Integration of a multi-sector antenna system on a wireless camera

Julian Thevenard, Dominique Lo Hine Tong, Nicolas Corinne, Christian Person, Jean-Philippe Coupez, Romain Pascaud, Raphaël Gillard, Renaud Loison

Integration of a Multi-Sector Antenna System on a Wireless Camera

J. Thévenard [(1)], A. Louzir*[(1)], D. Lo Hine Tong[(1)], C. Nicolas [(1)],
Ch. Person[(2)], J.Ph.Coupez[(2)], R. Pascaud[(3)], R. Gillard[(3)], R. Loison[(3)],

(1) THOMSON R&D, 1 av. de Belle-Fontaine, 35576 Cesson-Sévigné, France.
(2) Institut TELECOM – TELECOM Bretagne, UMR CNRS 3192 Lab-STICC,
CS 83818, 29238 Brest Cedex, France.
(3) IETR, 20 av. des Buttes de Coesmes, 35043 Rennes, France
E-mail: ali.louzir@thomson.net

Introduction

Wireless television cameras are already widely used for Electronics News Gathering (ENG) and Outside Broadcast (OB) and their usage is growing with the increasingly need of rapid deployment of mobile video production platform for the coverage of live sporting and news events. The use of wireless cameras gives also the camera crew much more freedom to capture the event without the hurdle of running cables. Unlike many wireless applications, the upstream link (from the mobile camera to the intermediate receiver) is the most constraining in terms of required bit rate and link reliability to achieve a professional picture quality, in particular in the case of live HDTV production. The power consumption of the wireless module that may limit the battery life of the camera is also an important design parameter. The use of a multi-sector antenna at the camera side may be very helpful to respond to the above constraints while at the same time it limits the interferences between several wireless production cameras.
This paper addresses the integration issue of a multi-sector antenna on a wireless camera from simulation and application point of view. First the multi-sector antenna system is presented. Then simulation results of the full structure (antenna + camera) using both Ansoft's HFSS software and a Dual-Grid FDTD (DG-FDTD) multi-resolution method are presented. The obtained results are finally compared with measurements.

The multi-sector antenna system description

A 4-sector antenna system operating in the 5GHz band is used. The chosen concept of the multi-sector antenna system, shown in Figure 1, is based on the use of 4 Vivaldi antennas arranged vertically around a common central axis to cover the entire 360° of the azimuth plane [1-2]. The Vivaldi antennas are excited through microstrip to slot line transitions and mounted onto a horizontal mother board that includes the feeding networks and the beam switching circuits.
Such 3D antenna arrangement offers more freedom in the optimization of the number of sectors and the control of the radiation pattern and gain of each individual beam. Figure 1 also shows the radiation patterns (measured at 6 GHz) in the azimuth plane of the designed multi-sector antenna taking into account a mother board square of 90x90 mm^2.

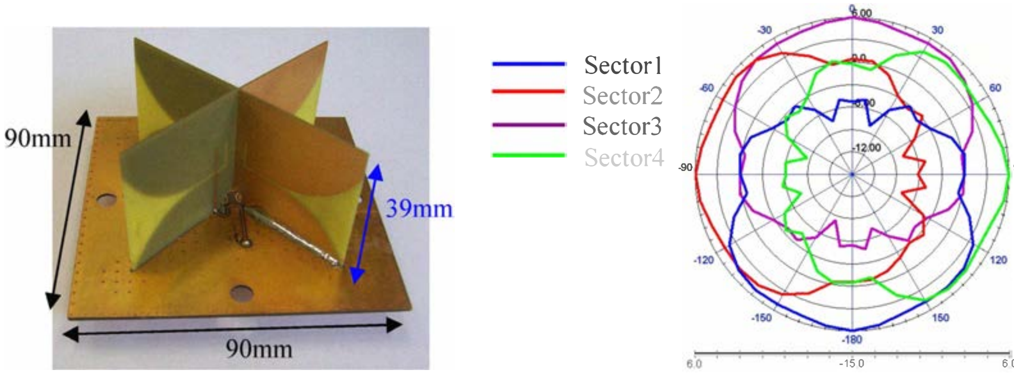


Figure 1: 4-sector switched beam antenna in FR4 substrate and associated radiation pattern at 6GHz in the azimuth plane (θ=90°).

Simulation and measurements of the integrated multi-sector antenna

After a comprehensive study taking into account both radio and application constraints, the place of the multi-sector antenna on the camera was chosen at the rear of the camera body, i.e. near the radio module enclosure and in a relatively cleared/quiet zone (Figure 2). Besides, the orientation of the 4 beams which are 90° from each other are chosen at 45° from the camera axis in order to limit the interaction of the radiation patterns with the camera metallic handling. Despite these precautions the surrounding environment of the multi-sector antenna system could not be neglected since it might affect its performances.

