Tutorial: On-Sensor Machine Learning with ST Toolchains

Abstract:

To enable artificial intelligence for time-critical and remote applications, tiny machine learning (tinyML) provides hardware and software paradigms that enable always-on, real-time, low-cost, and ultra-low-power inference at the extreme edge. To achieve even lower power envelope, lower latency, and smaller footprint, sensor manufacturers now integrate custom processing cores directly within the sensor die, eliminating the need for general-purpose processors for data analytics. These integrated processing units provide instructions for on-chip sensor fusion, signal conditioning, and running ML models. This tutorial provides an introduction to tools from STMicroelectronics that provides a no-code pathway to train and deploy ML models within the sensor die. The tutorial focuses on introducing ST's machine learning core (MLC) embedded in programmable iNemo inertial measurement units that can run decision trees on-chip. The tutorial covers data collection, filter and feature selection, model optimization, and pathways to port the trained decision tree on the AI-enabled inertial sensor. Example applications are illustrated and a live demo is showcased. The tutorial will enable participants learn the mechanics of tinyML for the next generation of smart sensors for consumer, automotive, and industrial applications.

Items required: If participants wish to follow the live demo, then the following items are required:

1. A Windows computer with Unico-GUI (https://www.st.com/en/development-tools/unico-gui.html) and Weka installed (https://www.cs.waikato.ac.nz/ml/weka/).
2. Professional MEMS Tool (https://www.st.com/en/evaluation-tools/steval-mki109v3.html).
3. LSM6DSOX adapter board (https://www.st.com/en/evaluation-tools/steval-mki197v1.html).
4. A micro-USB cable.

Speaker Biography:

Mahesh Chowdhary, Ph.D. is a fellow and senior director of MEMS software solutions at STMicroelectronics based in Santa Clara, CA, USA. He leads effort on development of solutions and reference designs for mobile phones, consumer electronic devices, automotive and industrial applications that utilize MEMS products, computing and connectivity products. His area of expertise includes AI/ML, MEMS sensors, IoT, digital transformation, and location technologies. He has been awarded 34 patents. Mahesh received Ph.D. in Applied Science (particle accelerators) from the College of William & Mary in Virginia.

Swapnil Sayan Saha, Ph.D. is an algorithm development engineer at STMicroelectronics based in Santa Clara, CA, USA. He received his Ph.D. and M.S. in Electrical and Computer Engineering from the University of California, Los Angeles in 2023 and 2021 respectively, and B.Sc. in Electrical and Electronics Engineering from the University of Dhaka in 2019. He explores the creation of deployable, physics-aware, uncertainty-injected, learning-enabled, and resource-constrained embedded systems. To date, he has published more than 25 peer-reviewed articles and received more than 30 awards in robotics, technical, and business-case competitions worldwide.