Automotive Simulation using WIPL-D Pro CAD

This article demonstrates the application of WIPL-D Pro to the simulation of electrically large automotive structures. WIPL-D is ideal for such applications for two reasons:

- The geometry can be easily imported from different CAD formats, and edited using the powerful user interface,
- Due to higher order polynomial basis functions, large structures are simulated very quickly.

The model used here was made manually, instead of being imported from some CAD file. We have simulated placement of two antennas at two different frequencies:

- Microstrip patch antenna at 2.5GHz (could be used as GPS antenna),
- Monopole antenna at 900MHz (GSM antenna).

Both antennas are mounted on the roof of the car. Because of symmetry of the model we have used one symmetry plane. Real ground is modeled as PEC. Results of our interest are radiation pattern and near field inside the car.

WIPL-D Modeling

The first step is modeling of the structure in WIPL-D Pro. In the example that is shown in this paper, we used WIPL-D Pro 3D modeler (based on using parameterized objects, quad plates and wires as building blocks). As a result, obtained mesh is an optimum one and minimizes memory usage and simulation time.

Model of the car is shown in Fig 1. One symmetry plane and PEC plane are used, so only one half of the car is modeled.

Model of the patch antenna that is added to the model of the car is shown in Fig 2. As we can see, it is a circular patch coupling-fed by a microstrip line.

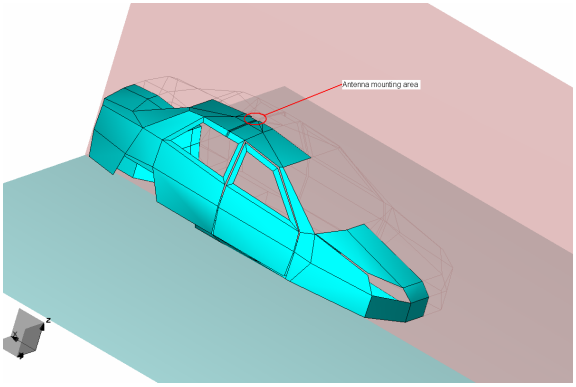

Figure1. Model of the car.

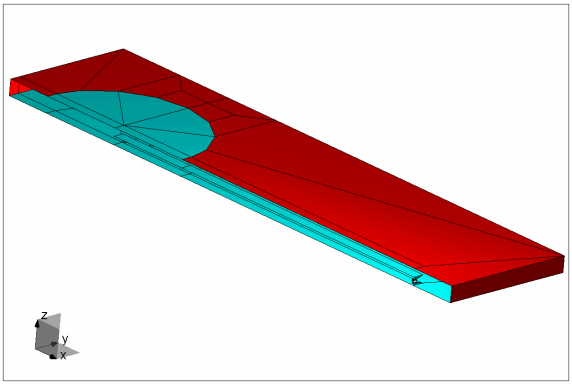

Figure 2. Patch antenna.

Antenna mounting areas for two cases (monopole antenna and patch antenna) are shown in Figs 3 and 4.

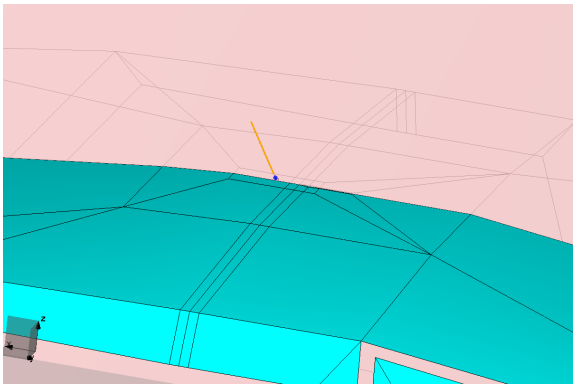

Figure 3. Monopole antenna on car roof.

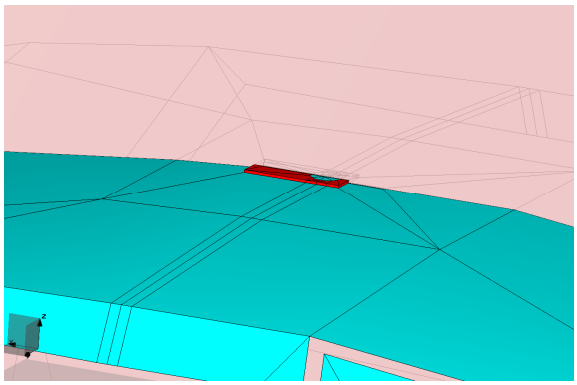

Figure 4. Microstrip patch antenna on car roof.