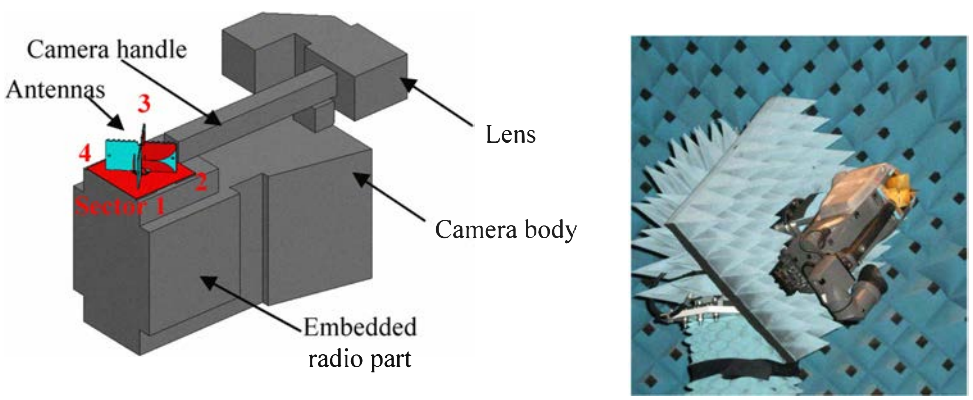
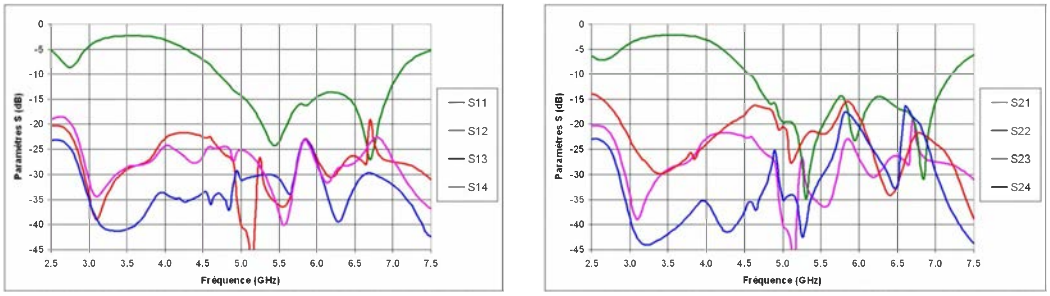


Figure 2: Camera + antenna system global views.

The full structure (antenna system + camera) have been first simulated using the Finite Element Method (FEM) Ansoft's HFSS software. Due to the size of the camera (410x225x250 mm^3 = 8.2λo x 4.5λo x 5λo) compared to the smallest antenna dimension (width of the slotline = 0.4 mm = 0.008 λo), the simulation of the full structure is very time and power consuming, approaching the processing limit of the used machine. Figure 3 shows the simulated S parameters with sector 1 (less perturbed by the camera) activated compared to the case with sector 2 (close to the camera handling) activated. While the return loss remains better than 10 dB over the full [4.8-6]GHz band in both cases, the isolation between sectors rises from typically - 25 dB (which is the value obtained for the multi-sector antenna system alone) to the value of -15 dB corresponding to the worst case when part of the power transmitted by sector 1 is reflected by the camera handle and captured by sector 3 antenna. Figure 4 presents the simulated radiation patterns for the 4 sectors in azimuth and elevation planes showing a significant disturbance due to the camera handle.



(a) (b)

Figure 3 : Simulated S-parameters with sector 1 (a) and sector 2 activated (b).

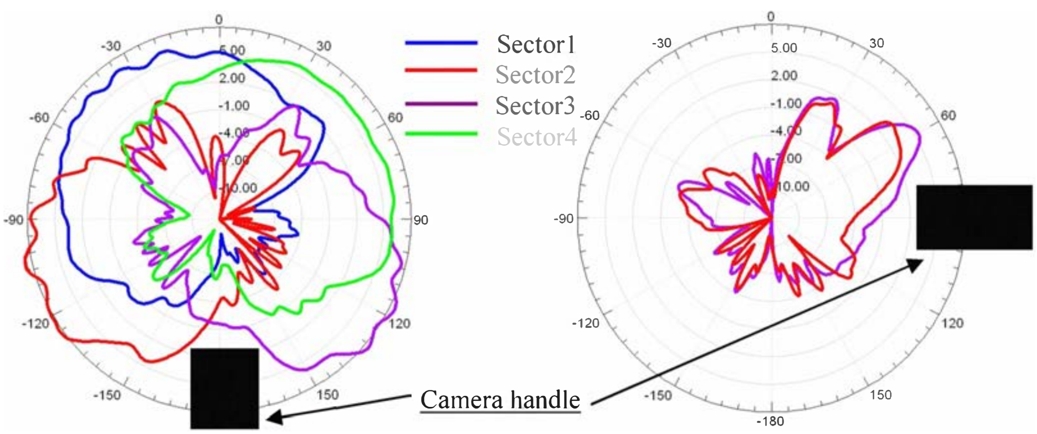


Figure 4 : HFSS simulated radiation pattern at 6GHz in the azimuth (θ=90°) and elevation plane (Φ=180°).

