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PREFACE OF THE SPECIAL ISSUE ON ARTIFICIAL INTELLIGENCE AND COMPUTATIONAL METHODS FOR THE MEDICAL CYBER-PHYSICAL SYSTEMS (MCPS)

Medical Cyber-Physical Systems (MCPS) represent the convergence of physical processes with networked computational resources in healthcare. As these systems continue to evolve, Artificial Intelligence (AI) plays an increasingly pivotal role in enabling intelligent sensing, adaptive decision-making, predictive analytics, and real-time control across medical applications.

The special issue attracted a large number of submissions; however, only eight papers were selected for publication, as they closely align with the scope of the issue. The accepted articles cover a wide range of technologies, including Explainable TinyML, Digital Twins, Deep Reinforcement Learning, and Genetic Algorithms, addressing diverse challenges in Medical Cyber-Physical Systems. This Special Issue includes selected papers presented at the ICCCNet 2025 conference. Each paper was reviewed by at least two reviewers and went through at least two rounds of reviews. The brief contributions of these papers are discussed below.

In the first paper of this special issue, the authors (S. Qiao et al., 2026) propose a Deep Reinforcement Learning-based Task Offloading and Service Caching optimization algorithm (DRL-TOSC) that jointly optimizes medical task offloading and AI service caching in MCPS. Experimental results demonstrate that DRL-TOSC reduces the average system cost by 42.3% and improves the service cache hit rate by 20.7% compared to existing benchmark algorithms.

The authors (M. Maashi et al., 2026), the FEL framework integrates heterogeneous biomedical IoT devices, such as ECG patches, continuous glucose monitors, neurostimulators, and implantable cardiac devices, which can communicate with localized edge gateways and engage in the federated model training with pre-processing performed on the devices. The proposed framework demonstrates adaptive and more trustworthy security with adversarial and privacy-constrained settings, demonstrating its feasibility in next-generation digital healthcare systems of high priority: Low latency, high accuracy, and privacy compliance.

The authors (S. Mansour et al., 2026) propose a decision support framework that incorporates a safety-restricted offline DRL agent with a post-hoc Explainable AI (XAI) module into a Clinical Cyber-Physical System (CCPS). Outcomes show better prediction of patient outcome and treatment safety with respect to baseline approaches.

In 2026, X. Xue et al. introduce a novel Genetic Algorithm with Semantic Search (GA-SS) to efficiently match biomedical ontologies. The proposed GA-SS is compared with the state-of-the-art ontology matching methods on the Ontology Alignment Evaluation Initiatives (OAEI) Benchmark Benchmark and Anatomy datasets, and the experimental results demonstrate that GA-SS is able to identify high-quality alignments while achieving superior matching efficiency, outperforming the state-of-the-art matching methods.

The authors (X. Zhou et al., 2026) presents an AI-engineered Digital Twin module that can be incorporated into a Medical Cyber-Physical System (MCPS) and allow the creation adaptable and patient-centered treatment plans. The suggested architecture presents a scalable and safe approach to real-time and data-driven optimization of cancer treatment and emphasizes the chance of closed-loop intelligent systems in precision oncology.

In 2026, Y. Qiao et al. the Digital Twin (DT) technology, Deep Learning (DL), and Cyber-Physical Systems (CPS) to facilitate improvements in therapeutic approaches. To predict the evolution of the tumor and response to treatment based on continuously evolving clinical data,

a hybrid mechanistic deep learning model is implemented to create a patient-specific DT. The results demonstrate prolonged time-to-progression and reduced cumulative toxicity compared to conventional treatment strategies, highlighting the potential of DT-CPS systems in advancing personalized oncology

A TinyML-enabled federated learning (FL) architecture for MCPS, in which resource-constrained devices train local models and transmit encrypted updates to facilitate secure aggregation has been proposed by (M.A. Alohali et al., 2026). Findings indicate that the linear model converges faster, lower smaller communication burden and is more interpretable, whereas the neural model achieves comparable performance with additional rounds of training.

The final article by (D. Li et al., 2026) propose a framework consists of four key stages: Data pre-processing, feature extraction, privacy-preserving feature encryption using Homomorphic Encryption, Secure Multi-Party Computation, and Secure Hash Algorithm-3, followed by authentication through a Transformer-based classifier for accurate and efficient fingerprint matching. Experimental evaluation on FVC2002, FVC2004, and LivDet 2015 datasets demonstrates superior performance in accuracy, FAR, FRR, EER, and processing efficiency.

To conclude, this special issue includes eight papers. The guest editors hope that the research contributions and findings in this special issue would benefit readers.

We want to express our sincere thanks to the Editor-in-Chief for allowing us to organize this particular issue. The editorial office staff are excellent, and we thank them for their support. We are also grateful to all the authors who made this special issue possible, and to the reviewers for their thoughtful contributions.

Guest Editors:

Deepak Gupta,
Maharaja Agrasen Institute of Technology, Delhi, India, e-mail: deepakgupta@mait.ac.in

Ali Kashif Bashir,
Manchester Metropolitan University, Manchester, UK, e-mail: a.bashir@mmu.ac.uk