Tetra Pak project for the development of real-time machine vision based trim width measurement system (PKR 3 million)
- Tetra Pak project for the development of applications for logistic optimization and traceability of quality parameters (PKR 1.44 million)
- LUMS Travel Grant and HEC Travel Grant PKR to attend ICASSP 2018 (PKR 0.5 million)
- Tetra Pak Project on the development of high-resolution surface profiler (PKR 1.4 million)
- Center of Water Informatics and Technology, LUMS seed grant award (PKR 0.35 million)
- LUMS Travel Grant and HEC Travel Grant PKR to attend ICASSP 2017 (PKR 0.8 million)
- Research Grant under HEC National Research Program for Universities (NRPU) 2016 for project titled "Development of Anisotropic, Fast, Robust and Sparse Spherical Signal Processing Methods with Application to Hydrology and Diffusion Tensor Imaging" (PKR 1.99 million)
- Dean's travel grant and ANU Vice Chancellor's travel grant for a research visit to UCL ($10K), 2012
- Endeavour International Postgraduate Research Scholarship, 2009
- Certificate of Merit for 1st Position out of 300 in Bachelor of Electrical Engineering
- University of Engg. and Tech., Lahore Gold Medal for best performance in EE, 2008
- NESPAK Gold medal, SIEMENS Gold medal, NEWAGE Gold medal and University Gold medal for best performance in Electrical Engineering, 2008

Teaching

Assistant Professor

- Fall 2020, Circuits 1
- Fall 2021, Mathematical Foundations for Machine Learning and Data Science
- Spring 2021, Machine Learning (Graduate course)
- Fall 2020, Circuits 1
- Summer 2020, Mathematical Foundations for Machine Learning and Data Science
- Spring 2020, Convex Optimization (Graduate course)
- Fall 2019, Circuits 1
- Spring 2019, Signals and Systems
- Fall 2018, Circuits 1
- Spring 2018, Feedback Control Systems
- Fall 2017, Circuits 1
- Spring 2017, Feedback Control Systems
- Spring 2017, Convex Optimization (Graduate course)
- Fall 2016, Signals and Systems
- Spring 2016, Feedback Control Systems
- Spring 2016, Convex Optimization (Graduate course)
- Fall 2015, Signals and Systems
- Spring 2015, Signals and Systems

Lecturer

- Semester 2, 2014, Signal Processing, with Prof. Rodney A. Kennedy, ANU
- Semester 1, 2014, Probability and Stochastic Processes in Engg. (Graduate course), ANU
- Semester 2, 2013, Signal Processing (Undergraduate course), with Prof. Rodney A. Kennedy, ANU
- Semester 1, 2013, Probability and Stochastic Processes in Engg. (Graduate course), ANU
- Semester 2, 2012, Business Decision Models (Graduate course), University of Canberra (UC)

Supervision Experience (Research Students)

