Phenomenology and node-level processing of MASINT sensor data across distributed sensor networks STL-016-19, Year 3 of 3

E. Kirk Miller

Jeremy Brookley, Howard Wong, Alex Berlanga, Harry McHugh, Ljube Boskic, Carmelo Gonzales, Kevin Lee, Jonathon Rivera, John Wesolowski, Les Drake, Tony Botello, Roger Bernal, Eliseo Pizano

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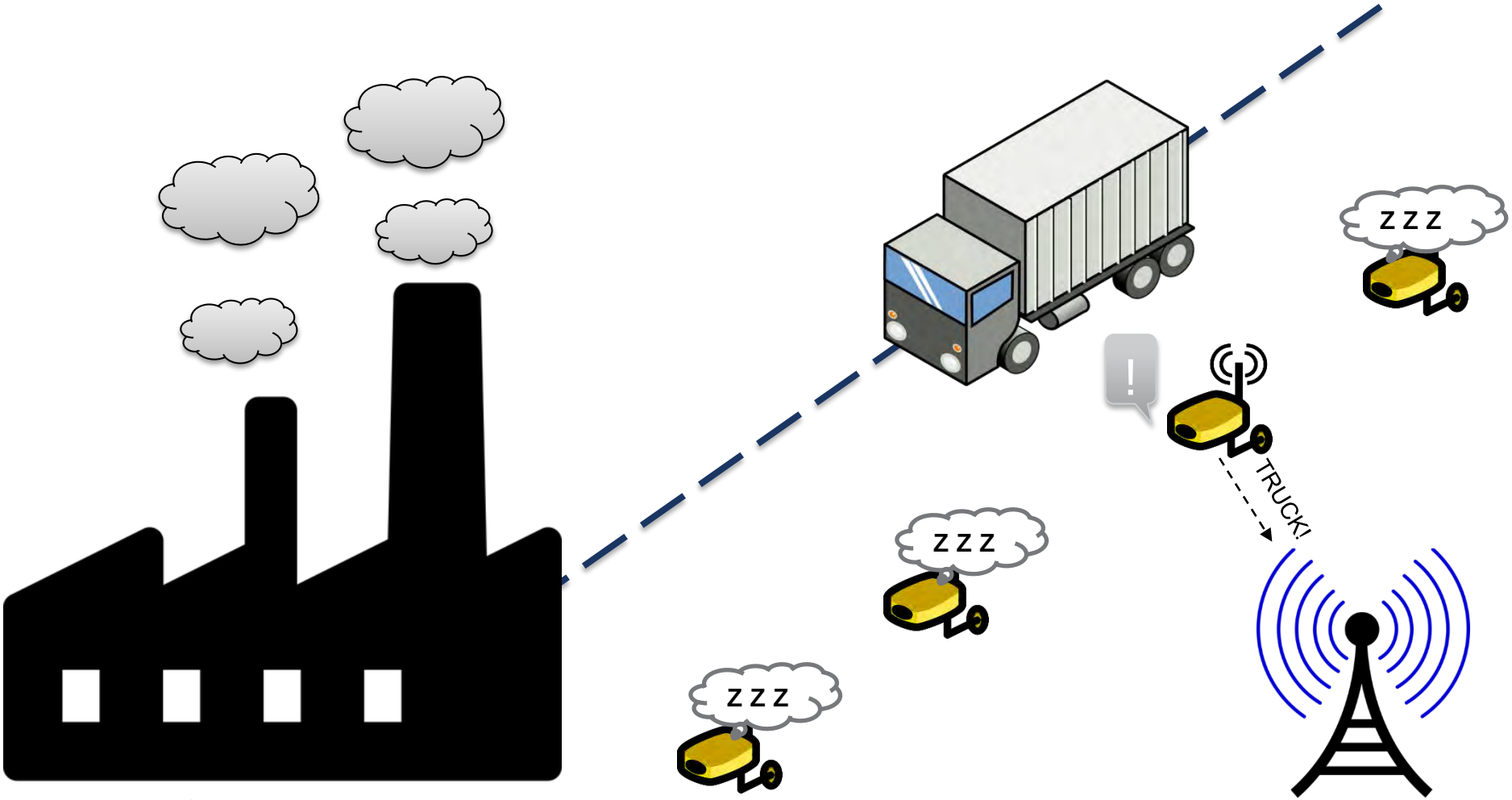
Challenge



