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CHAIRMAN'S MESSAGE

Dr. Partha Pratim Sarkar

It gives me great pleasure, at the beginning of my tenure as the Chairman of the IETE Kolkata Centre, to note the publication of SIGNAL, Volume 18, Issues 2 (April-June 2026).

We received sufficient high-quality contributions to cover the contents of these issue and we decided to publish this issues. The central theme of these issue is Wireless Sensor Networks (WSN). As we move towards increasingly smart and interconnected environments, WSN technology is becoming an integral part of our daily lives and will play an even more significant role in the future. I hope that the articles published in this edition will provide valuable insights into this rapidly evolving field and stimulate further research and innovation.

We warmly welcome your comments, suggestions, and feedback through our website, as they will help us continue to improve the quality and relevance of our publication.

I extend my sincere appreciation to all the authors, reviewers, editors, and everyone associated with the publication of this issue for their dedicated efforts.

Partha Pratim Sarkar
Chairman
IETE Kolkata Centre

1st EC Meeting at IETE Kolkata Center,
17th july 2026

Signals and Systems in the Internet of Underwater Things

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The **Internet of Underwater Things (IoUT**) has emerged as a transformative communication paradigm for monitoring and exploring underwater environments using interconnected sensors, autonomous underwater vehicles (AUVs), remotely operated vehicles (ROVs), smart buoys, underwater cameras, and intelligent gateways. Unlike terrestrial Internet of Things (IoT) systems that primarily rely on radio frequency (RF) communication, IoUT employs **acoustic, optical, and magnetic induction signals** because electromagnetic waves suffer severe attenuation in water. Consequently, signal generation, propagation, processing, and system design become the fundamental building blocks of underwater communication networks. Recent research has significantly advanced this field by integrating federated learning, edge intelligence, software-defined networking, and privacy-preserving artificial intelligence into IoUT architectures to enable sustainable underwater sensing and communication. Signals in IoUT are generated by diverse sensing devices that continuously monitor underwater environments. These include hydrophones for acoustic sensing, sonar systems for object detection, underwater cameras for coral reef monitoring, pressure sensors for ocean depth measurement, temperature and salinity sensors for environmental observation, and chemical sensors for pollution detection. These sensors produce either analog or digital signals that represent physical phenomena. Since underwater environments are highly dynamic due to water currents, turbulence, salinity variations, and marine organisms, the acquired **signals are often corrupted by noise, multipath fading, Doppler shifts, and severe attenuation**. Therefore, efficient signal conditioning, filtering, feature extraction, and adaptive modulation become essential before reliable communication can occur.

Acoustic communication remains the dominant transmission mechanism in IoUT because sound waves propagate much farther in water than electromagnetic signals. However, acoustic signals exhibit unique characteristics including low bandwidth, long propagation delay, frequency-dependent attenuation, and significant multipath interference. These limitations directly influence the design of **communication systems, routing protocols, synchronization algorithms, and error-control techniques. Signal processing methods such as adaptive equalization, channel estimation, beamforming, matched filtering, and Doppler compensation** are therefore extensively employed to improve communication reliability and energy efficiency.

The "systems" aspect of IoUT encompasses the integration of sensing devices, communication networks, computing infrastructure, and intelligent decision-making modules into a unified architecture. Modern IoUT systems generally consist of underwater sensor nodes, autonomous underwater vehicles, relay nodes, surface gateways, satellite links, cloud servers, and edge computing platforms. These components collaboratively collect, process, and transmit underwater information for applications such as **marine biodiversity monitoring, offshore oil and gas inspection, underwater archaeology**, naval surveillance, disaster prediction, and climate research. The heterogeneous nature of these interconnected systems requires efficient synchronization among sensing, communication, computation, and control subsystems. Traditional centralized machine learning requires raw underwater data to be transmitted to cloud servers, resulting in excessive communication overhead, energy consumption, and privacy concerns. Federated learning framework enables underwater sensor nodes to train local models independently while sharing only model parameters with aggregation servers. This decentralized learning strategy significantly reduces communication costs, enhances data privacy, and prolongs network lifetime. The framework has demonstrated promising results in underwater coral classification while addressing challenges related to bandwidth limitation and distributed learning.

