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M.A.S.-M.O.M. HYBRID METHOD WITH WIRE'S IMAGE USING IN EXCITATION PROBLEMS

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Abstract. The Method of Auxiliary Sources (MAS) with Method of Moments (MoM) is applied to solve excitation problem, where the wire with voltage source excitation is connected to the open metallic surface. For verification of proposed algorithm experimental structure was built and measured. Computer modeling results and experimental results are in good agreement. Some aspects and principles are described, which provide hybridization of MAS and the MoM. Image of objects is effectively applied for solution of particular problem.

1. Introduction

An important class of problems is the interaction antenna with cavity of semi-open metallic structure. When antenna is placed in a working environment, it may change its performance due to the interactions with the surroundings. This is especially true in automotive applications, because of the strong resonant properties of the objects. Therefore, it is important to consider the interaction of an antenna with possible resonating parts, and to solve these complex electrodynamics problems, together.

The development of methods for modeling and studying the problems of Electromagnetic Compatibility (EMC), for estimation, prevention and reduction of electromagnetic interaction in complex structures as open metal surfaces and wire communication has practical value. That allows modeling of system-level electromagnetic interference effects, with applications to automotive electronics, interference compatibility assessment of computer and communication devices, etc. All this makes simple to find out appropriate, best matched positions for EM devices.

2. Approach

The key idea of MAS is to present the unknown scattered field by a superposition of fundamental solutions of appropriate wave equation - Auxiliary Sources (AS), whose radiating centers are located on some auxiliary surface and shifted outside the area, where the field is to be determined [1-3]. In case of semi-open objects constructed by thin metallic surface with cavities, the imaginary surfaces covering the apertures are presented in the investigated object. They are introduced to represent the separated domains that are applicable for MAS algorithm [3].

The MAS allows solving complex problems, and also easy calculation of the near field, which helps to follow to antenna energy flow. The numerical calculation of near field distribution inside vehicles would predict electro-magnetic compatibility problem and interaction antenna with cavity phenomena. In order to perform this precise simulation, complex system is needed.

Usually in MAS, auxiliary sources are fundamental solutions of wave equation. In three-dimensional case, the finding of an effective auxiliary surface for complicated shapes is often impossible. Contribution of electric charges dominates in electrical field of Hertz's dipole. Describing of continuous current's field becomes complicated. In this case, the increase in density of auxiliary sources, which reduces efficiency of the MAS is necessary.

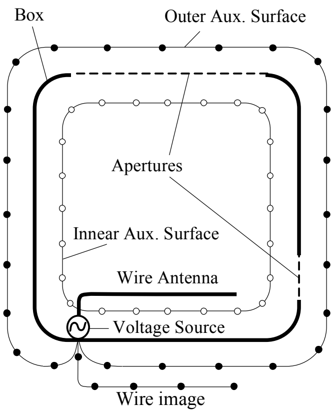

Fig 1. The model of the box with openings

This problem has solution, by replacing dipoles of Hertz with auxiliary current, which is continuous on auxiliary surface. Easiest and effective way of the representing of current on auxiliary surface is network, where segments of network are elements of current and corresponding charges are concentrated in junctions [4]. This distribution provides continuous current on auxiliary surface and satisfaction of Kirchhoff rule. Same time this approach of auxiliary sources is effective from points of view of convergence and calculation time. This allows more easy hybridization with Method of Moments, junction of real and auxiliary currents.

Wire antenna is modeled by MoM. Square basis function decomposition is used in modeling the wire antenna, and similar decomposition on the auxiliary surfaces. Wires are used as the auxiliary sources, and they are connected to a wire network on the auxiliary surface. Therefore, all the auxiliary currents are continuous.

As the wire antenna is attached to the inner surface of the enclosure, to make the continuity of current flowing from the antenna to the box body, the auxiliary surface is shifted smoothly and finally connected to the physical surface of the box at the joint point as shown in Fig. 1.

3. Results

The test structure is a box with one large opening and one small opening, as shown in Fig. 2(a). The box is made of square copper sheets (27.9cm×27.9cm). The large opening has dimensions of 24.3cm×24.3cm, and the small opening is 3.1cm×20.1cm. A wire with open end is used as an antenna for excitation. The wire is 21cm long, and 5cm away from the body of the box, with radius of 1.1 mm. It is located inside the box opposite to the large aperture, and is excited with a coaxial port, shown in Fig. 2. The Structure was built at the University of the Missouri-Rolla. The S11 was measured using an HP 8753 network analyzer with a frequency range from 100 MHz to 2 GHz. The box was modeled