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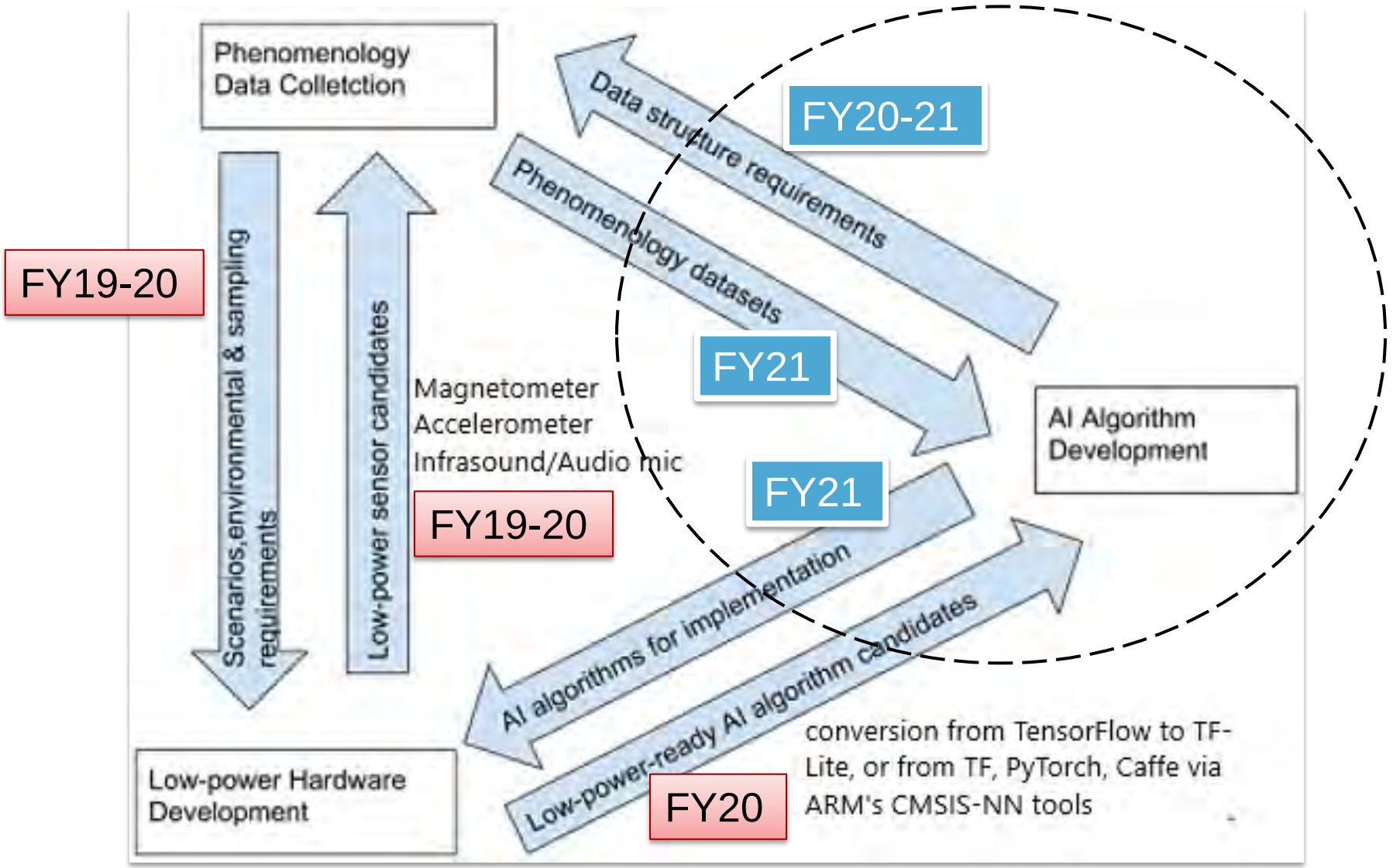
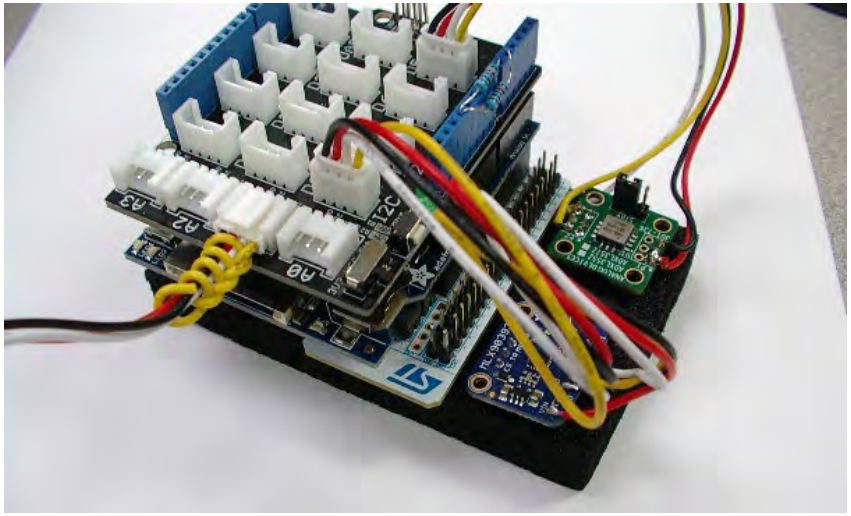
Progress over three-year project



