Project Title: Real-World Data Collection and Sensor Validation for Machine Health Monitoring
Faculty Supervisor: Michael Heilemann

Description: Prof. Heilemann is developing a small (1 cubic inch), power-efficient, sensor package to detect and diagnose faults in mechanical equipment. The sensor package consists of a sensing element to detect vibration data, a microcontroller to analyze the data and determine the operating state of the machine, and an analog front-end to interface between the sensing element and the microcontroller. The device operates in two different states: (1) data collection, where vibration data is recorded by the sensor and saved to a micro-SD card for analysis and labeling, and (2) data monitoring, where the microcontroller employs real-time inferencing with an embedded neural network to detect and diagnose the operating state of the machine (healthy or faulty).

The accuracy of the sensor package has been evaluated using both synthesized data, and real data collected by a different sensing module. The research assistant will work on the following tasks:

1) Field Testing: A mechanical test bench is currently in development that will allow a user to introduce several faults into a mechanical system (bearings, loading, decoupling, etc.) and return the system to its healthy state. The student will use this test bench to collect data for an array of faults, train a neural network to classify the faults, deploy the network on the microcontroller, and validate the accuracy of the sensor package in real-time when deployed on the test bench.

2) Quality Assurance Testing: The performance of the sensor package should not change on a unit-to-unit basis. The student will repeat the experiments described in the previous section using multiple sensor packages and verify that the data collected by one sensor package is not unique to the specific sensor on which it was recorded.

Skills:

Required:

- AME 272 and AME 233, or equivalent courses in signal processing and acoustics
- ECE 114 or equivalent coursework in C/C++ programming

Recommended

- Knowledge of, and experience with mechanical systems (motors, gears, pumps, etc.)
- Microcontroller programming
- Machine learning