From PocketQube to Glucose Monitoring – in ’24

Pal Varga

Let's see what the first issue of ICJ in 2024 has brought.

The first paper is by Iqbal Jebril et. al., in which they address the pressing challenge of securing IoT networks against Distributed Denial-of-Service (DDoS) attacks. The authors introduce a robust detection model that integrates three advanced deep learning approaches – CNN, BiLSTM, and transfer learning techniques – enhanced further with regularization to optimize performance. Tthis model not only showcases a high detection accuracy of 99.9%, outperforming previous models, but also demonstrates superior capability in distinguishing between legitimate and malicious traffic across various DDoS attack classes.

Balázs Solymos and László Bacsárdi propose an innovative post-processing framework designed to enhance the reliability and security of optical quantum random number generators (QRNGs) that measure photon arrival times. This framework effectively compensates for potential errors arising from non-ideal system components or external attacks, utilizing minentropy estimation and universal hashing techniques. Their method ensures the generation of a high-quality, uniformly distributed bitstream, even under non-ideal conditions. Results underscore the necessity of minimizing or precisely characterizing error sources to optimize the performance of this QRNG post-processing method in practical applications.

In their paper, Jyoti P. Patra, Bibhuti Bhusan Pradhan, and M. Rajendra Prasad address the computational challenges inherent in massive MIMO (m-MIMO) systems, which are exacerbated by the large number of antennas at the base station. The paper introduces two novel signal detection methods: QR Decompositions (QRD) and Ordered QRD (OQRD). These methods aim to reduce computational complexity while main-taining or improving performance compared to MMSE and other suboptimal methods like Gauss-Seidel and Jacobi. The effectiveness of these proposed techniques is demonstrated through simulations, which show a notable enhancement in symbol error rate (SER) and a reduction in computational complexity. The results suggest that the OQRD method, in particular, offers substantial improvements over traditional approaches, making it a promising candidate for efficient signal detection in uplink massive MIMO systems.

Yasir A. I. Humad and Levente Dudás introduce a new method for tracking and identifying PocketQube satellites using a resonant radar reflector. Their approach utilizes a minimal power VHF/UHF antenna subsystem on the satellite, which does not emit RF signals but reflects a continuous wave RF signal sent from a ground-based illuminator. The onboard microcontroller switches a PIN diode to create BPSK-modulated reflections detectable by ground stations equipped with correlation receivers familiar with the specific BPSK code. The paper emphasizes the efficiency in terms of low power consumption, reduced weight, and compact size, making this method ideal for PocketQube satellites which adhere to global standardization and technology readiness levels.

In their survey on Advancements in Expressive Speech Synthesis, Shaimaa Alwaisi and Géza Németh provide a detailed analysis of the progression and current trends in expressive text-to-speech (TTS) systems. It highlights the significant growth and acceptance of speech synthesis technology, particularly in enhancing the naturalness and expressiveness of synthetic speech. The paper focuses on novel methodologies, such as style transfer and speaker variability enhancement among others, and discusses both subjective and objective metrics used to evaluate the quality of synthesized speech. A unique aspect of this paper is its emphasis on the under-explored area of child speech synthesis, identifying it as a fertile ground for future research.

Frigyes Viktor Arthur and Tamás Gábor Csapó introduce significant advancements in the field of Brain-Computer Interfaces (BCI). They demonstrate the feasibility of synthesizing speech from intracranial stereotactic electroencephalography (sEEG) recordings using advanced deep neural network models and a neural vocoder. Their research present the application of FC-DNN, 2D-CNN, and 3D-CNN architectures for converting sEEG data into Mel spectrograms, a critical step for achieving accurate speech synthesis. The subsequent use of the WaveGlow neural vocoder marks a novel approach, significantly enhancing the naturalness and quality of the synthesized speech compared to traditional methods like the Griffin-Lim algorithm.

In their paper Taha A. Elwi and his co-authors present a novel approach to noninvasive glucose monitoring using a metamaterial (MTM) based antenna sensor. This sensor, integrating a defected patch antenna with an interdigital capacitor, enhances electric field fringing to penetrate the human skin effectively for glucose detection. Operating optimally at 0.6GHz with impressive S11 impedance matching, the sensor demonstrates high efficiency in detecting blood glucose variations through direct skin contact. Experimental validations show the sensor’s ability to measure glucose levels accurately. This technology promises a low-cost, efficient solution for continuous glucose monitoring, highlighting its potential impact on diabetes management.

The study by Attila Zoltán Jenei, Dávid Sztahó, and István Valálik explores the potential of using multimodal datasets to improve Parkinson’s disease (PD) diagnosis. Focusing on both drawing and acceleration data, the research team applied pre-trained models to extract features from transformed spiral drawing images and visual motion data representations. Although motion data initially showed superior predictive performance, statistical analysis via the Mann-Whitney U test indicated no significant difference in the diagnostic efficacy between the two modalities across various classification scenarios. The study’s main discovery is that combining predictions from both drawing and motion data significantly enhances disease recognition.

This again, is a colorful compilation of recent proceedings.

Pal Varga is the Head of Department of Telecommunications and Media Informatics at the Budapest University of Technology and Economics. His main research interests include communication systems, Cyber-Physical Systems and Industrial Internet of Things, network traffic analysis, end-to-end QoS and SLA issues – for which he is keen to apply hardware acceleration and artificial intelligence, machine learning techniques as well. Besides being a member of HTE, he is a senior member of IEEE, where he is active both in the IEEE ComSoc (Communication Society) and IEEE IES (Industrial Electronics Society) communities. He is Editorial Board member in many journals, and the Editor-in-Chief of the Infocommunications Journal.