Innovation

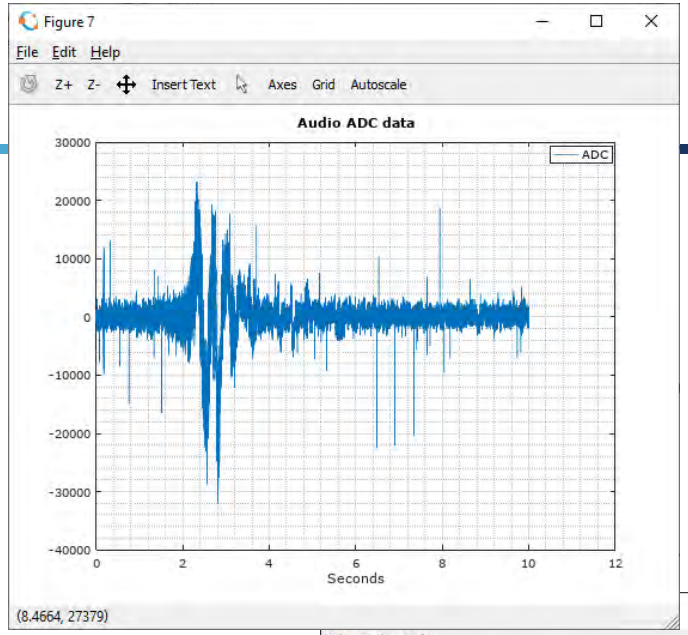
- Edge-based sensor approach
  - Allows each node to collect data and make classifications
  - Multiple nodes allow for better vehicle tracking
  - Microphone, magnetometer, accelerometer

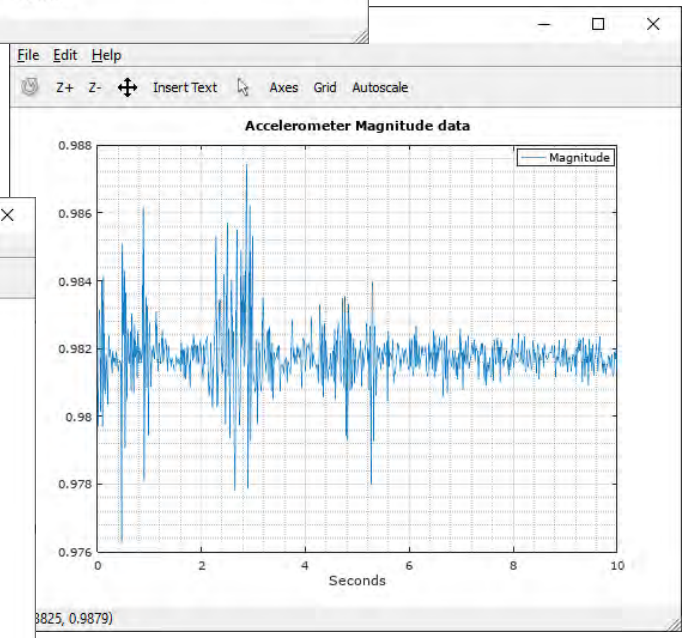
- Machine learning in microcontroller
  - Implementing Tensorflow Lite model on microcontroller
  - Microcontroller is able to make decisions based on patterns and not just data

