Program an On-Board Sound Intensity Data Acquisition System

Description of the technical problem

Volpe needs a computerized method to perform On-Board Sound Intensity (OBSI) measurements, using the LabVIEW development environment and existing NI hardware. OBSI is a measure of energy generated at the tire/pavement interface, which is a significant source of highway noise that can disturb communities and wildlife at substantial distances from the roadway. Demand for OBSI data acquisition is increasing as these data are used to evaluate new technologies rapidly transforming the vehicle fleet such as electric passenger cars, trucks, and buses.

Figure 1 depicts the hardware used for this measurement, consisting of two intensity probes mounted on the wheel according to the standard test method.[1] The cables routed from the hardware through the window shown in Figure 1 feed into the data acquisition system running on a laptop inside the car, such that data can be collected while the car is moving. Volpe currently uses obsolete and cumbersome software to obtain OBSI data and is in need of a modern and more user-friendly replacement.

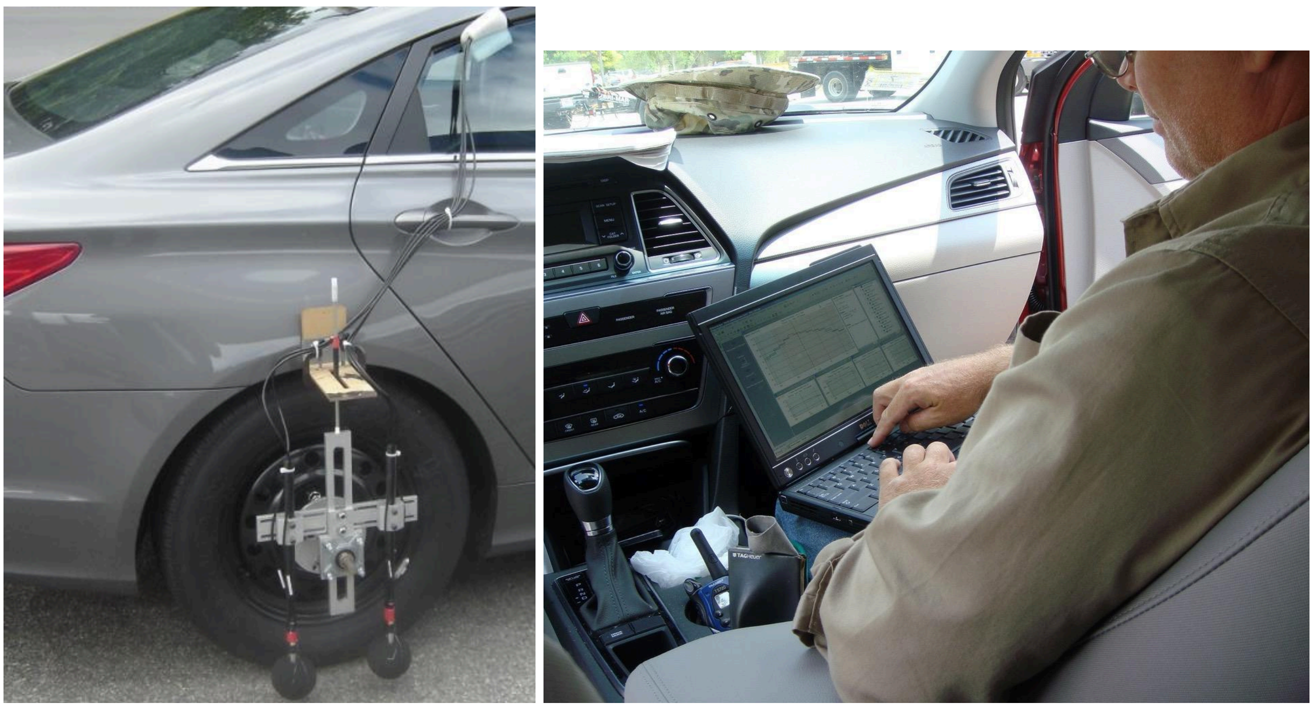

Figure 1. Example of OBSI probes mounted on a passenger car (left) and example of existing OBSI data acquisition software in use (right) (VOLPE CENTER)

Expected deliverables at the end of the course

A LabVIEW 2017-compatible program with a graphical user interface to collect sound pressure level data at four microphones simultaneously, subsequently compute sound intensity levels for two acoustic intensity probes (paired microphones shown in Figure 1 (left)), and combine computed intensity levels into overall values.

1. The software should include as many of the following functional steps as time allows, in order of highest to lowest priority:

[1] AASHTO TP76-10

1.1. Calibrate all four microphones via user-editable sensitivity parameter for each microphone that defaults to nominal factory sensitivity (precision of one tenth mV/Pa)
1.2. Manually trigger each measurement trial for a user-specified duration, ranging from 3 to 60 seconds (precision of one tenth second)
   1.2.1. Collect sound pressure level data in one-third octave-bands from 250 to 5000 Hz (precision of one tenth decibel)
   1.2.2. Collect coherence data between microphones in each pair in one-third octave-bands from 250 to 5000 Hz (unitless precision of one tenth; LabVIEW guidance on coherence here)
1.3. Use acquired data from step 1.2.1 to calculate sound intensity level for each intensity probe (example code here); computed data for each trial should include:
   1.3.1. Sound intensity level in one-third octave-bands from 250 to 5000 Hz (precision of one tenth decibel)
   1.3.2. Logarithmic sum of all one-third octave-bands in step 1.3.1 (precision of one tenth decibel)
1.4. Combine the computed intensity levels for each probe into overall values:
   1.4.1. Logarithmic average of each one-third octave-band in step 1.3.1 (precision of one tenth decibel)
   1.4.2. Logarithmic sum of all one-third octave-bands in step 1.4.1 (precision of one tenth decibel)
1.5. Save measured and computed data in steps 1.2 through 1.4 for dozens of measurement trials
1.6. Export data from step 1.5 to human readable format (CSV preferred); file should be named by date and time

Contact information for the project client

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Items or budget to be supplied by client (if any)

Volpe will supply transducers and all associated hardware, calibrator, cables, data acquisition unit, and batteries. Volpe time and budget will also be required to test and validate LabVIEW programs. Time permitting, it may be possible to collaborate for an on-vehicle demonstration. Note that the student(s) would be required to have their own LabVIEW license(s).

Intellectual property issues (if any)

N/A