IoT and AI Based Smart Event Monitoring Applications- Concepts, Recent Trends, and Future Directions

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Abstract: With recent technological advancements in sensors and high speed processor and high data-rate wireless radios, internet of things (IoT) and artificial intelligence (AI) are widely explored for automatic detection, recognition, localization and prediction of events in major practical applications of health (human, machine and structural) monitoring, environmental (air, water, noise, climate or weather) monitoring, precision agriculture (farm monitoring), industry (machine and robotics) automation, autonomous vehicles (land, aerial, surface and underwater), smart grid, smart city, and smart surveillance and defence security. In order to timely detect abnormality/anomalies and mitigate them, sensed data need to be processed continuously in wearable processors or edge computing devices. Both continuous edge data processing and IoT network based data transmission can lead to higher level of energy consumption, which demands frequent charging or replacement of batteries in long-term event monitoring applications. Recent signal processing techniques and deep learning networks can play major roles in improving accuracy and reliability of event monitoring and control systems but demands higher computational resources because of computationally expensive signal processing technique(s) and larger deep model size with increased computational burden. Exploring a lightweight, low-latency, and low-power DNN architecture is highly demanded for enabling real-time event detection and prediction and also maximizing lifetime of battery-operated IoT sensors and edge AI computing devices. Therefore, improving energy-efficiency of battery-operated automation systems is highly demanded to maximize battery lifetime in long-term, continuous event monitoring and control application scenarios.

This talk presents various energy consumption strategies which can be adopted for energy-constrained wearable computing or edge data analytics systems by exploring intelligent signal processing protocols including signal quality assessment and noise-aware signal denoising, quality-aware data compression and event-triggered IoT communication protocols. Resource-efficient signal processing and deep learning architectures can be developed by exploring analog and digital compressed sensing or imaging techniques. Compressed sensing (CS) is new efficient data acquisition technique with a sub-Nyquist sampling rate that allows perfect recovery of sparse signals from only few random measurements using the sparse recovery algorithm. This talk presents key concepts of analog and digital compressed sensing methods for IoT enabled sensing and control nodes, and design considerations for selecting best sensing matrix which plays major role in reducing hardware complexity of measurement generation architecture and can also enable direct measurement of essential parameters (features) for detecting or predicting events in compressed sensing domain. Different signal analysis and deep learning architectures will be presented with real-time implementation by directly estimating essential parameters from limited CS measurements and for development of lightweight, low-latency, and low-power CS based deep learning architectures for directly performing event detection, classification and prediction from a limited number of CS measurements without original reconstruction.

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