TUJournal

Future and evolving technologies

Volume 4, Issue 3, September 2023



ISSN: 2616-8375



The ITU Journal on Future and Evolving Technologies (ITU J-FET) is an international journal providing complete coverage of all communications and networking paradigms, free of charge for both readers and authors.

The ITU Journal considers yet-to-be-published papers addressing fundamental and applied research. It shares new techniques and concepts, analyses and tutorials, as well as learning from experiments and physical and simulated testbeds. It also discusses the implications of the latest research results for policy and regulation, legal frameworks, the economy and society. This publication builds bridges between disciplines, connects theory with application, and stimulates international dialogue. Its interdisciplinary approach reflects ITU's comprehensive field of interest and explores the convergence of ICT with other disciplines.

The ITU Journal welcomes submissions at any time, and on any topic within its scope.

Publication rights

© International Telecommunication Union, 2023

Some rights reserved. This work is available under the CC BY-NC-ND 3.0 IGO license:

https://creativecommons.org/licenses/by-nc-nd/3.0/igo/.

SUGGESTED CITATION:

ITU Journal on Future and Evolving Technologies, Volume 4, Issue 3, September 2023

COMMERCIAL USE:

Requests for commercial use and licensing should be addressed to ITU Sales at: sales@itu.int.

THIRD PARTY MATERIALS: If the user wishes to reuse material from the published articles that is attributed to a third party, such as tables, figures or images, it is the user's responsibility to determine whether permission is needed for that reuse and to obtain permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

GENERAL DISCLAIMERS: The designations employed and the presentation of the material in the published articles do not imply the expression of any opinion whatsoever on the part of ITU concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by ITU in preference to others of a similar nature that are not mentioned.

ADDITIONAL INFORMATION

Please visit the ITU J-FET website at:

https://www.itu.int/en/journal/j-fet/Pages/default.aspx.

Inquiries should be addressed to Alessia Magliarditi at: journal@itu.int.

EDITORIAL BOARD

Editor-in-Chief

Ian F. Akyildiz, Truva Inc., USA

Regular papers

Editors

Andreas Pitsillides, *University of Cyprus*, Cyprus & University of Johannesburg (Visiting Professor), South Africa

Athanasios D. Panagopoulos, *National Technical University of Athens, Greece*

Zhi Sun, Tsinghua University, China

Reviewers

Ling Cheng, *University of the Witwatersrand,* South Africa

Iacovos Ioannou, University of Cyprus, Cyprus

Theodore Kapsis, National Technical University of Athens, Greece

Zhangyu Li, South-Central Minzu University, China

Nikolaos Lyras, National Technical University of Athens, Greece

Nagaradjane Prabagarane, Sri Sivasubramaniya Nadar College of Engineering, India

Haoyu Wang, Tsinghua University, China

Special issue on "AI and machine learning solutions in 5G and future networks"

Leading Guest Editor

Ahmed Alkhateeb, *Arizona State University, USA*

Guest Editors

Paul Harvey, University of Glasgow, UK

Ilan Correa, Federal University of Pará, Brazil

Rentao Gu, Beijing University of Posts and Telecommunications, China

Reviewers

Paul Almasan, *Universitat Politècnica de Catalunya, Spain*

Damien Anderson, *University of Strathclyde*, *UK*

Huifeng Bai, Beijing Smartchip Microelectronics Technology, China

João Paulo Borges, Federal University of Pará Brazil

Davi da Silva Brilhante, Federal University of Rio de Janeiro, Brazil

Miguel Camelo Botero, IMEC, Belgium

Gouranga Charan, *Arizona State University*, *USA*

Umut Demirhan, Arizona State University, USA

Diego Gomes, Federal University of Southern and Southeastern Pará, Brazil

Glauco Gonçalves, Federal University of Pará, Brazil

Luan Gonçalves, Federal University of Pará, Brazil

Shoaib Imran, Arizona State University, USA João Morais, Arizona State University, USA

Francisco Müller, Federal University of Pará, Brazil

Tiago Oliveira, Rakuten Institute of Technology, Japan

Tawfik Osman, Arizona State University, USA

Paola Soto, IMEC, Belgium

Bjorn Stenger, Rakuten Institute of Technology, Japan

Huanlai Xing, Southwest Jiaotong University, Cina

Yubin Zhao, Sun Yat-Sen University, Cina

The full list of the ITU J-FET Editors is available at https://www.itu.int/en/journal/j-fet/Pages/editorial-board.aspx.

ITU Journal Team

Alessia Magliarditi, ITU Journal Manager Erica Campilongo, Publishing Editor

TABLE OF CONTENTS

	Page
Regular papers	
360° View on Zero-Touch (Zero-Touch) Networks Somayya Madakam, Shlomo Mark, Yotam Lurie	397
Channel estimation and PAPR reduction in OFDM based on dual layers-superimposed training Kun Chen-Hu, M. Julia Fernández-Getino García, Ana García Armada	407
FuzDeMa: A portable fuzzy-based decision-making tool for reliable communication in wireless underground sensor networks Damien Wohwe Sambo, Jens Dede, Nathalie Mitton, Anna Förster	419
Papers of the special issue on "AI and machine learning solutions in 5G and future networks"	,
Towards zero downtime: Using machine learning to predict network failure in 5G and beyond Emmanuel Basikolo, Thomas Basikolo	434
DRF codes: Deep SNR-robust feedback codes Mahdi Boloursaz Mashhadi, Deniz Gündüz, Alberto Perotti, Branislav M. Popovic	
Multimodal transformers for wireless communications: A case study in beam prediction Yu Tian, Qiyang Zhao, Zine el abidine Kherroubi, Fouzi Boukhalfa, Kebin Wu, Faouzi Bader	461
Oracle-based data generation for highly efficient digital twin network training Eliyahu Sason, Yackov Lubarsky, Alexei Gaissinski, Eli Kravchik, Pavel Kisilev	472
Data-efficient GNN models of communication networks using beta-distribution-based sample ranking	105
Max Helm, Benedikt Jaeger, Georg Carle	485
Designing graph neural networks training data with limited samples and small network sizes Junior Momo Ziazet, Charles Boudreau, Oscar Delgado, Brigitte Jaumard	492
Build your own closed loop: Graph-based proof of concept in closed loop for autonomous networks Jaime Fúster de la Fuente, Álvaro Pendás Recondo, Paul Harvey, Tarek Mohamed, Chandan Singh, Vipul Sanap, Ayush Kumar, Sathish Venkateswaran, Sarvasuddi Balaganesh, Rajat Duggal, Sree Ganesh Lalitaditya Divakarla, Vaibhava Krishna Devulapali, Ebeledike Frank Chukwubuikem, Emmanuel Othniel Eggah, Abel Oche Moses, Nuhu Kontagora Bello, James Agajo, Wael Alron, Fathi Abdeldayem, Melanie Espinoza Hernández, Abigail Morales Retana, Jackeline García Alvarado, Nicolle Gamboa Mena, Juliana Morales Alvarado, Ericka Pérez Chinchilla, Amanda Calderón Campos, Derek Rodríguez Villalobos, Oscar Castillo Brenes, Kodandram Ranganath, Ayushi Khandal, Rakshesh P Bhatt, Kunal Mahajan, Prikshit CS, Ashok Kamaraj, Srinwaynti Samaddar, Sivaramakrishnan Swaminathan, M Sri Bhuvan, Nagaswaroop S N, Blessed Guda, Ibrahim Aliyu, Kim Jinsul, Vishnu Ram	503