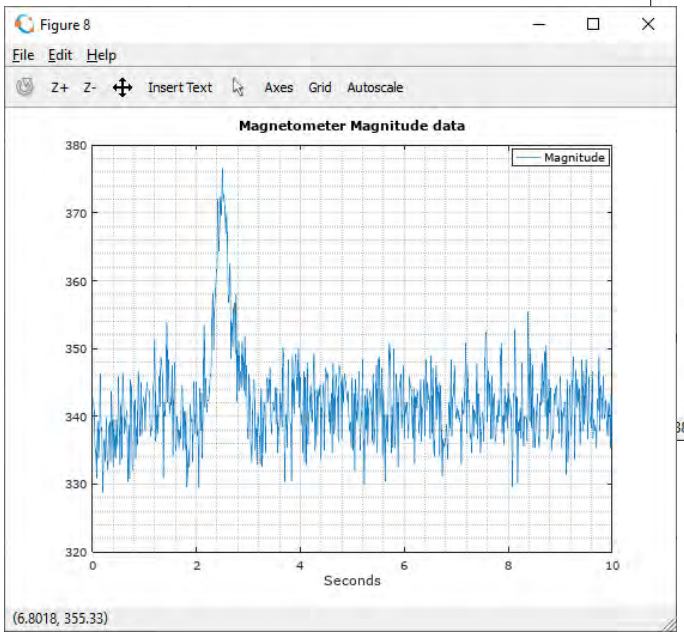


Technical Approach

- Designed hardware platform
  - Microphone/ADC
  - Accelerometer
  - Magnetometer
  - GPS
  - SD Card
- Data collected
  - Car
  - Van
  - SUV
  - Flatbed

