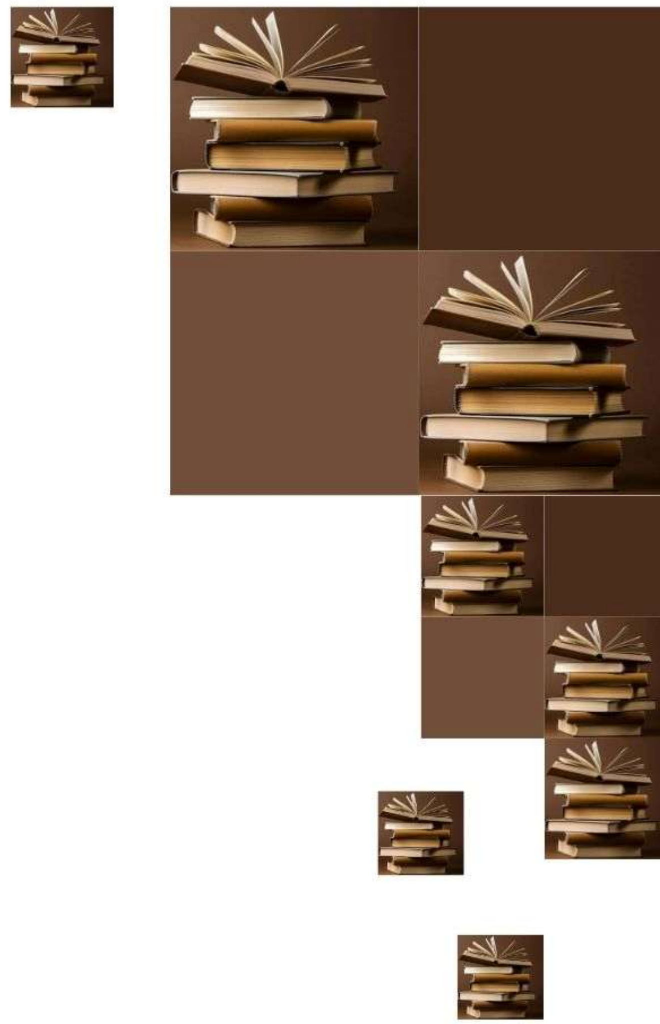
GLOBAL PERSPECTIVES IN INTERDISCIPLINARY RESEARCH



FIRST EDITION
2026

EDITOR-IN-CHIEF

DANIEL JAMES

ASDF UK

GLOBAL PERSPECTIVES IN INTERDISCIPLINARY RESEARCH 2026

GPIR 2026

FIRST EDITION 2026

GLOBAL PERSPECTIVES IN INTERDISCIPLINARY RESEARCH 2026

FIRST EDITION GPIR 2026

By

ASDF, UK

Financially Sponsored By

Association of Scientists, Developers and Faculties, India

Editor-in-Chief

Daniel James

Editors:

Anbuoli Parthasarathy and Katsuo Shichirou

Published by
Association of Scientists, Developers and Faculties
Address: 483 Green Lanes, London N13 4BS. England. United Kingdom.
Email: admin@asdf.res.in || www.asdf.international

Global Perspectives in Interdisciplinary Research 2026 (GPIR 2026)

First Edition

Editor-in-Chief: Daniel James
Editors: Anbuoli Parthasarathy and Katsuo Shichirou
Cover Design: ArishKannan B

Disclaimer

The GPIR 2026 Publisher accepts no liability for any injury or damage to persons or property arising from products liability, negligence, or otherwise, or from the use or application of any method, product, or idea described in this material. Each article reflects the content submitted and approved by its contributor following any formatting changes. While every effort is made to keep the articles stylistically consistent, neither the GPIR 2026 Publisher nor the Editor(s) accept responsibility for the accuracy, correctness, or representation of any statement or material presented within the articles.

