Exposure evaluations of mm-wave band handset on the human head

Keisuke Kimura[†a)], ***Member***, **Kazuyuki Saito**[†], ***Member***, **Masaharu Takahashi**[†], ***Fellow***, ***and*** **Tomoaki Nagaoka**[††], ***Member***

1. Introduction

Exposure evaluations of radio waves have been performed assuming the use of smartphones. A part of the frequency band used in fifth-generation mobile communication systems is allocated to mm-wave frequencies, and faster communication is expected to be realized. Therefore, it is necessary to evaluate human exposure to mm-wave band wireless communications using handsets. In this study, we evaluated the exposure to the human head using a smartphone model with built-in mm-wave antennas.

2. Analytical model

Fig.1 shows a mm-wave antenna model that can be embedded in a smartphone. This model is 1 × 4 patch array antenna with a simple structure. The operating frequency was 28 GHz, and S_{11} to S_{44} of each patch antenna in free space were found to be less than -10 dB. The model was built into the left, right, and top sides of the numerical smartphone model case created in our previous study [1]. The numerical smartphone model is a model that simulates the same size and component layout as a commercial smartphone. Fig.2 shows an analytical model. The model consists of the smartphone model with built-in mm-wave antenna models and TARO [2], a human head model. The smartphone model was placed in front of the mouth because some people bring the device to the front of their face to use it. The electric properties of the TARO were epidermis and dermis and were taken from the database provided by National Institute of Information and Communications Technology [3].

The analysis was performed using XFDTD ver. 7.9.2. The radio waves radiated from all antennas are in-phase and same amplitude, and the total radiated power is 0.2 W.

3. Analysis using mm-wave band handset

For exposure to radio waves above 6 GHz, guidelines have been specified using the absorbed power density. This paper

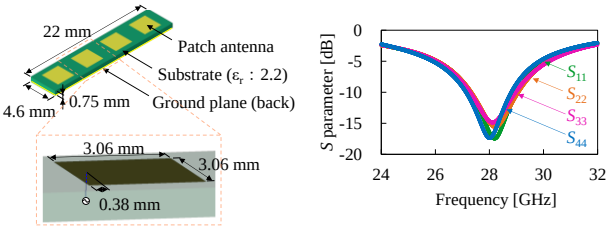

Fig. 1 mm-wave antenna model

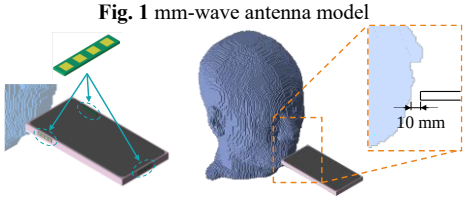

Fig. 2 Analytical model

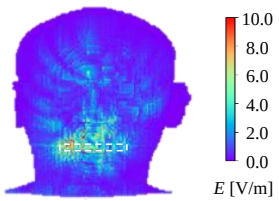

Fig. 3 Electric field distribution on TARO surface

shows the electric field distribution on a TARO model surface (Fig.3). From Fig.3, the electric field was distributed over a wide area of the face, mainly around the mouth. The reason for the wide distribution is considered to be that the mm-wave antenna models were placed in three locations.

Conclusion

In this study, we analyzed exposure of the human head in the mm-wave frequency band. In the next step, we will obtain the absorbed power density.

Acknowledgments

A part of this study was supported by the Ministry of Internal Affairs and Communications, Japan, Grant Number JPMI10001.

References

[1] K. Kimura *et al*., 2022 URSI-Japan Radio Science Meeting, p. 123, Tokyo, Japan, Sep. 2022.
[2] T. Nagaoka *et al*., Phys. Med. Biol., vol. 49, pp. 1-15, 2004.
[3] https://www2.nict.go.jp/cgi-bin/202303080003/public_html/index.py

[†]The author is Chiba University.
[††]The author is National Institute of Information and Communications Technology.
[a)] E-mail: kimura_kk0430@chiba-u.jp