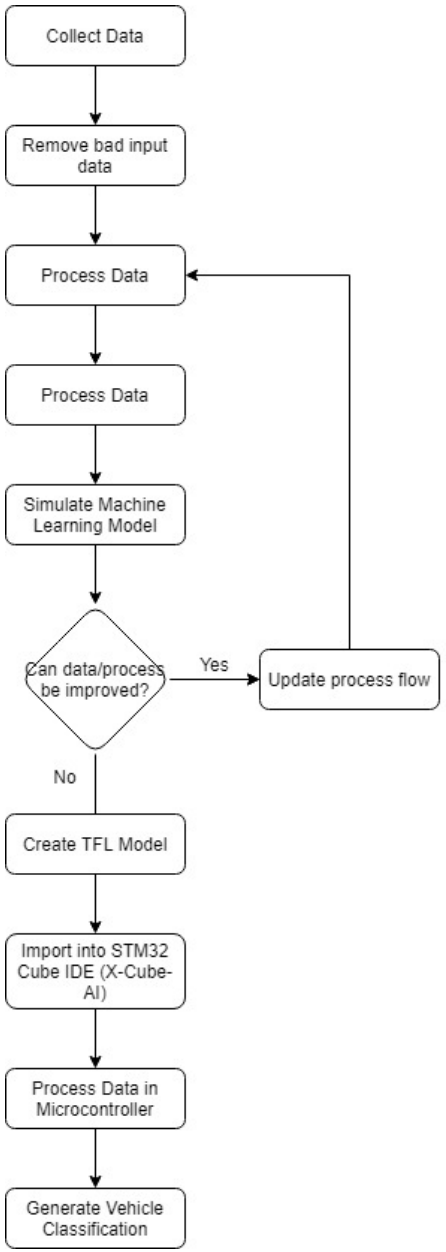




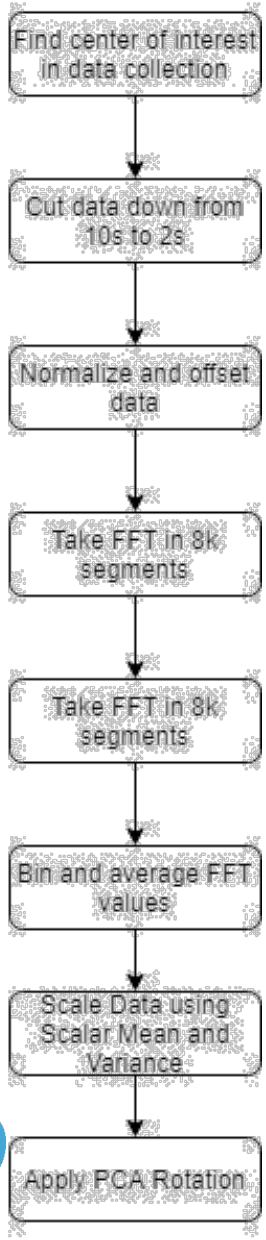


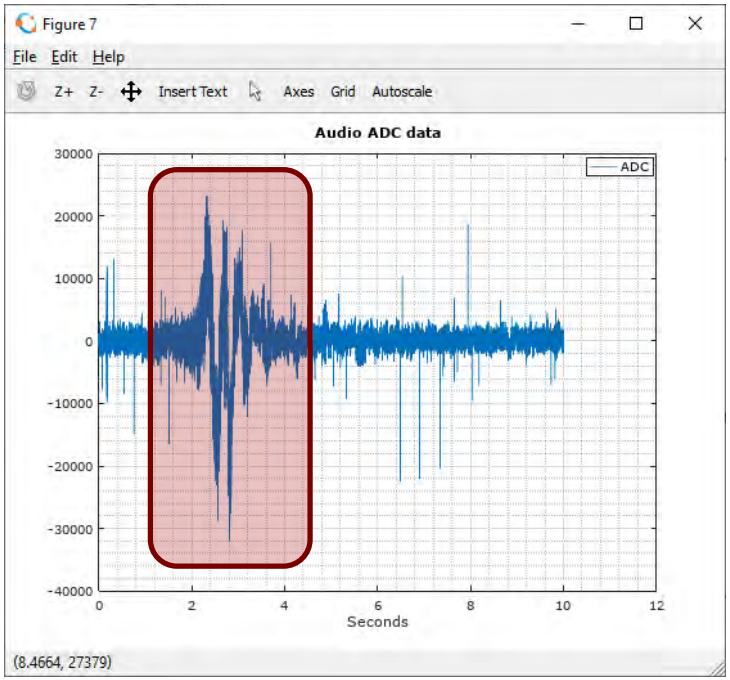
Technical Approach – Data Collection

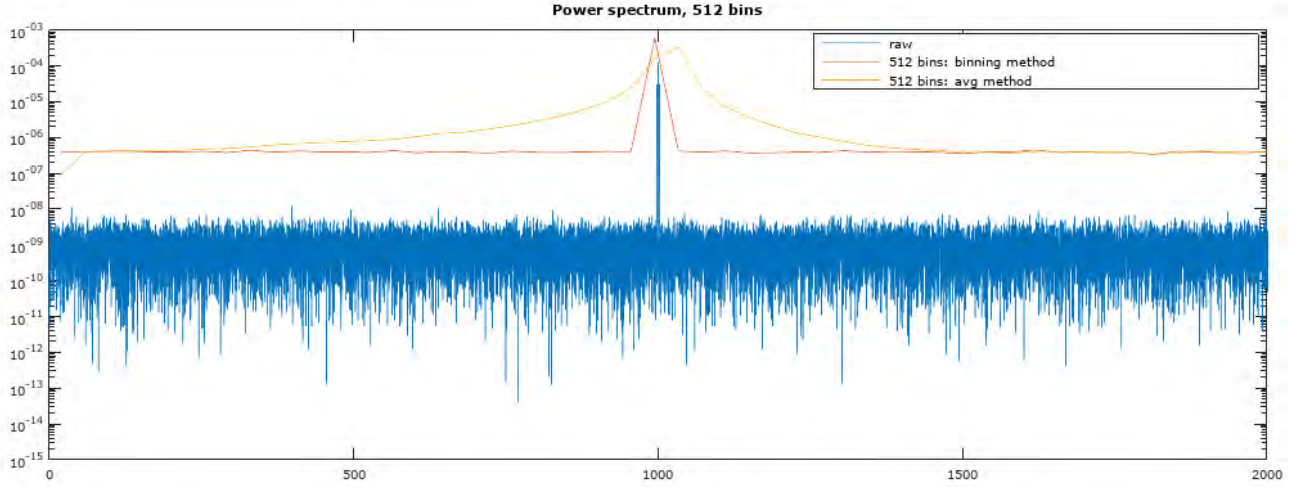
- Condition data
  - Remove bad input data
  - Process data
    - Reduce data size from 10s to 2s
    - Condition data to create usable ML model data
  - Generate and test ML model
  - Optimize data and model
    - Limited resources on microcontroller
      - RAM
      - Flash
    - Need to process data resource efficiently
  - Generate vehicle classification



