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Increase of exposure levels due to near-field antenna/body coupling at 60 GHz

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Abstract

When a wireless device is located close to human body, near-field interactions may modify the absorbed power density (APD). In this study, we performed numerical and experimental analysis of antenna/human body interactions at 60 GHz. APD distribution is measured using a novel method of near-field pattern visualization at the surface of the human body model. Results demonstrated that APD may be significantly altered due to the antenna/body coupling (increase up to 103.3%). The results suggest that the exact APD cannot be retrieved from free-space measurements of the incident power density in absence of a body model.

1 Introduction

Wireless devices intended to be used in the vicinity of the human body should comply with the exposure limits. In the 6–300 GHz range, the absorbed power density (APD) is used as the main dosimetric quantity [1, 2]. The existing dosimetry systems are designed to measure the incident power density in free-space [3]. In such measurements, the variations of the power density due to the coupling of a wireless device with the human body are not taken into account. In intended use cases, when an antenna is located close to a the human body, near-field interactions modify the field [3]. The main purpose of this study is to analyze numericaly and experimentaly the impact on the APD of the antenna/human body interactions in the near-field for a 4-elements patch antenna array at 60 GHz.

2 Exposure assessment

2.1 Exposure scenarios

To analyze the variations of the APD, two scenarios are considered:

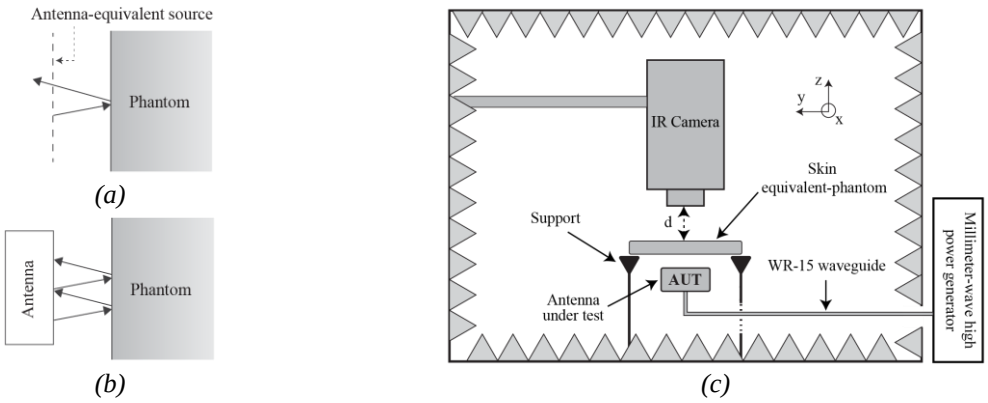

Figure 1. Exposure scenarios: (a) scenario 1 (numerical simulation); (b) scenario 2 (numerical simulation); (c) scenario 2 (experimental validation).

- **Scenario 1:** An antenna equivalent source radiating towards a skin-equivalent model (Figure 1a). This scenario assumes no interactions between the source and skin model.
- **Scenario 2:** Antenna placed in the vicinity of the skin model (Figure 1b). A 4-elements patch antenna array operating around 60 GHz is considered.

APD is computed numerically using CST Microwave Studio (APD_1^{num} and APD_2^{num}). The antenna input power is set to 10 mW. To validate numerical results experimentally, APD is measured experimentally using an *ad hoc* technique based on infrared thermography (APD_2^{exp}) (Figure 1.c).

2.2 Results

APD_2^{num} demonstrates a damped oscillatory behavior around APD_1^{num} (increase up to 79.2% and decrease down to 30.1%) (Figure 2). The variations depend on the electromagnetic properties of skin (for instance, for wet skin and children it can reach 98.25% and 103.3%, respectively), ground plane size (APD increases from 10% to 79% for 2.5×2.5 and 10×10 mm^2 ground plane), and antenna directivity (higher directivity leads to higher enhancement), and scattering characteristics of antenna. The distribution of APD_2 changes with d (concentrated around its maximum at $d = 6.5\ mm$ and extends over a larger surface at $d = 5.0\ mm$) (Figure 3).

3 Conclusion

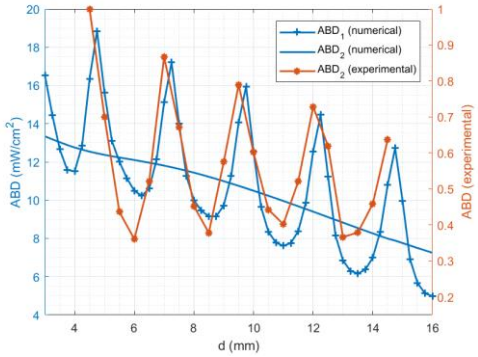

Figure 2. APD

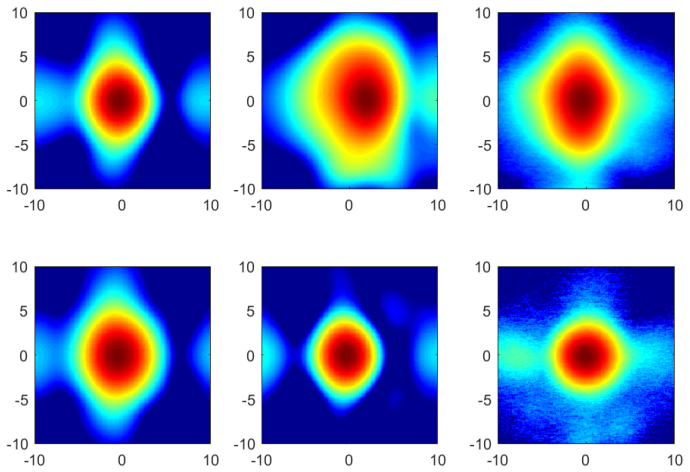

Figure 3. APD distribution: (b) APD_1^{num}; (c) APD_2^{num}; (c) APD_2^{exp} at $d = 5\ mm$ (first row) and 6.5 mm (second row).

In this study, we analyzed numerically and experimentally for the first time the impact of the near-field antenna/body interactions on APD at 60 GHz. A novel technic of near-field pattern measurement at the surface of the human body model was introduced for APD measurements. Results showed that APD (average and distribution) is strongly impacted by the presence of a body (increase up to 103.3%). The results suggest that the APD can not be retrieved from free-space measurement of the incident power density in absence of human body.

4 References

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