ISBN-13: 978-93-88122-15-3
ISBN-10: 93-88122-15-1

Table of Contents

CHAPTERS	PP
A Study on Career Self-Efficacy and Industry Readiness Among Generation Z Graduates: A Quantitative Study *Mrs. K. Lakshmi, Dr. A. Meenakshi*	1 – 5
Beyond The Glass Ceiling: Informal Organizational Networks, Perception Bias and The Old Boys' Club as Hidden Barriers to Women's Leadership Advancement – A Conceptual Review *Devi Nair R*	6 – 13
Determinants of Successful Startup Ecosystems: A Comparative Global Perspective *R. Pushpam, Dr. V. Geetha, G. Durga Devi*	14 – 20
Digital Leadership in The Era of Artificial Intelligence: Transforming Organizational Decision-Making *Dr. N. Vivek*	21 – 29
Resilience And Entrepreneurial Success in The Digital Economy: A Study Among Women Entrepreneurs in Southern Districts of Tamil Nadu *Dr. Anbuoli P*	30 – 36
Survey On Spectrum Sensing For 6G Networks *Pandeeswari. G, Velmurugan. M*	37 – 41
Sustainable Finance and ESG Integration in Modern Banking: An Indian Perspective *Praveen Asokan, Kokula Krishna Hari*	42 – 60
Technology Adoption and Digital Transformation: Drivers of Organizational Performance in The Digital Economy *G. Durga Devi, Dr. V. Geetha, R. Pushpam*	61 – 67
The Gig Economy, Remote Work, and Digital Transformation: An Economic Analysis *Mrs. Poongodi P*	68 – 75
The Startup Ecosystem in The Age of Artificial Intelligence: Opportunities, Challenges, And Future Prospects *Dr. P. Mangayarkarasi*	76 – 80

A Study on Intuitionistic Soft Set Topological Spaces *Balamurugan, Dr. A. Arivu Chelvam*	81 – 87
Adoption Of Digital Transformation Practices by Business Organizations in Madurai City *Dr. M. Sakthivel*	88 – 94
Artificial Intelligence and green innovation: driving sustainable business transformation *Dr. A. Nixon Jesuraj*	95 – 99

Survey On Spectrum Sensing For 6G Networks

Pandeeswari. G[1], Velmurugan. M[2]

[1]*Department of Electronics and Communication*

Mannar Thirumalai Naicker College, Pasumalai, Madurai. 625004, Tamil nadu, India.

[2]*Department of Electronics and Communication*

Mannar Thirumalai Naicker College, Pasumalai, Madurai. 625004, Tamil nadu, India.

ABSTRACT

Spectrum sensing is a fundamental technology that enables efficient utilization of radio spectrum in cognitive radio networks by detecting unused frequency bands for opportunistic access. As sixth-generation (6G) wireless networks emerge, spectrum sensing has become increasingly critical due to the integration of artificial intelligence (AI), edge computing, Integrated Sensing and Communication (ISAC), and terahertz (THz) communications. This survey reviews conventional spectrum sensing techniques, including energy detection, matched filter detection, cyclostationary feature detection, and cooperative spectrum sensing, while highlighting their strengths and limitations in 6G environments. The paper further discusses AI-enabled spectrum sensing approaches based on machine learning, deep learning, reinforcement learning, and federated learning, along with emerging technologies such as Reconfigurable Intelligent Surfaces (RIS), digital twins, and edge intelligence. Finally, the survey outlines key applications, current challenges, and future research directions for intelligent spectrum management in next-generation wireless communication systems.

Keywords: *6G Networks, Spectrum Sensing, Cognitive Radio, Artificial Intelligence, Machine Learning, Deep Learning, Integrated Sensing and Communication (ISAC), Reconfigurable Intelligent Surfaces (RIS), Terahertz Communication, Dynamic Spectrum Access.*

INTRODUCTION

The exponential growth of wireless devices, Internet of Things (IoT) applications, autonomous vehicles, industrial automation, and immersive technologies such as augmented reality (AR) and virtual reality (VR) has significantly increased the demand for radio spectrum. Although the radio spectrum is a limited natural resource, several licensed frequency bands remain underutilized at different times and locations. This inefficient utilization has led to the concept of dynamic spectrum access (DSA), where unlicensed users can opportunistically access unused licensed spectrum without causing harmful interference to licensed users.

Cognitive Radio (CR), introduced by Joseph Mitola III, enables intelligent spectrum sharing through four primary functions: spectrum sensing, spectrum decision, spectrum sharing, and spectrum mobility. Among these, spectrum sensing is the most fundamental because it determines whether a frequency band is occupied by a primary user or available for secondary access.