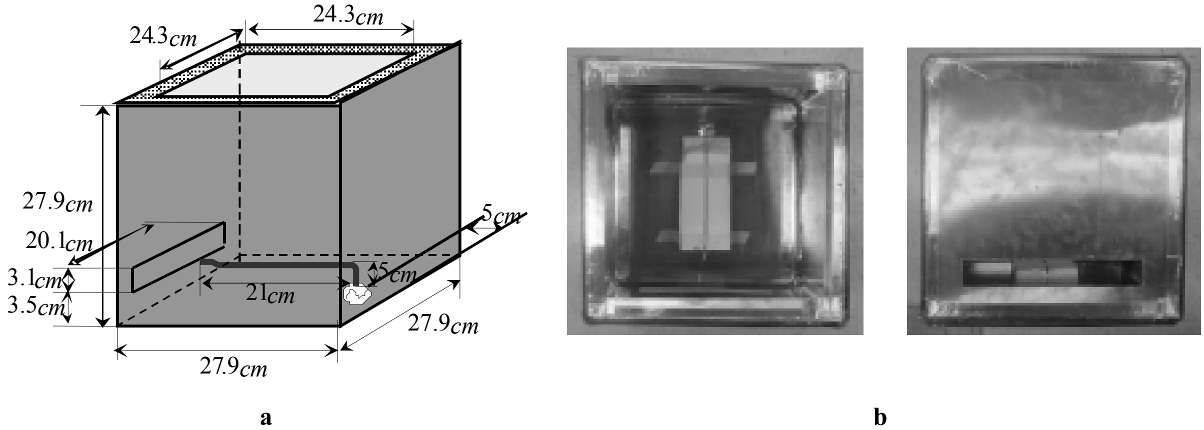

Fig 2. (a) Geometry data of wire and semi-open box; (b) Experimental model of the semi-open box

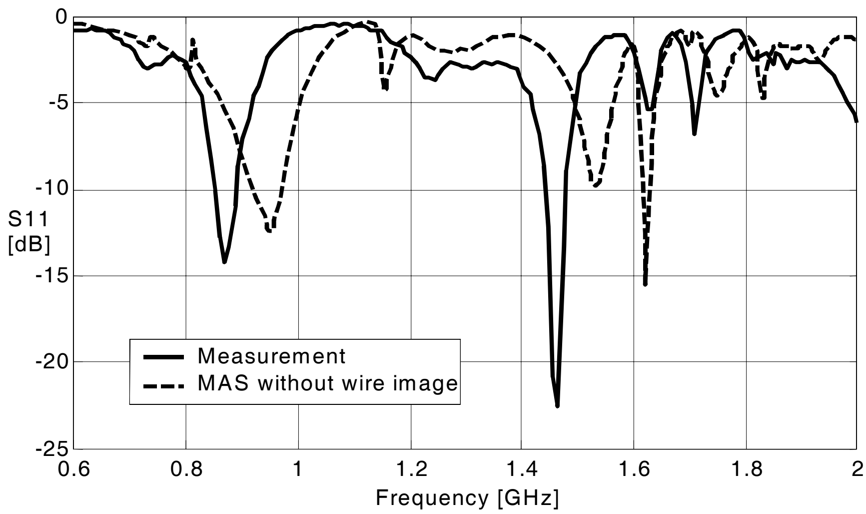

Fig.3. Experimental and simulation results in case when wire image was not allowed for solution

by MAS using the proposed methodology.

Two cases of algorithm were considered. First wire image was not taken in account. Corresponding result is shown in Fig.3. The dotted line is the simulation result, and the solid line is the measurement data. For Solution this problem N=4345 unknowns was needed. Roughly speaking the two curves have same performance, but resonance frequencies are different.

Second case - wire image was allowed for solution and added to outer auxiliary current. Fig.4. shows the experimental data and dynamics of simulation results convergence. The Simulation plots are in good agreement with experiment. It is worth pointing out that considering the mirror image of the wire antenna in the MAS model can significantly improve the accuracy of the solution than in previous case for same number of unknown.

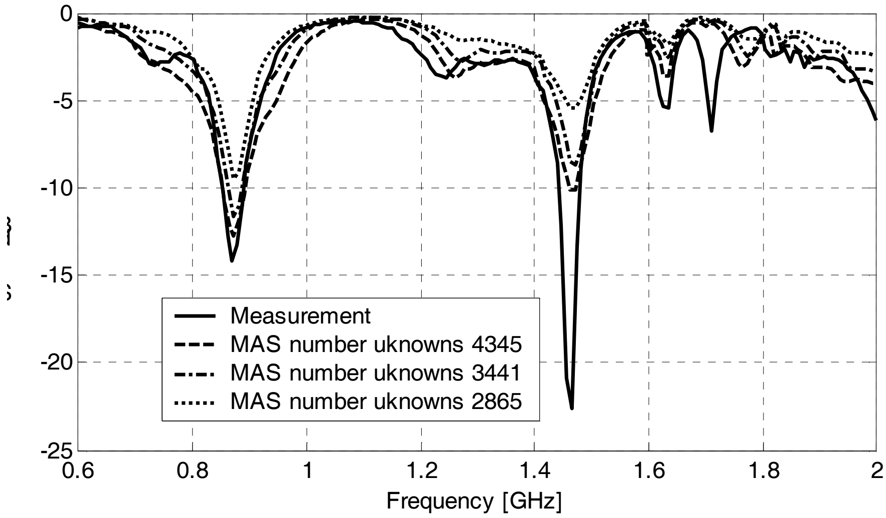

Fig.4. Experimental and simulation results in case when wire image was allowed for solution

5. Conclusion

MAS was improved with using MoM technique for solving EMC problems such as wires attached to metallic surface. Considering wire image in MAS allows us to get better convergence, good agreement with experimental data and to gain time of calculation.

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