Simulation Results

Operation frequency is 900MHz for the model with monopole antenna, and 2.5GHz for the model with patch antenna. Direct incore solver is used for the model with monopole, and for model with patch antenna we have used the out-of-core solver.

Computer used for these simulations is Intel(R) Core(TM)2 Quad CPU, 2.67 GHz , 4 GB of RAM.

Number of unknowns, memory requirements, and simulation time of analysis are given in Tab. 1.

Table 1. Analysis characteristics

Model (Antenna)	No. of unknowns	Memory used [GB]	Simulation Time [min]
Monopole	5556	0.242	1
Patch	42171	3.5 GB (42.3 GB hard disk space)	101

Radiation patterns of monopole and patch antenna on car roof are shown in Figs 5 and 6. The second parameter of interest is near field inside the car and in the surrounding area. Near field is calculated in the symmetry plane (Figs 7 and 8). Although near fields are low inside the car in both cases, they are lower when patch is used due to main-lobe orientation.

Conclusion

Based on presented, the simulation time is relatively short, and we haven't used adaptive order reduction in these examples, which is a powerful technique that could further speed-up simulation and eliminate the need for the out-of-core solver. So, we can conclude that WIPL-D software can be efficiently used for simulation of electrically large automotive structures.

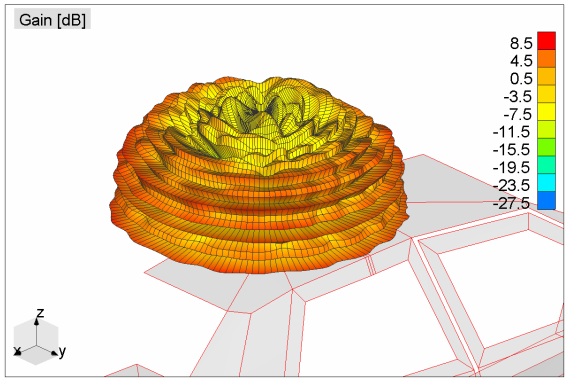

Figure 5. Radiation pattern of monopole antenna.

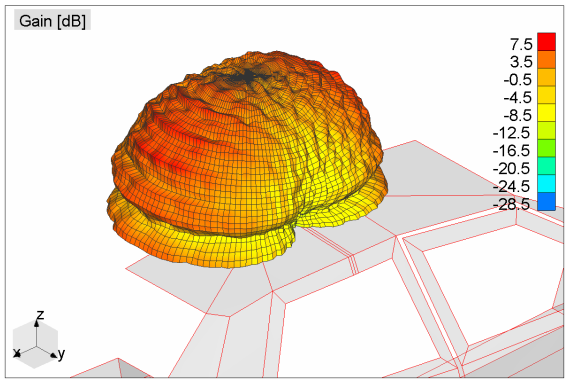

Figure 6. Radiation pattern of patch antenna.

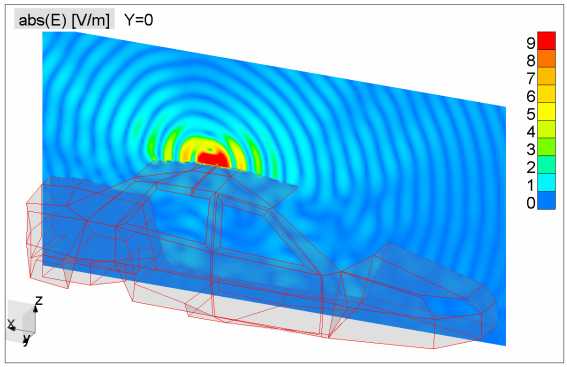

Figure 7. Near field for monopole antenna.

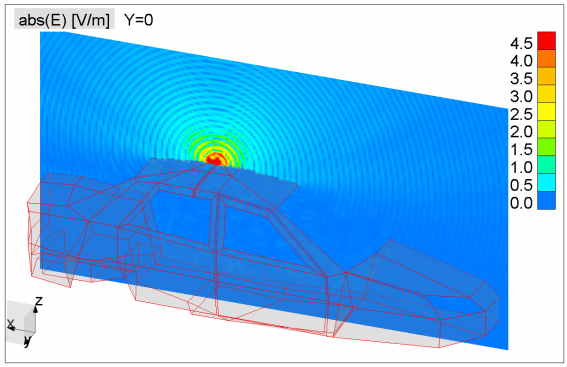

Figure 8. Near field for patch antenna