As wireless communication evolves toward sixth-generation (6G) networks, spectrum sensing has become increasingly important. Unlike previous generations, 6G aims to integrate communication, sensing, artificial intelligence (AI), edge computing, and satellite networks into a unified ecosystem. Future 6G systems are expected to operate across sub-6 GHz, millimeter-wave (mmWave), and terahertz (THz) frequency bands while supporting ultra-low latency, extremely high reliability, and intelligent decision-making. These ambitious goals require highly accurate, adaptive, and AI-enabled spectrum sensing mechanisms. Recent 6G research also emphasizes Integrated Sensing and Communication (ISAC), where communication and sensing share the same spectrum and hardware resources to improve efficiency.

FUNDAMENTALS OF SPECTRUM SENSING

Spectrum sensing refers to the process of continuously monitoring the radio environment to identify unused frequency bands, commonly called spectrum holes or white spaces. A cognitive radio periodically observes the spectrum and decides whether a primary user is present.

The quality of spectrum sensing is evaluated using three important metrics:

- Probability of Detection (Pd): Probability of correctly detecting a primary user.
- Probability of False Alarm (Pfa): Probability of incorrectly declaring that a spectrum band is occupied.
- Probability of Missed Detection (Pm): Probability of failing to detect an active primary user, potentially causing interference.

An effective sensing algorithm should maximize the probability of detection while minimizing false alarms and computational complexity.

CONVENTIONAL SPECTRUM SENSING TECHNIQUES

Several traditional spectrum sensing methods have been developed.

Energy Detection

Energy detection is the simplest and most widely used method because it does not require prior knowledge of the transmitted signal. The received signal energy is compared with a predefined threshold. It is simple to implement, low computational complexity and Suitable for unknown signals

Matched Filter Detection

Matched filtering provides optimum detection when the characteristics of the primary signal are known.

Advantages

Fast sensing
High detection accuracy

Cyclostationary Feature Detection

Many communication signals exhibit periodic statistical properties known as cyclo- stationarity. These characteristics allow reliable detection even under noisy conditions.

Advantages

Excellent low-SNR performance and Distinguishes signal from noise

Cooperative Spectrum Sensing

Multiple cognitive radios cooperate by sharing sensing information with a fusion center. This approach mitigates fading, shadowing, and hidden terminal problems while improving sensing reliability.

SPECTRUM SENSING REQUIREMENTS IN 6G NETWORKS

Unlike 5G, 6G is envisioned as an AI-native communication platform supporting communication, sensing, localization, and intelligence simultaneously. Consequently, spectrum sensing must satisfy several new requirements.

- Ultra-low latency: Decisions should be made within milliseconds.
- High sensing accuracy: Reliable detection is required even below –20 dB SNR.
- Energy efficiency: Battery-powered IoT devices require low-power sensing algorithms.
- Massive scalability: Millions of connected devices must perform spectrum sensing without excessive overhead.
- THz spectrum awareness: New sensing algorithms are required for terahertz communications because of severe path loss and atmospheric absorption.
- Satellite integration: Future 6G systems will integrate terrestrial and non-terrestrial networks, requiring spectrum sensing across heterogeneous environments.

AI - ENABLED SPECTRUM SENSING FOR 6G

Artificial Intelligence is expected to become a core component of 6G networks. Instead of relying solely on fixed thresholds, AI enables intelligent learning from radio environments and adaptive decision-making.

Machine Learning

Traditional machine learning algorithms such as Support Vector Machines (SVM), Random Forests, Decision Trees, and K-Nearest Neighbors classify spectrum occupancy using handcrafted features.

Deep Learning

Deep learning automatically extracts features from raw radio signals.

Popular architectures include:

- Convolutional Neural Networks (CNN)
- Long Short-Term Memory (LSTM)
- Auto encoders
- Transformer Networks

Deep learning significantly improves detection accuracy in low-SNR environments.

Reinforcement Learning

Reinforcement learning enables cognitive radios to learn optimal sensing policies by interacting with the wireless environment. It minimizes sensing overhead while maximizing spectrum utilization.

Federated Learning

In federated learning, multiple devices collaboratively train a global sensing model without sharing raw sensing data, improving privacy while reducing communication overhead.

Recent 6G research also explores AI-enhanced radio sensing within Integrated Sensing and Communication (ISAC), enabling networks to jointly perceive the environment and optimize spectrum usage.

EMERGING TECHNOLOGIES SUPPORTING SPECTRUM SENSING

Several emerging technologies are reshaping spectrum sensing in 6G.

