

Advancing Healthcare Technology: From Edge-AI Diagnostics to Metagenomic Intelligence and Biomaterial Sensors

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The intrinsic convergence of computational intelligence, material science, and molecular biology underpins modern healthcare engineering. At the nexus of this multidisciplinary interaction lies the urgent need for scalable, real-time diagnostic tools that can operating seamlessly from the planetary scale of metagenomic tracking to the micro-scale of wearable, edge-deployed physical sensors. Accelerating the translation of clinical workflows requires bridging the gap between algorithmic models and physical engineering realities. Addressing these complex healthcare demands necessitates robust software optimization frameworks, highly sensitive biomaterial substrates, assistive accessibility pipelines, and reference-free deep learning models that transcend classical alignment bottlenecks.

In response to these critical needs, we introduce the inaugural issue of the *Journal of Biomedical Systems and Engineering* - a peer-reviewed, open-access forum dedicated to advancing research at the intersection of medicine, hardware engineering, data science, and molecular diagnostics. Embracing the paradigm of translational technology, the journal serves as a multidisciplinary platform for high-impact original research, comprehensive reviews, and computational proof-of-concepts. Our inaugural issue features four contributions that collectively span the continuum from individual edge-hardware optimization and localized point-of-care biosensors to real-time assistive frameworks and deep-learning metagenomic architectures:

Odiba *et al.* provide a comprehensive review of the integration of Deep Learning (DL) with metagenomic sequencing for advanced microbial species differentiation.^[1] The authors evaluate four foundational neural architecture families - convolutional, recurrent, transformer-based genomic language, and graph neural networks - across clinical tasks including taxonomic classification, genome-resolved binning, and microbiome-phenotype association.^[2,3] The review contrasts these DL methodologies against conventional alignment-based limitations, specifically highlighting hurdles such as data leakage, domain shift across platforms, and database reference dependency. Ultimately, they outline the strategic necessity of reference-free, multi-modal foundation models to achieve biologically robust microbial identification. Basak and Sahu execute a comprehensive compression-aware ablation study aimed at continuous vital-sign anomaly detection on wearable and bedside Internet of Medical Things (IoMT) hardware.^[4] Utilizing a synthetic multi-variate vital-sign dataset mapped against National Early Warning Score 2 (NEWS2) thresholds, the authors systematically benchmark a baseline CNN-LSTM network against structured

channel pruning, partial dynamic post-training 8-bit integer quantization, and knowledge distillation to a 1,662-parameter GRU student.^[5] While the baseline achieved an exceptional F1-score of 0.955, knowledge distillation yielded a massive 40.8-fold reduction in multiply-accumulate operations while preserving a high F1-score of 0.912. Crucially, the authors separate their software-sandbox metrics from a rigorous, self-contained implementation protocol designed to guide future physical edge-hardware deployment and clinical verification. Shifting focus toward molecular-level real-time monitoring, Kumar *et al.* present the numerical design and optimization of a highly sensitive, multilayer Surface Plasmon Resonance (SPR) sensor for label-free urine glucose detection.^[6] The architecture integrates a calcium fluoride (CaF₂) prism coupled with a copper plasmonic layer, silicon dioxide (SiO₂), blue phosphorus (BlueP), and a 2D Franckeite mineral heterostructure to maximize the interaction of the evanescent field with the analyte.^[7,8] The optimized configuration demonstrates an extraordinary maximum angular sensitivity of 385.55°/RIU and a peak Figure of Merit (FoM) of 82.31/RIU. This computational proof-of-concept establishes a vital theoretical baseline for subsequent physical prototyping and clinical translation using real patient urine samples. Moving from biochemical assays to human-computer interactions, Siddiqui *et al.* develop a real-time assistive pipeline combining Indian Sign Language (ISL) alphabet recognition with temporal stabilization.^[9] To accommodate users experiencing involuntary hand movements, such as Parkinson's disease tremors, the system tracks 21 three-dimensional skeletal joints via a webcam using MediaPipe Hands.^[10] These landmarks are mapped to a convolutional neural network (CNN) that achieves a macro F1-score of 99.27% across a 13,000-image dataset. Operating at an inference rate of ~9.23 frames per second, the prototype integrates a strict 20-frame consecutive prediction rule to smooth shaky-motion artifacts, delivering real-time text interpretation and augmented reality (AR) style feedback. Collectively, these inaugural contributions demonstrate that safeguarding human health relies on a continuous synthesis of precise software optimization, sensitive material substrates, and scalable machine learning frameworks. They also delineate recurrent translational challenges - such as domain shift across clinical environments, laboratory-to-field hardware constraints, and the need for physical experimental validation - which we warmly encourage future contributors to address in upcoming issues.

The Editorial Office remains dedicated to a rigorous, transparent, and timely peer-review process adhering to the highest standards of scientific and ethical integrity. We enthusiastically invite biomedical engineers, computer scientists, material researchers, and clinical technologists to contribute their work and assist in establishing the *Journal of Biomedical Systems and Engineering* as a leading global venue for integrative health technology.

Conflict of Interest

The author is a co-author of one article featured in this issue (Ref. 6); its peer review and editorial handling were carried out independently of the author.

Artificial Intelligence (AI) Use Disclosure

The author declare that artificial intelligence (AI)-assisted tools were used only for language refinement, grammar improvement, and manuscript structuring purposes during the preparation of this work. All content and interpretations were reviewed and verified by the author.

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