CORRELATION CAR BODY-ANTENNA, FOR GOOD RECEPTION IN COMMUNICATIONS AND ENTERTAINMENT

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ABSTRACT - The new cars are equipped with the most modern communication systems. The implementation of communication systems are positive consequences in safety, comfort and entertainment. A good reception on the car is influenced by a lot of parameters, but the antenna is the first element. Using an antenna on the roof of car body or on other places of the body, is a complex and interactive process of designing, adapting and measuring the performances. Finding optimal positions is a reiterating process based on simulating methods and measurements. This study presents the simulation process for the assembly: metallic car body – integrated antenna, using mathematic methods.

INTRODUCTION

The modern equippments permit to driver to be permanently in direct contact with the road control services, emergency rooms, phones, radio, TV, Internet, GPS etc. The new systems work within a wide range of frequencies between 0,33 MHz and 77 GHz.

On board of cars receiving can be influenced by specific factors: car body, distorsions, interferences, meteorogical conditions, atmosphere electricity, environment (relief, buildings etc.).

A good reception on board depends on the following aspects: type of antenna, frequency band used, characteristic diagram, antenna gain, adapting (cables, connectors, antenna amplifiers etc), transmission technique.

The antenna is the first element in the electronic communication system at car board.

Using an antenna on the roof or on other places of car body is a complex and interactive process, repeated for each new automotive model. Several types of antenna are now in use: External antennae, glass integrated antenae, patch antennae GPS, frontal antennae.

External antennae can be: short dipole antenna, low-profile antenna (GSM, GPS), multifunctional antenna (S-DARS), shark fin (S-DARS), dipol antenna (DAB), dipol antenna combined (AM/FM, DAB, GSM, GPS).

INTERFERENCE SUPPRESSIONS:

Interference suppression is simply the reduction of unwanted noise produced from the speakers of communication and entertainment system.

There are two issues to be considered relating to interference suppression on a car:

- short range interference: the effect of interference on the vehicle’s radio system
- long range interference: the effect of the vehicle on external receivers

Interference can propagate in four ways:

- line borne – conducted through the wires;
- air borne – radiated through the air to the aerial;
- through capacitive coupling, by an electric field;
- through inductive coupling, by magnetic linking;

The sources of interference in a motor vehicle can be summarised quite simply as any circuit that is switched or interrupted suddenly. This includes the action of a switch and the communication process in a motor, both of which produce rapidly increasing signals. The secret of suppression is to slow down this increase. Interference is produced from four main areas of the cars ignition system, the charging system, motors and switches, through static discharges.

There are basically five techniques for suppressing radio interference using: resistors, bonding, screening, capacitors, inductors.

When the range of interference frequency is known, suitable values of components can be determined to filter out its effect.

For reception in the AM bands, the antenna has a capacitance of 80 pF with a shunt resistance of about 1MΩ. The set will often incorporate a trimmer to ensure that the antenna is matched to the set. The contact resistance between all parts of the antenna should be less than 20 mΩ. This is particularly important for the earth connection.

When a signal is being received in the FM range it is the length of the antenna which is very important. The ideal length of a rod antenna for FM reception is one quarter of weavelength.

Antenna embedded into the vehicle windows or using the heated rear window element are good from the damage prevention point of view and because they are insensitive to moisture, but produce a weak signal often requiring an amplifier to be included. The latter will also amplify interference.

Consideration must be given to the position of an external antenna. This has to be a compromise, taking into account the following factors: length of antenna, coaxial cable length (longer cable reduces the signal strength), position relative to the ignition coil and leads (as far away as reasonably possible), potential for vandalism, aestetic appearance, angle of fitting (vertical best for AM, horizontal best for FM) etc.

Most quality sets also include a system known as interference absorption. This is a circuit built into the set consisting of high quality filters.

CRITERIA OF ANTENNA CHOICE

When we choose a car antenna we are taking into account the following aspects:

External antenna (on the roof):

- performances of a dipole antenna are close to an ideal isotropic antenna;
- the positioning of antenna on the roof is the best position for receiving/sending EM signals;
- it doesn't need special technical manufacturing solutions;
- it is easy to fix it on the body;
- it offers possibility to combine more applications;
- are accesible due to the low price.

In glass integrated antennae:

- manufactured with a new technology;
- they are modular;
- all applications are integrated;
- for integrating they do not need changes of car body design;
- they need electric short connection and feeding cables;
- amplifier is integrated;
- it fits to most technology

Fractal antennae:
The fractal structures are geometric bidimenensional or tridimensional figures which can be scaled by consecutive reception. The structures arase energy at each change of direction of an element of the structure. The symetrical fractal structures can be built to be independent to the frequency.

This alternative technologies have the following advantages:

- can be positionned and integrated in non-conventional positions (in car body or in glass);
- they offer possibility to combine more services (multiband);
- they do not need changing of car design for integration;
- advantages to be integrated on cabriolet or caravan models.