- Integrated Sensing and Communication (ISAC): Communication signals simultaneously support wireless data transmission and environmental sensing, improving spectrum utilization and reducing hardware complexity.
- Reconfigurable Intelligent Surfaces (RIS): RIS dynamically controls wireless propagation, improving sensing reliability in obstructed environments.
- Edge Intelligence: AI models deployed at network edges enable real-time spectrum decisions with minimal latency.
- Digital Twins: Virtual replicas of wireless networks help predict spectrum occupancy and optimize sensing strategies before deployment.

These technologies are considered key enablers of intelligent spectrum management in future 6G systems

Applications of Spectrum Sensing in 6G:

Spectrum sensing supports numerous real-world applications.

- Smart cities with intelligent traffic management.
- Autonomous vehicles requiring uninterrupted wireless connectivity.
- Industrial automation and smart manufacturing.
- Remote healthcare and wearable medical devices.
- Disaster recovery through UAV-assisted emergency communication.
- Smart agriculture using low-power IoT sensors.
- Satellite–terrestrial integrated communication systems.

These applications require highly reliable and adaptive spectrum sensing to ensure seamless communication.

8. Challenges and Future Research Directions

- Despite significant progress, several challenges remain.
- Reliable sensing under extremely low SNR.
- Efficient sensing in terahertz frequency bands.
- Security against spectrum sensing data falsification and primary user emulation attacks.
- Energy-efficient AI algorithms for battery-powered devices.
- Explainable AI for trustworthy sensing decisions.

- Standardization of AI-enabled spectrum sensing for 6G.

Future research is expected to combine AI, ISAC, RIS, edge intelligence, and digital twins to create autonomous spectrum management systems capable of self-learning and real-time adaptation.

CONCLUSION

Spectrum sensing remains the cornerstone of cognitive radio and dynamic spectrum access. As wireless networks evolve toward 6G, traditional sensing techniques alone are insufficient to meet stringent requirements for ultra-low latency, massive connectivity, energy efficiency, and high reliability. AI-driven spectrum sensing, integrated sensing and communication, reconfigurable intelligent surfaces, and edge intelligence are transforming spectrum management into an intelligent and autonomous process. These technologies will play a vital role in enabling efficient spectrum utilization, supporting emerging applications, and realizing the vision of intelligent 6G wireless networks

REFERENCES

1. Mitola, J., & Maguire, G. Q. (1999). *Cognitive Radio: Making Software Radios More Personal*. IEEE Personal Communications, 6(4), 13–18.
2. Haykin, S. (2005). *Cognitive Radio: Brain-Empowered Wireless Communications*. IEEE Journal on Selected Areas in Communications, 23(2), 201–220.
3. Yucek, T., & Arslan, H. (2009). *A Survey of Spectrum Sensing Algorithms for Cognitive Radio Applications*. IEEE Communications Surveys & Tutorials, 11(1), 116–130.
4. Akyildiz, I. F., Lee, W. Y., Vuran, M. C., & Mohanty, S. (2006). *Next Generation/Dynamic Spectrum Access/Cognitive Radio Wireless Networks: A Survey*. Computer Networks, 50(13), 2127–2159.
5. Saad, W., Bennis, M., & Chen, M. (2020). *A Vision of 6G Wireless Systems: Applications, Trends, Technologies, and Open Research Problems*. IEEE Network, 34(3), 134–142.
6. Dang, S., Amin, O., Shihada, B., & Alouini, M. S. (2020). *What Should 6G Be?*. Nature Electronics, 3(1), 20–29.
7. ITU-R. (2023). *Framework and Overall Objectives of the Future Development of IMT for 2030 and beyond*.
8. Zhang, Z., Xiao, Y., Ma, Z., et al. (2019). *6G Wireless Networks: Vision, Requirements, Architecture, and Key Technologies*. IEEE Vehicular Technology Magazine, 14(3), 28–41.

£ 45/ ₹ 5500

ASSOCIATION OF SCIENTISTS, DEVELOPERS AND FACULTIES

483 Green Lanes, London N13 4BS

India | Thailand | South Korea | United Kingdom

+44 20 8144 5548 | asdf@asdf.international | www.asdf.international

A S D F

ISBN 978-93-88122-15-3

5 901234 123457