- **Salaar Arif** (Ph.D. student), Sep. 2020 - Present
  - Topic: Artificial Intelligence on the Sphere
- **Adeem Aslam** (Ph.D. student), Jul. 2016 - Jun. 2021
  - Proposal Defense Completed.
  - Topic: Optimal Filtering, Localized Analysis and Multiscale Representations on the Sphere
  - Research output: 7 Journal papers, 3 Conference papers
- **Atiqa Kayani** (Ph.D. student), Jul. 2018 - Jul. 2021
  - Topic: Spatial Correlation in Massive MIMO Systems
  - Co-supervision with Ijaz Haider Naqvi
- **Wajeeha Nafees** (Ph.D. student), Jan. 2016 - Jun. 2020
  - Topic: Development of Novel Signal Processing Methods for Signal Analysis on Spherical Manifolds
  - Research output: 4 Conference papers, 1 journal paper
- **Usama Elahi** (Ph.D. student), Nov. 2015 - May. 2019
  - Topic: Optimal Dimensionality Sampling for Spin Functions on Sphere
  - Co-supervision with Prof. Rodney A. Kennedy
  - Research output: 1 Journal papers, 6 Conference papers
- **Alice P. Bates** (Ph.D. student), Feb. 2014 - Oct. 2016
  - Topic: Anisotropic spherical signal processing with applications in medical imaging
  - Co-supervision with Prof. Rodney A. Kennedy
  - Research output: 4 Journal papers, 6 Conference papers
- **Yibeltal F. Alem** (Ph.D. student), Apr. 2013 - Jun. 2015
  - Topic: Compressive sampling on the sphere
  - Co-supervision with Prof. Rodney A. Kennedy
  - Research output: 2 Journal articles and 2 conference papers
- **Anam Rasul** (MS Electrical Engineering), 2019 - Present
  - Topic: Using sensor fusion for anomaly detection
- **Muhammad Osama Tarar** (MS Electrical Engineering), 2017 - 2019
  - Topic: Spherical Convolutional Neural Networks Functions
  - Research output: 1 conference papers (EUSIPCO 2020)
- **Safa Ashraf** (MS Electrical Engineering), 2017 - 2019
  - Topic: Use of MODIS Data for the Localization of Air Pollution Sources Functions
- **Asad Ali** (MS Electrical Engineering), 2017 - 2019
  - Topic: Optimal Adaptive Placement of Drones for Power Minimization in a Dynamic User Environment Functions
- **Naima Munir** (MS Electrical Engineering), 2016 - 2017
  - Topic: Reconstruction of Sparse Signals on the Sphere Using Overcomplete Dictionary of Slepian Functions
- **Sameul Stefopolous** (B. Eng. R&D student), Semester 1, 2014 - Semester 2, 2014
  - Topic: Optimal sampling on the rotation group

- **Yundong Zhang** (B. Eng. R&D student) - Current
  - Topic: Fast conjugate gradient extrapolation on the sphere
- **Kaihao Wang** (B. Eng.) - Semester 1, 2015
  - Topic: Sparse Reconstruction on the Sphere
- **Jing Guo** (B. Eng. R&D student), Semester 1, 2012
  - Topic: Connectivity of ad-hoc networks distributed in a finite region
  - Co-supervision with Dr. Salman Durrani
  - Research output: 1 journal paper
- **Victoria Zhong** (B. Eng. student), Semester 2, 2013
  - Topic: Spatial correlation from multipath with 3D power distributions having rotational symmetry
  - Co-supervision with Prof. Rodney A. Kennedy
- **Weiyu Huang** (B. Eng. R&D student), Semester 2, 2011
  - Topic: Efficient computation of spherical harmonics transform using CUDA
  - Co-supervision with Prof. Rodney A. Kennedy
  - Research output: 1 conference paper

Expertise

Mathematics:

- Applied Mathematics, Real and Complex Analysis, Differential Geometry, Stochastic Geometry, Graph Theory

Machine Learning and Signal Processing:

- Machine Learning, Signal Analysis, Harmonic Analysis, Advanced Signal Processing, Probability Theory, Stochastic Processes, Information Theory, Estimation, Wireless Networks

Research Application Areas:

- Cosmology, Machine Vision, Acoustics, Geophysics, Urban Development, Speech Processing, Astrophysics, Medical Imaging

Collaborations

Industries and State Institutions

- Tetra Pak, Bulleh Shah Packages, Jazz, LWMC, 1122 Emergency Response, National Transport and Research Centre (NTRC), National Highway and Motorway Police (NHMP), M&P Logistics.

Academics

- Dr. Jason D. McEwen, Professor at Mullard Space Science Laboratory, UCL, UK
- Dr. Frederik J. Simons, Professor at Department of Geosciences, Princeton University
- Dr. Yves Wiaux, Professor, Heriot-Watt University, Edinburgh
- Dr. Salman Durrani, Associate Professor, Australian National University, Australia

Talks or Presentations (Selected)