CORRELATION BETWEEN ANTENNA AND CAR BODY

The antenna is a resonant electric system characterized by the following parameters:

- resonance frequency;
- frequency band;
- radiation characteristic;
- strength (power) gain;

These functional parameters are influenced by metallic car body.
For each type of antenna it must be found the optimal integrating position in the car.
Finding optimal position is a reiterating process based on simulating methods and parameters measurements. In order to confirm the results got by simulation, real physical measurements in special screened precincts will be done. Simulation process for the assembly metallic car body – integrated antenna, uses the following mathematic methods:

a. Simulation of car body by using NASTRAN coordinates;

b. Simulation of electric characteristics of assembly body – antenna by following methods:
- GDT (Geometrical Theory of Diffraction);
- MoM (method of Moments);
- FDTD (Finite Difference Time Domain);
- CNN (Cellular Neural Network).

c. Maximization of results:

The chart of simulating and maximizing the working characteristics of assembly, car body – antenna, is shown in fig. 1.

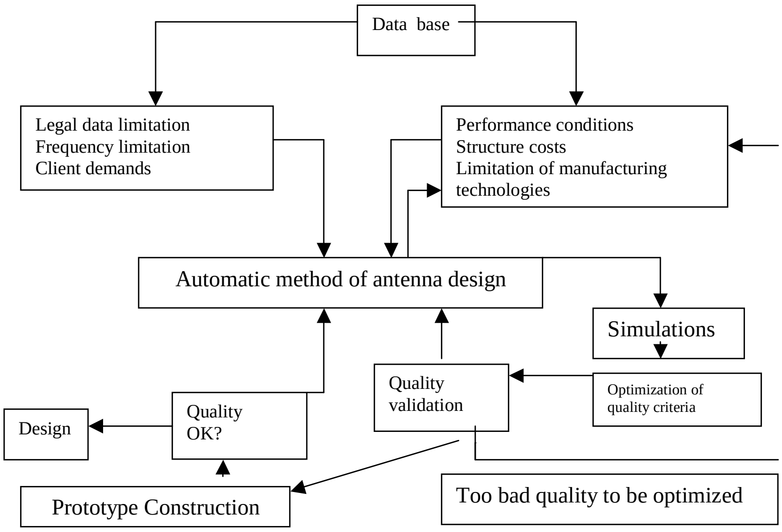

Fig. 1 Simulation and maximization of the working characteristics of assembly, car body – antenna

In the first phase it is considered a geometric structure of a resonant system with antenna characteristics. For example a planar structure (antenna patch). This structure is analyzed with a simulation method of EM characteristics (GDT, FDTD, NEC2) and a radiation characteristic is simulated, fig. 2.

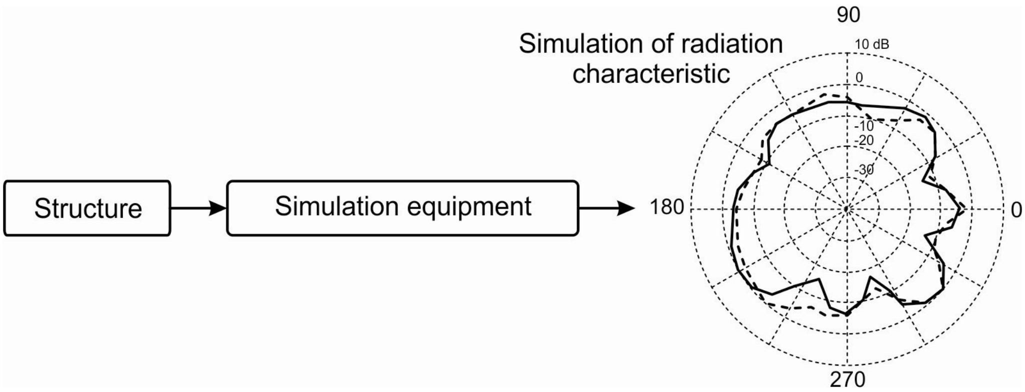

Fig. 2 Radiation characterstic

The result is not still optimized. For simulation of structure frequency band, the procedure is similar.

During the 2nd phase this resonance characteristic is used as starting point for optimizing the resonant geometric structure using CNN (Cellular Neural Network), fig. 3.