The above conclusions have been confirmed by radiation pattern measurements of the antenna system attached to the camera. The results presented in Figure 5 at the frequency of 6 GHz, correspond to the total radiated field, obtained by adding E and H components and are representative of the measurements made at other frequencies.

However, while the measured radiation patterns in the elevation plane are relatively similar to those obtained by simulations using HFSS software, a significant discrepancy between simulation and measurement could be noticed in the azimuth plane.

A second simulation of the full structure has then been done using the Dual-Grid Finite-Difference Time-Domain (DG-FDTD) method [3]. This method divides the classical FDTD simulation of the overall problem into two different FDTD simulations. First the antenna system is simulated without its environment using the required high resolution mesh, while its “primary radiation” is saved. Then the saved contribution is used as an excitation of the second FDTD simulation that uses a coarse mesh to represent the antenna with the large camera. Figure 7 shows the simulation results of the radiation patterns in the azimuth plane obtained by this method, compared with both HFSS simulations and measurements made at 6 GHz for both sector 1 and 3. It could be noticed that the obtained results with the DG-FDTD simulation seems closer to the measurements. In the elevation plane, the obtained results by the DG-FDTD method and HFSS are very close and fairly match the measured results.

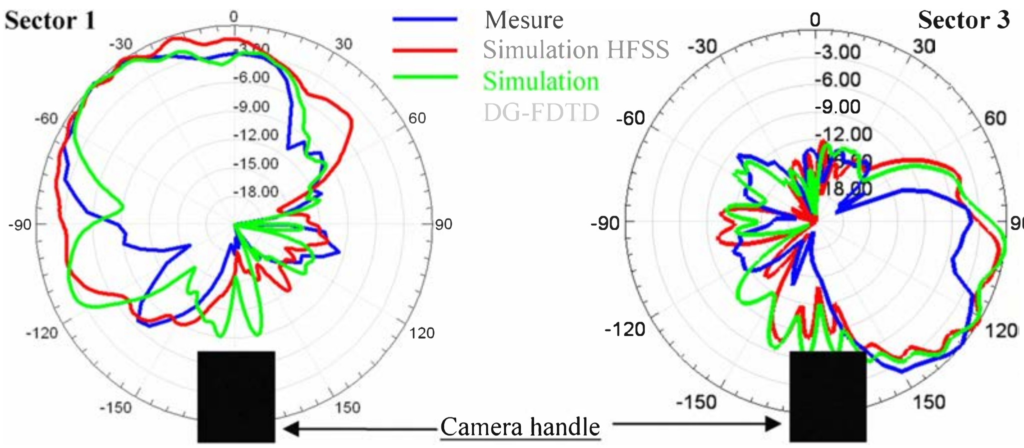


Figure 5 : Radiation patterns at 6GHz in the azimuth plane (θ=90°).

Conclusion and future work

The issue of the integration of a multi-sector antenna system onto a wireless camera has been addressed from simulation and application point of view. The obtained results show that the effect of the camera on the multi-sector antenna system could not be neglected and should be taken into account at the early phase of the antenna design. Simulations and measurements have shown the interest of using a multi-resolution method such as the DG-FDTD method in the simulation of antenna system including its close environment. One potential solution to limit the disturbance of the antenna performances by the camera handling may rely on the tilt of the concerned beams by using metallic directors properly positioned into the antenna radome [4].

References

[1] J. Thévenard, D. Lo Hine Tong, A. Louzir, C. Nicolas, C. Person, J.P. Coupez, "3D multi-sector Vivaldi antennas based on metallized plastic technology" ; APS International Symposium, 2007

[2] J.Thévenard, D.Lo Hine Tong, A.Louzir, C.Nicolas, C.Person, J.P.Coupez, "Switched beam 3d-vivaldi antennas for WLAN applications" ; International Symposium on Antennas and Propagation, Niigata, Japan, August 2007

[3] R.Pascaud, R.Gillard, R.Loison, J.Wiart, M.F.Wong, "Dual-grid finite-difference time-domain scheme for the fast simulation of surrounded antennas" ; IET Microw. Antennas Propag., vol. 1, pp. 700-706, June 2007.

[4] J. Thévenard, D. Lo Hine Tong, A. Louzir, C. Nicolas, C. Person, J.P. Coupez, "Radome Enhancing Multi-Sector Antenna Radiation Performances" ; APS International Symposium, 2008.