- Jun. 2021, Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Toronto, Canada (Virtual)
  - Estimation of Ground Water Storage Variations in Indus River Basin using GRACE Data
- May. 2020, Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Barcelona, Spain (Virtual)
  - Optimal Window Design For Joint Spatial-Spectral Domain Filtering OfSignals On The Sphere
- May. 2019, Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Brighton, UK
  - Sampling Schemes for Accurate Reconstruction and Computation of Performance Parameters of Antenna Radiation
  - An Antipodally Symmetric Optimal Dimensionality Sampling on the Sphere
  - Accurate Reconstruction of Finite Rate of Innovation Signals on the Sphere
  - Construction of Overcomplete Multiscale Dictionary of Slepian Functions on the Sphere
- Oct. 2018 World Space Week Event 2018
  - Cosmic Microwave Background: Looking Back at the Beginning of Time
- Apr. 2018, Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Calgary, Canada
  - An improved iterative algorithm for band-limited signal extrapolation on the sphere
  - W. Nafees, Z. Khalid and R. A. Kennedy, "Spatially-limited sampling of band-limited signals on the sphere
  - A. Aslam, Z. Khalid and R. A. Kennedy, "Efficient sampling on healpix grid
- Mar. 2017, Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), New Orleans, USA
  - Robust Reconstruction of Spherical Signals with Finite Rate of Innovation
  - Improving the Spatial Dimensionality of Gauss-Legendre and Equiangular Sampling Schemes on the Sphere (Poster presentation)
- Jun. 2014, Proc. Workshop on Statistical Signal Processing (SSP), Gold Coast, Australia
  - Minimum Mean Square Error Equalization on the 2-Sphere
  - Adaptive Multi-Resolution Windowing Technique For Localized Spatio-Spectral Analysis
- Apr. 2014, Australian National University
  - An Optimal-Dimensionality Sampling Scheme on the Sphere for Fast Spherical Harmonic Transforms
- Aug. 2013, Australian National University
  - Spatio-spectral formulation and design of spatially varying filters for signal estimation on 2-Sphere
- Jan. 2013, University College London
  - Spatially varying spectral filtering of signals on the sphere

Transactions/Journals:

[1] Z. Khalid, S. Durrani, P. Sadeghi, and R. A. Kennedy, "Spatio-spectral analysis on the sphere using spatially localized spherical harmonics transform," *IEEE Trans. Signal Process.*, vol. 60, no. 3, pp. 1487–1492, Mar. 2012.

[2] P. Sadeghi, R. A. Kennedy, and Z. Khalid, "Commutative anisotropic convolution on the 2-sphere," *IEEE Trans. Signal Process.*, vol. 60, no. 12, pp. 6697–6703, Dec. 2012.

[3] Z. Khalid, P. Sadeghi, R. A. Kennedy, and S. Durrani, "Spatially varying spectral filtering of signals on the unit sphere," *IEEE Trans. Signal Process.*, vol. 61, no. 3, pp. 530–544, Feb. 2013.

[4] Z. Khalid, R. A. Kennedy, S. Durrani, P. Sadeghi, Y. Wiaux, and J. D. McEwen, "Fast directional spatially localized spherical harmonic transform," *IEEE Trans. Signal Process.*, vol. 61, no. 9, pp. 2192–2203, 2013.

[5] Z. Khalid and S. Durrani, "Distance distributions in regular polygons," *IEEE Trans. Veh. Technol.*, vol. 62, no. 5, pp. 2363–2368, Jun. 2013.

[6] Z. Khalid, S. Durrani, and J. Guo, "A tractable framework for exact probability of node isolation and minimum node degree distribution in finite multi-hop networks," *IEEE Trans. Veh. Technol.*, vol. 63, no. 6, pp. 2836-2847, July 2014.

[7] Z. Khalid, R. A. Kennedy, and J. D. McEwen, "An optimal-dimensionality sampling scheme on the sphere with fast spherical harmonic transforms," *IEEE Trans. Signal Process.*, vol. 62, no. 17, pp. 4597–4610, Sep. 2014.

[8] Z. Khalid, R. A. Kennedy and J. D. McEwen, "Slepian spatial-spectral concentration problem on the ball," *Applied Computation. and Harmonic Analysis*, vol. 40, no. 3, pp 470,504, May 2016.

[9] A. Bates, Z. Khalid, and R. A. Kennedy, "Novel Sampling Scheme on the Sphere for Head-Related Transfer Function Measurements," *IEEE Trans. on Audio, Speech and Language Processing*, vol. 23, no. 6, pp. 1068,1081, Jun. 2015.

