Selected Research Translation Opportunities

ERVA REPORT: STRATEGIC ENGINEERING FOR NEXT-GENERATION WIRELESS COMPETITIVENESS

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The following are research translation opportunities based on the actionable recommendations found in the ERVA report for two areas: **ISAC** and **AI in Wireless Networks**.

1. Integrated Sensing and Communication **(ISAC)**

Integrated Sensing and Communication (ISAC) refers to the integration of communication and sensing systems, allowing for the sharing of data in real-time to optimize both communication efficiency and sensor data processing. Here are some promising research translation opportunities in this field:

Smart Cities and IoT

Smart cities integrate **IoT sensors** for monitoring infrastructure, air quality, energy use, and traffic. Combining sensing and communication can enable more effective management of city systems. ISAC-based solutions may utilize **edge computing** and **distributed sensing** to reduce the reliance on centralized data centers, improving scalability and responsiveness in urban environments.

Health Care and Wearable Devices

Wearable health devices and **remote patient monitoring** systems can benefit from ISAC by sharing real-time health data with medical professionals while using sensors to monitor patients' vitals. Such ISAC-based solutions may incorporate integrated communication systems into health care devices to provide continuous, real-time health monitoring and telemedicine, particularly in **rural or underserved areas**.

Military and Defense

In military operations, integrating sensing and communication can help with situational awareness, improving the accuracy of data collection, and communication across various platforms (e.g., drones, vehicles, soldiers). ISAC will improve **spectrum management** (i.e., sensing) and **communications resilience** (i.e., communication) for **military drones, robotics**, and **unmanned vehicles** for enhanced **surveillance** and **target identification** in challenging environments. Integrated sensing and communication enable more detailed and richer data generation capabilities, including mobility pattern identification and user density information.

Industrial IoT and Automation

In **smart factories** or **industrial IoT**, sensors are used to monitor machinery, energy usage, and production lines, while communication systems manage data flow and remote control. Jointly optimizing **sensor networks** and **communication systems** in industrial settings can enhance **predictive maintenance**, reduce downtime, and increase efficiency.

Autonomous Vehicles

Autonomous vehicles rely heavily on **sensor data** (e.g., LiDAR, radar, and camera feeds) and communication systems (e.g., V2X—Vehicle to Everything). ISAC can improve data sharing and processing, enhancing safety, navigation, and real-time decision-making. **Intelligent communication networks** are an example application for **autonomous transportation systems** that efficiently share sensor data across vehicles, traffic management systems, and other infrastructure.

Environmental Monitoring and Disaster Management

Environmental sensors (e.g., for air quality, water levels, and seismic activity) can communicate in real-time with disaster response systems to provide timely information for action. ISAC-based **real-time environmental data sharing** will improve response times during natural disasters, such as earthquakes, hurricanes, or wildfires.

Smart Agriculture

In **precision agriculture**, sensors can monitor soil moisture, crop health, and weather conditions, while communication systems relay this data to farmers for decision-making. **Smart agricultural networks** that integrate sensors and communication infrastructure will significantly improve **crop management** and **resource allocation**.

2. AI in Wireless Networks

AI is playing an increasingly crucial role in enhancing wireless networks by offering a few promising areas, such as optimization, filling missing information, and network automation. Research translation opportunities in these areas span a variety of applications that can significantly impact both commercial and operational aspects of wireless networks, particularly in 5G/6G and future networking technologies.

A few promising opportunities include:

AI for Filling Missing Information in Wireless Networks

Wireless networks often suffer from missing or incomplete information due to packet loss, signal degradation, interference, or network congestion. AI can help fill in these gaps by using machine learning techniques to predict missing data or reconstruct lost packets. A few example applications include:

- Channel upsampling
- Digital twins: Channel modeling

AI for Optimization in Wireless Networks

Optimization is crucial in wireless networks to improve performance, reduce energy consumption, and ensure efficient resource management. AI can help optimize various aspects of network performance, such as spectrum management, traffic flow, resource allocation, and interference mitigation. A few example applications include:

- Physical layer: Channel prediction/estimation
- MAC layer: MU scheduling and link adaptation
- Power saving

AI for Network Automation

Network automation powered by AI enables networks to automatically configure, manage, and maintain themselves. This significantly reduces operational costs, improves scalability, and enables dynamic optimization in response to changing conditions. A few example applications include:

- Network analytics
- Network parameter optimization.

Download the full ERVA report, 'Strategic Engineering for Next-Generation Wireless Competitiveness,' and see all the engineering research priorities at ervacommunity.org.

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