Signal processing also plays a crucial role in **intelligent underwater image analysis**. Coral reef monitoring, fish species identification, underwater habitat assessment, and pollution detection rely heavily on image signals acquired under poor illumination, scattering, and water absorption conditions. Advanced preprocessing techniques including contrast enhancement, noise reduction, color correction, feature extraction, and deep convolutional neural networks improve the quality of underwater visual information before classification. The **transfer federated learning** framework proposed further enhances classification performance while preserving the privacy of distributed underwater datasets.

Another important system-level contribution involves the development **of Edge-Drone-based Software-Defined IoUT architectures.** In this model, underwater sensor networks are integrated with autonomous drones, edge computing devices, and software-defined networking controllers. Instead of transmitting every signal to distant cloud servers, computationally intensive tasks are executed at nearby edge nodes, thereby reducing latency and conserving energy. Software-defined networking further enables centralized management of routing, resource allocation, and network optimization, making the overall underwater communication system more flexible and adaptive to changing marine environments.

Energy efficiency remains one of the most challenging aspects of underwater signal processing systems. Since underwater sensor batteries are difficult and expensive to replace, communication protocols must minimize unnecessary transmissions. Signal compression, adaptive sampling, sleep scheduling, clustering algorithms, and data aggregation techniques substantially reduce energy consumption. Federated learning further contributes by exchanging compact model updates instead of raw sensor data. Recent work on entropy-driven federated learning for sustainable IoUT demonstrates how intelligent communication strategies simultaneously improve energy efficiency, communication performance, and environmental sustainability.

Noise mitigation is another essential requirement in underwater signal systems. Ambient noise generated by ships, marine animals, rainfall, waves, and industrial activities often overlaps with useful acoustic signals. Furthermore, multipath propagation causes delayed replicas of transmitted signals to arrive at receivers, increasing inter-symbol interference. Adaptive filtering, wavelet transforms, spectral analysis, and machine learning-based denoising techniques are increasingly adopted to improve signal quality. Future intelligent receivers are expected to combine classical digital signal processing with deep learning for real-time underwater communication enhancement.

Security and privacy are becoming equally important in underwater systems. Military surveillance, offshore infrastructure monitoring, and environmental sensing require secure communication mechanisms capable of protecting sensitive underwater information. Conventional encryption methods often introduce **excessive computational overhead** for energy-constrained underwater devices. The federated learning-based privacy-preserving architecture provides an effective alternative by ensuring that sensitive underwater data remain locally stored while collaborative intelligence is still achieved across distributed nodes.

Future IoUT systems will increasingly integrate artificial intelligence, explainable AI, digital twins, autonomous underwater vehicles, 6G communications, underwater edge intelligence, and sustainable green computing. Hybrid communication systems combining acoustic, optical, and magnetic induction channels will provide higher data rates and improved reliability. Intelligent signal processing algorithms will dynamically adapt transmission parameters according to channel conditions, mobility patterns, and application requirements. Advanced machine learning models will optimize localization, routing, channel estimation, fault prediction, anomaly detection, and underwater resource management with minimal human intervention. In conclusion, signals and systems constitute the foundation of the Internet of Underwater Things, enabling reliable acquisition, processing, transmission, and interpretation of underwater information. The unique characteristics of underwater environments demand specialized communication models, robust signal processing techniques, energy-efficient architectures, and intelligent computing frameworks. introducing federated learning, transfer learning, software-defined edge architectures, and privacy-preserving intelligent systems for sustainable IoUT applications. Their work demonstrates that integrating modern artificial intelligence with advanced signal processing and communication systems can transform underwater monitoring into a scalable, secure, and intelligent cyber-physical ecosystem capable of supporting future marine science, environmental conservation, smart ocean infrastructure, and the blue economy.