[10] Y. F. Alem, Z. Khalid and R. A. Kennedy, "3D Spatial Fading Correlation for Uniform Angle of Arrival Distribution," *IEEE Communication Letters*, vol. 19, no. 6, pp 1073,1076, Jun. 2015.

[11] Y. F. Alem, Z. Khalid and R. A. Kennedy, "Spherical Harmonic Expansion of Fisher-Bingham Distribution and 3D Spatial Fading Correlation for Multiple-Antenna Systems," *IEEE Trans. Veh. Technol.*, vol. 65, no. 7, pp 5695–5700, Jul. 2016.

[12] A. Bates, Z. Khalid, and R. A. Kennedy, "An Optimal Dimensionality Sampling Scheme on the Sphere with Accurate and Efficient Spherical Harmonic Transform for Diffusion MRI," *IEEE Signal Processing Letters*, vol. 23, no. 1, pp 15–19, Jan. 2016.

[13] Z. Khalid, R. A. Kennedy, S. Durrani, Y. Wiaux and J. D. McEwen "Gauss-Legendre Sampling on the Rotation Group," *IEEE Signal Processing Letters*, vol. 23, no. 2, pp 207–211, Feb. 2016.

[14] A. Bates, Z. Khalid, and R. A. Kennedy, "Slepian Spatial-Spectral Concentration Problem on the Sphere: Analytical Formulation for Limited Colatitude–Longitude Spatial Region," *IEEE Trans. Signal Process.*, vol. 65, no. 6, pp. 1527–1537, Mar. 2017.

[15] A. Bates, Z. Khalid, and R. A. Kennedy, "Efficient Computation of Slepian Functions for Arbitrary Regions on the Sphere," *IEEE Trans. Signal Process.*, vol. 65, no. 16, pp. 4379–4393, Aug. 2017.

[16] U. Elahi, Z Khalid and R. A. Kennedy "An Optimal-Dimensionality Sampling for Spin-s Functions on the Sphere," *IEEE Signal Processing Letters*, vol. 25, no. 10, pp. 1470-1474, Oct. 2018.

[17] A. P. Bates, Z. Khalid, J. D. McEwen, R. A. Kennedy, A. Daducci and E. J. Canales-Rodríguez, " Optimal-Dimensionality Sampling and Robust 3D Diffusion Signal Reconstruction," *IEEE Trans. Signal Process.* (submitted)

[18] W. Nafees, Z. Khalid, and R. A. Kennedy, "Differential and Weighted Slepian Concentration Problems on the Sphere," *IEEE Trans. Signal Process.*, vol. 68, no. 1, pp. 2830–2840, Dec. 2020.

[19] A. Aslam and Z. Khalid, "Localized Analysis of Signals on the Sphere over Polygon Regions," *IEEE Trans. Signal Process.*, vol. 68, pp. 4568-4582, 2020.

[20] A. Aslam and Z. Khalid, "Joint SO(3)-Spectral Domain Filtering of Spherical Signals in the Presence of Anisotropic Noise," *IEEE Signal Processing Letters*, vol. 27, pp. 2109-2113, Nov. 2020.

[21] A. Aslam, Z. Khalid and J. D. McEwen, "Linear Transformations and Signal Estimation in the Joint Spatial-Slepian Domain," *IEEE Signal Processing Letters* (Accepted: Jan. 2021).

[22] A. Aslam and Z. Khalid "Multiscale Optimal Filtering on the Sphere," *IEEE Signal Processing Letters* (Accepted: May 2021).

[23] A. Aslam and Z. Khalid, "Spatial-Slepian Transform on the Sphere," *IEEE Trans. Signal Process.* (Accepted: May 2021).

Conference Publications

[24] Z. Khalid, S. Durrani, R. A. Kennedy, and P. Sadeghi, "On the construction of low-pass filters on the unit sphere," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2011*, Prague, Czech Republic, May 2011, pp. 4356–4359.

[25] W. Huang, Z. Khalid, and R. A. Kennedy, "Efficient computation of spherical harmonic transform using parallel architecture of cuda," in *5th International Conference on Signal Processing and Communication Systems, ICSPCS'2011*, Honolulu, HI, Dec. 2011, p. 6.