Technical Approach – Data Processing

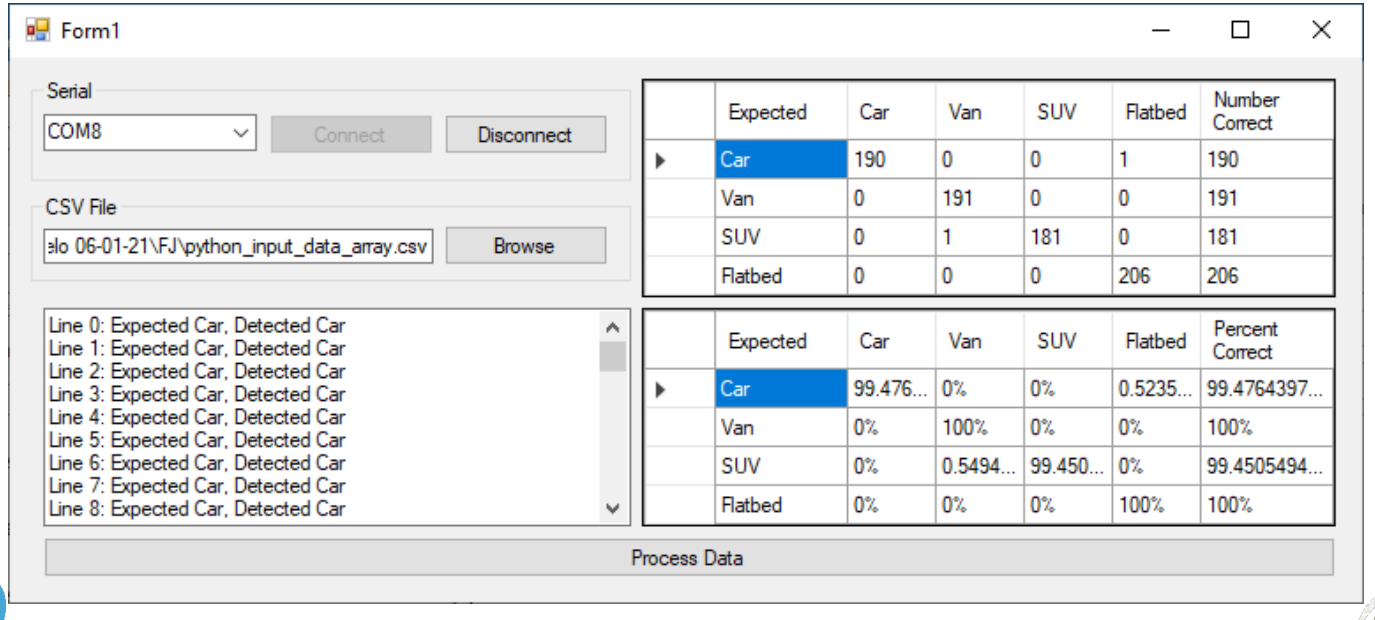






Results

- Model simulated in Tensorflow
- Data optimized and processed in Octave
- PCA output array fed into microcontroller model using custom vehicle simulation tool
  - Sends generated PCA arrays to microcontroller to determine vehicle classification
  - Classification data sent back to tool from micro for accuracy calculations



	Expected	Car	Van	SUV	Flatbed	Number Correct
▶	Car	190	0	0	1	190
	Van	0	191	0	0	191
	SUV	0	1	181	0	181
	Flatbed	0	0	0	206	206

	Expected	Car	Van	SUV	Flatbed	Percent Correct
▶	Car	99.476...	0%	0%	0.5235...	99.4764397...
	Van	0%	100%	0%	0%	100%
	SUV	0%	0.5494...	99.450...	0%	99.4505494...
	Flatbed	0%	0%	0%	100%	100%

Summary of Results, Path Forward

- Proven microcontroller capability
  - Collect data
  - Process data
  - Infer vehicle classification
  - Accuracy with current vehicle data very accurate (99%+)

- Additional goals
  - Complete data processing on microcontroller
  - Implement additional sensors in vehicle classification
    - Currently, primarily focused on audio data

Impact

- Follow-on project 21-BRASSBOARD, with IC partner
- Engagement with DNN projects:
  - MINOS, Persistent DyNAMICS, ADAPD – MERLYN sensors
  - AP3LS
- Emerging and special opportunities addressed:
  - SNM movement
  - Data analytics
- Gaps addressed:
  - Data science
  - Proliferation detection
  - Rapid threat analysis
  - Data-driven analytics solution architectures
- Mentorship:
  - 2 summer interns mentored by senior staff over three-year project
  - 2 former summer interns hired on full-time to work on project