Developing Ultra-Lite ML Models for Crash Detection in Noisy Environments

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This project focuses on developing a novel machine-learning (ML) solution on edge-devices, operating in high-noise environments, to detect major faults and events (such as crashes). Every year, tens of thousands of people are subject to bicycle crashes that result from factors like motor-vehicle accidents or poor conditions. A more reliable and on-site anomaly detection will allow for quicker response times in emergencies, helping reduce long-term injuries. Currently, statistical analysis models (with sensor fusion algorithms) are being used, but they struggle to detect such anomalies in high-noise environments, because they do not generalize well to new data, leading to false alarms. The underlining research question is if an ultra-lite ML model can be developed to detect bicycle crashes better than statistical analysis models in these high noise environments. As a solution, an edge device (mounted on a bicycle frame) was developed that deploys a ML model to better detect crashes, then notify an emergency contact. A bicycle crash simulation methodology was developed, utilizing bicycle self-stabilizing properties, to get the data for training. The simple and cost-efficient crash-simulation methodology devised is shown to be rather effective, circumventing the project's cost limitations and other safety-related limitations. The prototype consists of a Particle Boron LTE microcontroller, an accelerometer, and a GPS. A separate device was also developed to do the data collection and data storage via an SD Card. An ultra-lite ML (<10 KB) was trained, tested, and developed iteratively (in a trial-and-error process), tuning the ML hyper-parameters, data augmentation, etc. In a comparison with two statistical analysis models, the ML model had a 130% improvement in accuracy.