[26] Z. Khalid, S. Durrani, R. A. Kennedy, and P. Sadeghi, "Revisiting Slepian concentration problem on the sphere for azimuthally non-symmetric regions," in *5th International Conference on Signal Processing and Communication Systems, ICSPCS'2011*, Honolulu, HI, Dec. 2011, p. 7.

[27] Z. Khalid, S. Durrani, P. Sadeghi, and R. A. Kennedy, "Concentration uncertainty principles for signals on the unit sphere," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2012*, Kyoto, Japan, Mar. 2012, pp. 3717–3720.

[28] Z. Khalid, R. A. Kennedy, S. Durrani, and P. Sadeghi, "Conjugate gradient algorithm for extrapolation of sampled bandlimited signals on the 2-sphere," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2012*, Kyoto, Japan, Mar. 2012.

[29] Z. Khalid, S. Durrani, P. Sadeghi, and R. A. Kennedy, "Ambiguity function and Wigner distribution on the sphere," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2012*, Kyoto, Japan, Mar. 2012.

[30] Z. Khalid, R. Kennedy, and P. Sadeghi, "Efficient computation of commutative anisotropic convolution on the 2-sphere," in *6th International Conference on Signal Processing and Communication Systems, ICSPCS'2012*, Gold Coast, Australia, Dec. 2012, p. 7.

[31] Z. Khalid and S. Durrani, "Connectivity of three dimensional wireless sensor networks using geometrical probability," in *Proc. Australian Communications Theory Workshop (AusCTW)*, 2013, pp. 47–51.

[32] R. A. Kennedy, Z. Khalid, and Y. F. Alem, "Spatial correlation from multipath with 3D power distributions having rotational symmetry," in *7th International Conference on Signal Processing and Communication Systems, ICSPCS'2013*, Gold Coast, Australia, Dec. 2013, p. 7.

[33] R. A. Kennedy, P. Sadeghi, Z. Khalid, and J. D. McEwen, "Classification and construction of closed-form kernels for signal representation on the 2-sphere," in *Wavelets and Sparsity XV, SPIE international symposium on optics and photonics, San Diego, CA*, 2013. (invited contribution)

[34] Z. Khalid, R. A. Kennedy, P. Sadeghi, and S. Durrani, "Spatio-spectral formulation and design of spatially-varying filters for signal estimation on the 2-sphere," in in *Wavelets and Sparsity XV, SPIE international symposium on optics and photonics, San Diego, CA*, 2013. (invited contribution)

[35] Z. Khalid and R. A. Kennedy, "On the Choice of Window for Spatial Smoothing of Spherical Data," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2014*, Florence, Italy, May 2014.

[36] Y. F. Alem, Z. Khalid and R. A. Kennedy, "Band-Limited Extrapolation on the Sphere for Signal Reconstruction in the Presence of Noise," in Proc. *IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2014*, Florence, Italy, May 2014.

[37] P. Sadeghi, R. A. Kennedy and Z. Khalid, "Minimum Mean Square Error Equalization on the 2-Sphere," in *Proc. Workshop on Statistical Signal Processing., SSP'2014*, Gold Coast, Australia, Jun 2014.

[38] R. A. Kennedy, Z. Khalid and P. Sadeghi, "Efficient Kernel-Based Formulations of Spatio-Spectral and Related Transformations on the 2-Sphere," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2014*, Florence, Italy, May 2014.

[39] Z. Khalid, R. A. Kennedy, S. Durrani and P. Sadeghi, "Adaptive Multi-Resolution Windowing Technique For Localized Spatio-Spectral Analysis," in *Proc. Workshop on Statistical Signal Processing., SSP'2014*, Gold Coast, Australia, Jun 2014.

[40] Z. Khalid and R. A. Kennedy, "On the Placement of Latitudes in Iso-Latitude Optimal-Dimensionality Sampling Schemes on the Sphere," in *8th International Conference on Signal Processing and Communication Systems, ICSPCS'2014*, Gold Coast, Australia, Dec. 2014, p. 7.