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GLIMPSES OF THE EVENTS

March – June, 2026

IETE Kolkata Centre Activity During March to June 2026

Celebration of Students' Day

14th March, 2026

The event was conducted under the leadership of Ms. Sharmila Ghosh, Chairperson of IETE Kolkata Centre, and Prof. (Dr.) Jyoti Sekhar Banerjee, Secretary of I. ETE Kolkata Centre. They felicitated the speakers in recognition of their valuable contributions to the program.

Celebration of International Women's Day

14th March, 2026

The International Women's Day Celebration Program was organized at the IETE Kolkata Centre on 14th March, 2026 at 1.30 p.m. at IETE Kolkata Centre Auditorium to recognize and honour the remarkable contributions of women in science, technology, and academia. The event was conducted in a vibrant and inspiring atmosphere, with the participation of distinguished guests, faculty members, and enthusiastic students.

AI Utkarsh Summit, 2026

7–8 April, 2026

AI UTKARSH SUMMIT 2026, held on 7–8 April 2026, was a landmark two-day International-Level Artificial Intelligence Summit organized by Narula Institute of Technology (NiT), Kolkata as part of its Silver Jubilee Celebrations. The summit emerged as one of the most significant AI events in Eastern India, bringing together distinguished academicians, industry leaders, policymakers, researchers, innovators, entrepreneurs, startups, and students on a common platform to discuss the future of Artificial Intelligence and its transformative impact on society.

Celebration of 58th World Telecommunication & Information Society Day – 2026

21st May, 2026

The celebration of World Telecommunication and Information Society Day was successfully held at Institution of Electronics and Telecommunication Engineers on 21.05.2026 in the presence of more than 65 participants, including 56 students of Techno India, 7 professors of different colleges, and 6 IETE members. The President's message was gracefully read out by Mrs. Sharmila Ghosh, Chairperson of Institution of Electronics and Telecommunication Engineers

Celebration of World Environment Day

5th June, 2026

Kolkata, June 5, 2026: The Institution of Electronics and Telecommunication Engineers (IETE), Kolkata Centre, celebrated World Environment Day with great enthusiasm and environmental awareness. The program witnessed the active participation of faculty members, Chairperson Ms Sharmila Ghosh and around 35 students, who joined hands to promote environmental sustainability through a tree plantation drive conducted within the IETE premises. The event aimed to encourage environmental responsibility and highlight the importance of increasing green cover to combat climate change and ecological degradation.

UPCOMING EVENTS

Date	Event Name
22/8/2026	Eastern Zonal ISF Congress. Theme : AI for Sustainable Society. Venue: ISF MCKVIE ISF Activity, Expert Talk, Technical Quiz
29/8/2026 – 30/8/2026	IETE Eastern Zonal Seminar, Venue: Narula Institute of Technology, Student Poster Context, Quiz
24th- 26th Sep 2026	Tutorial on 24/09/26, venue: IETE Kolkata Centre 69th AIC on 25th Sep at IETE Kolkata Centre
26th- 27th 2026	GC Meeting and INSBT
15th Sep 2026	Engineers Day, Venue :IETE Kolkata Centre
2/11/2026	Foundation Day, Venue :IETE Kolkata Centre
30/11/2026	A. J. C Bose Memorial Lecture Venue :IETE Kolkata Centre
24/09/26	Workshop on IoT and Drones Venue :IETE Kolkata Centre
21/11/26	Workshop on EM Radiation and AntenaTechnology, Venue :IETE Kolkata Centre
15/09/2026	Workshop Venue: Narula Institute of Technology
4th to 5th sep 2026	Hackathon Venue: IEM, Kolkata
21st Aug 2026	International Conference Metasphehe 2026
Jan 2027	Outreach Program
15th to 17th 2027	FDP at Narula Institute of Technology
2nd Feb 2027	Students day observation, Venue: IETE Kolkata Centre
8th Mar 2027	Women's Empowerment program, Venue: IETE Kolkata Centre
17th May 2026	World Telecommunication and International Society day Venue: IETE Kolkata Centre
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