Vehicle pass-by noise prediction and sound synthesis

VAMPPASS is a modeling tool providing simulations and predictions of road and railway vehicles’ pass-by exterior noise. The model is based on a representation of the vehicle as a repartition of equivalent acoustic point sources. The software is designed to produce high quality sound samples and precise level predictions at a rather low computation cost. It is designed to help in predicting and hearing the effects of noise sources modifications and noise barriers integration.

This software is named VAMPPASS, an acronym for Vehicle Acoustics Modeling for Prediction of Passby and Audio Sound Synthesis. It is born from a partnership in the European project SILENCE between mainly SNCF and LMA-CNRS.

### Applications
- Pass-by noise level prediction
- Prediction of the effect of a source modification
- Noise barrier assessment (straight and Y-shaped)
- Noise synthesis for 3D sound playback

### Key technologies
#### Fast computations
For given pass-by scenario and vehicle, algorithms are optimized so that computation time of sound samples and levels indicators is of same order than the length of the final sound sample.

#### Precise predictions
A vehicle is modeled as a set of point sources, given their position, spectral properties and radiation patterns. Doppler effect and ground effect are taken into account, leading to accurate sound pressure level predictions at a receiver point.

#### 3D Sound synthesis
The sound produced by the software is provided either in mono or in B-format samples, allowing reproducing in various loudspeaker configurations.

### VAMPPASS features
- Prediction and simulation of the sound pressure level emitted at a vehicle passby, both in level and hearing
- Wide variety of supported vehicles (car, truck, tram, train, motorcycle, …)
- User-controlled operating conditions (changes in speed of the vehicle, noise sources evolving during passby, noise source modifications effects)
- A vehicle is built as a set of several acoustic point sources
  - VAMPPASS provides:
    - sound pressure level
    - multi-channel sound sample (B-format, i.e. spherical harmonics of order 1)
    - third octave spectra
    - standard indicators: $L_{Aeq,Tp}$, $SEL$, $TEL$, $L_{A,max}$, $dB(SPL)$, $dB(A)$
    - temporal signature (dBA vs. time)
    - Possibility to set two different grounds and to integrate a noise barrier
    - Possibility to set two receiver positions
    - Possibility of source ranking computation and analysis
    - Each source can be controlled separately
    - An additional B-format samples player is supplied to reproduce sounds in various loudspeaker configurations
    - Open noise source data set: VAMPPASS is able to use your own models of acoustic sources
VAMPPASS overview

VAMPPASS software is installed on a standard Windows PC. Every data is loaded at the start-up from a project configuration, or built ex nihilo and saved into a new project. VAMPPASS computes and generates vehicle passby sounds and data according to the user configurations, and provides figures and indicators. Every data and samples may then be exported into WAV or ASCII files.

Figure 1: acoustic source characteristics settings

Figure 2: vehicle design as a combination of equivalent acoustic point sources positioned in space

Figure 3: ground and noise barrier settings

Figure 4: VAMPPASS outputs from source ranking

Synthesis data

VAMPPASS is delivered with one train sources data set.

Scenario:
- evolution of the speed of the vehicle in time Vehicle: (Figure 2)
- a vehicle is a set of acoustic point sources, given their acoustical characteristics, behavior and positions

Source types and behaviors (Figure 1):
- stationary
  - constant within speed intervals
  - evolving with speed
  - following a law of evolution with speed

Source characteristics: (Figure 1)
- broadband component (third octave levels in dB SPL at 1m)
- monofrequency components: level and frequency
- radiation pattern: monopole, dipole or more detailed patterns (spherical harmonics projections)
Spatial settings (Figure 3):
  • two grounds may be configured, with three different choices of modeling
  • noise barrier: straight with inclination angle, or Y-shaped vertical screen

Output: (Figure 4)
  • sound pressure level in time at receiver position
  • sound sample (mono or multi-channel)
  • standard analysis indicators

If needed, GENESIS can help in modeling or measuring sound sources characteristics.

Product information
VAMPPASS is a standalone application (.exe) that runs under Windows 2000, XP and Vista.
VAMPPASS requires at least 1 GB of RAM memory.

About GENESIS company
GENESIS is a high-technology company whose core business is high-performance 3D audio simulators and sound quality tools & expertise.

GENESIS real-time audio simulators are used for industrial or military applications that require a realistic and interactive soundscape, with an accurate sound reproduction. Examples include:
  • Training simulators: helicopter flight simulators, car simulators, training facilities for sonar operators, etc.
  • Simulators for research and study purposes: car simulators for multisensory analysis tests, virtual aircraft cockpit to study ergonomics, train coach simulation tool for studying passenger sound comfort, etc.
  • Virtual reality platforms.

The GENESIS’ know-how is based on more than 10 years’ experience with major simulators built for Industry and Defense: RENAULT, PSA, DCNS, AIRBUS, EUROCOPTER, SNCF, etc.

Credits
SILENCE European project: http://www.silence-ip.org
SNCF, Direction de l’Innovation et de la Recherche: http://recherche.sncf.com/
LMA, research laboratory of CNRS: http://www.lma.cnrs-mrs.fr/ FIST: http://www.fist.fr/