[41] Z. Khalid and R. A. Kennedy, "Iterative Method to Compute the Maximal Concentration Slepian Band-limited Eigenfunction on the Sphere," in *8th International Conference on Signal Processing and Communication Systems, ICSPCS'2014*, Gold Coast, Australia, Dec. 2014, p. 7.

[42] Z. Khalid and R. A. Kennedy, "Spherical Harmonic Transform for Minimum Dimensionality Regular Grid Sampling on the Sphere," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2015*, Brisbane, Australia, April 2015.

[43] Z. Khalid and R. A. Kennedy, "Maximal Multiplicative Spatial-Spectral Concentration on the Sphere: Optimal Basis," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2015*, Brisbane, Australia, April 2015.

[44] A. P. Bates, Z. Khalid and R. A. Kennedy, "An Optimal Dimensionality Sampling Scheme on the Sphere for Antipodal Signals in Diffusion Magnetic Resonance Imaging," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process., ICASSP'2015*, Brisbane, Australia, April 2015.

[45] A. P. Bates, Z. Khalid and R. A. Kennedy, "On the Use of Antipodal Optimal Dimensionality Sampling Scheme on the Sphere for Recovering Intra-voxel Fibre Structure in Diffusion MRI," in *Workshop on Computational Diffusion MRI, International Conference on Medical Image Computing and Computer Assisted Intervention MICCAI'2015*, Munich, Germany, October 2015.

[46] A. P. Bates, Z. Khalid, and R. A. Kennedy, "On the use of slepian functions for the reconstruction of the head-related transfer function on the sphere," in *2015 9th International Conference on Signal Processing and Communication Systems (ICSPCS)*.IEEE, 2015, pp. 1–7.

[47] U. Elahi, Z. Khalid and R. A. Kennedy, "Comparative analysis of geometrical properties of sampling schemes on the sphere," 2016 10th International Conference on Signal Processing and Communication Systems (ICSPCS), Gold Coast, QLD, 2016, pp. 1-7.

[48] A. P. Bates, Z. Khalid, R. A. Kennedy, and J. D. McEwen, "Multi-shell sampling scheme with accurate and efficient transforms for diffusion MRI," in Biomedical and Astronomical Signal Processing Frontiers (BASP), 2017.

[49] Z. Khalid, R. A. Kennedy and S. Durrani, "Improving the spatial dimensionality of Gauss-Legendre and equiangular sampling schemes on the sphere," 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), New Orleans, LA, 2017, pp. 4531-4535.

[50] Y. Sattar, Z. Khalid and R. A. Kennedy, "Robust reconstruction of spherical signals with finite rate of innovation," 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), New Orleans, LA, 2017, pp. 4024-4028.

[51] A. P. Bates, Z. Khalid, J. D. McEwen and R. A. Kennedy, "An optimal dimensionality multi-shell sampling scheme with accurate and efficient transforms for diffusion MRI," 2017 IEEE 14th International Symposium on Biomedical Imaging (ISBI 2017), Melbourne, VIC, 2017, pp. 770-77

[52] W. Nafees, Z. Khalid and R. A. Kennedy, "Signal analysis on the ball: Design of optimal basis functions with maximal multiplicative concentration in spatial and spectral domains," 2017 International Conference on Systems, Signals and Image Processing (IWSSIP), Poznan, 2017, pp. 1-5

[53] W. Nafees, Z. Khalid, R. A. Kennedy and J. D. McEwen, "Optimal-dimensionality sampling on the sphere: Improvements and variations," 2017 International Conference on Sampling Theory and Applications (SampTA), Tallin, 2017, pp. 87-91.

[54] U. Elahi, Z. Khalid, R. A. Kennedy and J. D. McEwen, "Iterative residual fitting for spherical harmonic transform of band-limited signals on the sphere: Generalization and analysis," 2017 International Conference on Sampling Theory and Applications (SampTA), Tallin, 2017, pp. 470-474.

[55] U. Elahi, Z. Khalid, and R. A. Kennedy, "On the choice of kernel for signal interpolation on the sphere using reproducing kernel hilbert spaces," in *2017 11th International Conference on Signal Processing and Communication Systems (ICSPCS)*.IEEE, 2017, pp. 1–7.