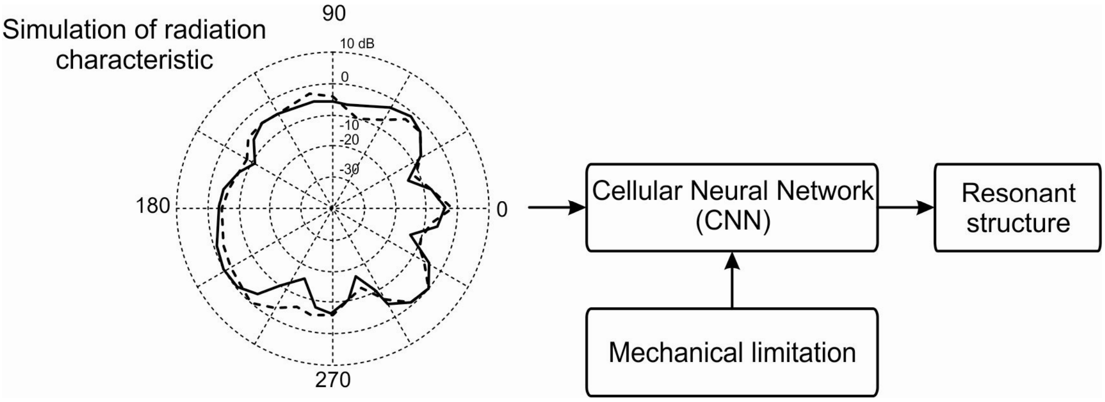

Fig. 3 Optimisation of resonant geometric structure

The neural network is fed with primary data corresponding to antenna radiation characteristic, namely: vectorial components of electromagnetic field, polarity, direction, gain of antenna, dielectric medium and geometric limits. After analyzes, the neural network has the following results: the component values of EM fields and cell geometric structure of the new structure.

During the 3rd phase is optimized the geometric structure of planar antenna:

The data corresponding to the radiation characteristic are introduced again in the learned neural network and optimized by using a genetic algorithm, fig. 4.

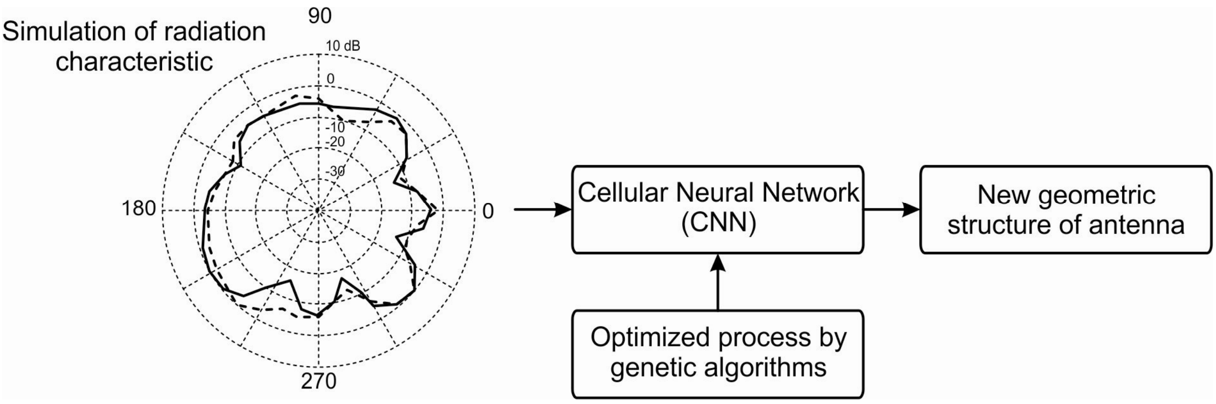

Fig. 4 Optimisation of geometric structure

The results show a new optimized geometric structure of antenna.
The advantages of method: it generates a new geometric structure of antenna, it offers new electric parameters.
The simulation of car body can be done with simulation programs regarding the distribution of magnetic and electric field components depending on frequency. As result of simulation the optimum position placement of antenna, for a certain frequency field, can be determined.

The proceeding continues for the system antenna-car body, repeating simulation for more possible positions of antenna.

One of the simulation results is getting the radiation characteristic of antenna integrated in car body as shown in fig. 5.

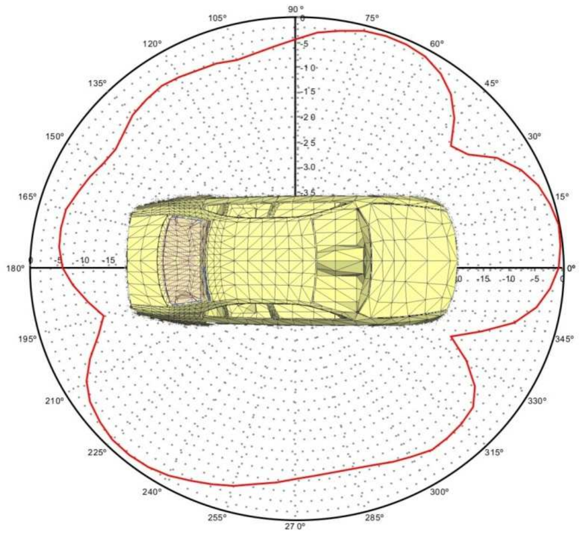

Fig. 5. Radiation characteristic of antenna integrated in car body

The results got after simulating on computer can be confirmed only by experimental measurements of car-antenna system. This can be done in specialized EMC (Electro Magnetic Compatibility) centers, according to European and International Standards.

CONCLUSIONS

The new communication systems enable to extend equipments on board of automotives increasing their safety and comfort. The communication systems work in a wide frequency range between 0.53 MHz and 77 GHz. In order to reduce the number of antennae, the actual tendency is to use multi band antennae. For each antenna type, the optimum position on the car body must be found. Finding the optimum position is a complex process based on simulation methods followed by physical measurements done in special screened points.

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