[56] Z. Khalid and R. A. Kennedy, "Fast extrapolation of band-limited signals on the 2-sphere," in *2017 11th International Conference on Signal Processing and Communication Systems (ICSPCS)*. IEEE, 2017, pp. 1–6.

[57] U. Elahi, Z. Khalid and R. A. Kennedy, "An improved iterative algorithm for band-limited signal extrapolation on the sphere," 2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Calgary, Canada, 2018.

[58] W. Nafees, Z. Khalid and R. A. Kennedy, "Spatially-limited sampling of band-limited signals on the sphere," 2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Calgary, Canada, 2018.

[59] A. Aslam, Z. Khalid and R. A. Kennedy, "Efficient sampling on healpix grid," 2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Calgary, Canada, 2018.

[60] U. Elahi, Z. Khalid and R. A. Kennedy, "Spatially Constrained Anti-aliasing Filter using Slepian Functions on the Sphere," in Proc. 12th International Conference on Signal Processing and Communication Systems, ICSPCS'2018, Carins, Australia, Dec. 2018

[61] U. Ahmad and Z. Khalid, "Sampling Schemes for Accurate Reconstruction and Computation of Performance Parameters of Antenna Radiation," 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Brighton, UK, 2019.

[62] W. Nafees and Z. Khalid, "An Antipodally Symmetric Optimal Dimensionality Sampling on the Sphere," 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Brighton, UK, 2019.

[63] Y. Sattar, Z. Khalid and R. A. Kennedy, "Accurate Reconstruction of Finite Rate of Innovation Signals on the Sphere," 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Brighton, UK, 2019.

[64] A. Aslam and Z. Khalid, "Construction of Overcomplete Multiscale Dictionary of Slepian Functions on the Sphere," 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Brighton, UK, 2019.

[65] U. Elahi, Z. Khalid and R. A. Kennedy, "Design of a Spatially Constrained Anti-aliasing Filter using Slepian Functions on the Sphere," in Proc. 12th International Conference on Signal Processing and Communication Systems, ICSPCS'2019, Gold Coast, Australia, Dec. 2019

[66] A. Aslam and Z. Khalid, "Optimal Window Design For Joint Spatial-Spectral Domain Filtering Of Signals On The Sphere," 2020 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Barcelona, Spain, 2020.

[67] M. O. Tarar and Z. Khalid, "Reconstruction of Finite Rate of Innovation Spherical Signals in the Presence of Noise Using Deep Learning Architecture", in Proc. 28th European Signal Processing Conference (EUSIPCO 2020), Amsterdam, NL, Jan. 2021.

[68] Y. Sattar and Z. Khalid, "Estimation of Ground Water Storage Variations in Indus River Basin using GRACE Data," 2021 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Toronto, Canada, 2021.

Conference Abstracts

[69] R. A. Kennedy, P. Sadeghi, and Z. Khalid, "Optimal signal processing on the 2-sphere: A general operator approach to signal recovery," in *International Biomedical and Astronomical Signal Processing (BASP) Frontiers workshop*, 2013.

[70] J. Guo, S. Durrani and Z. Khalid, "Exact Probability of Node Isolation in Finite Wireless Sensor Networks," in *14th Australian Communications Theory Workshop (AusCTW)*, 2013.

Book Chapters

[71] Z. Khalid and A. Muhammad, "Compressive Sensing on the Sphere: Slepian Functions for Applications in Geophysics," in *Compressive Sensing of Earth Observations*, First Ed., C. H. Chen, CRC Press, 2017.

Other Publications

[72] Z. Khalid, "Spatio-spectral analysis on the Unit Sphere," Ph. D. Thesis, ANU, 2013

Professional Service

Membership

- Senior Member, IEEE (2010-present)
- Member, IEEE Signal Processing Society (2010-present)
- Member, IEEE Industrial Applications Society (2019-Present)
- Life Member, Khwarizmi Science Society

Referee Service

- IEEE Transactions on Signal Processing
- IEEE Signal Processing Letters
- IEEE Transactions on Vehicular Technology
- ACM Transactions on Sensor Networks
- Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)
- International Conference on Signal Processing and Communication Systems (ICSPCS)
- International Symposium on Biomedical imaging (ISBI)