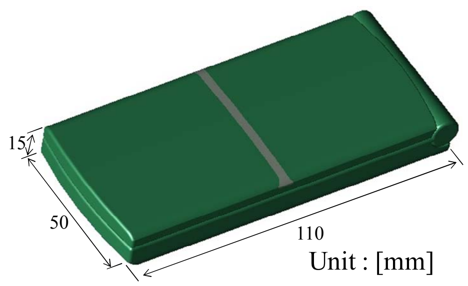
Construction of a realistic calculation model of a flip phone for SAR evaluations

#Kensuke Tanaka [1], Akihiro Tateno [1], Kazuyuki Saito [2], Tomoaki Nagaoka [2], Masaharu Takahashi [1], Koichi Ito [1]
[1] Graduate School of Engineering, Chiba University
1-33 Yayoi-cho, Inage-ku, Chiba 263-8522, Japan, ken-t.516@chiba-u.jp
[2] National Institute of Information and Communications Technology
4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184-8795, Japan

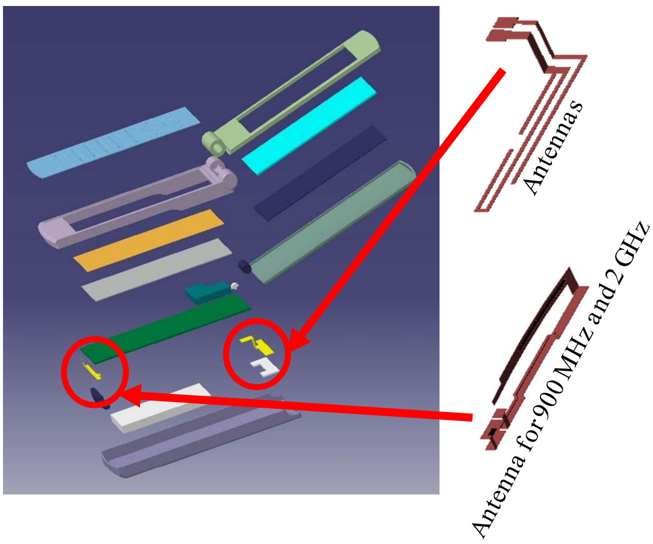
1. Introduction

Recently, influences of electromagnetic (EM) wave to human body need to be estimated along with the popularization of EM devices. For example, the penetration of cellular phones continues to grow. Therefore, to estimate the influence of EM wave, we have calculated specific absorption rate (SAR) distributions in the human body in this paper. In order to calculate the SAR distribution in the human body, we use mostly numerical calculation. In the numerical calculation, we need two calculation models, the human body model and the device model. The human body model is already developed and it is high resolution. We collected the data of human body by use of magnetic resonance imaging (MRI) to construct the model. Therefore the human body model has the anatomically characteristic [1]. In our previous studies, several types of EM sources, such as a half-wavelength dipole antenna, a planar inverted-F antenna (PIFA) with a metallic case, and some other antennas, are employed [2]. However, these device models we have used were simple models. There still remains a necessity to evaluate the SAR due to more realistic device models.

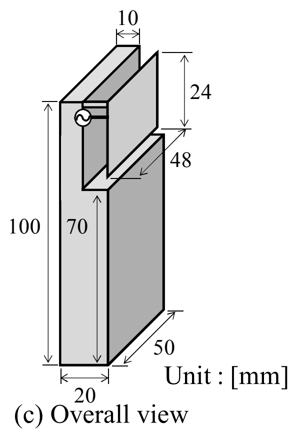
In this study, we have constructed a high resolution model of a flip phone, which has some antennas. In these antennas, the dual-band antenna for 900 MHz and 2GHz radiates EM wave the most intensively in comparison with other antennas. Therefore, we analyzed the antenna for 900 MHz and 2GHz. Figures 1 (a) and (b) show an overall view and an exploded view of the flip phone model. Figures 1 (c) and (d) show an overall view of the Planar inverted F antenna (PIFA) with a metallic case of 900 MHz and 2 GHz. We previously calculated the SAR distributions in the human body with PIFA. Therefore to compare the high resolution model and the simple model, we made the comparison of the SAR distributions in a simple phantom model between flip phone model and PIFA by use of the finite-difference time-domain (FDTD) method.



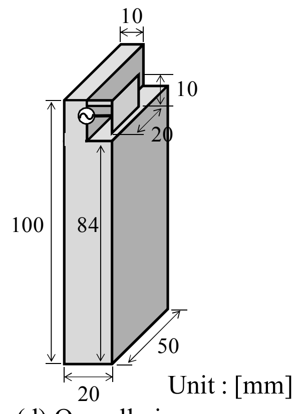
(a) Overall view of the flip phone



(b) Exploded view of the flip phone



(c) Overall view of the PIFA (900 MHz)

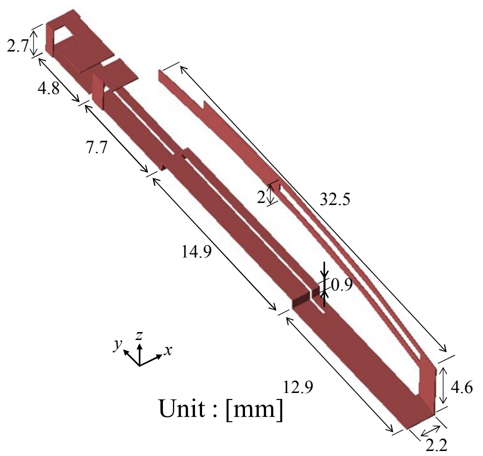


(d) Overall view of the PIFA (2 GHz)

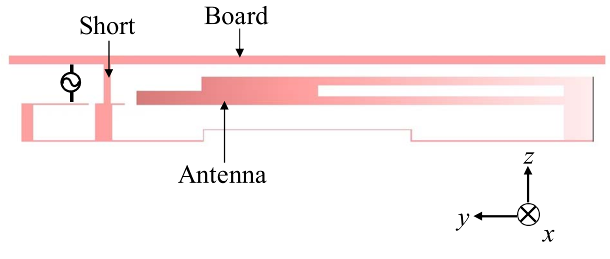
Figure 1: Device models.

2. Calculation Model

Figures 2 (a) and (b) show an overall view and a side view of the antenna in the flip phone model. The operating frequencies of the antenna in the flip phone are 900 MHz and 2 GHz. The reflection coefficient of the antenna in the flip phone was calculated in the free-space by FDTD method. Analytical region for this case is 130 mm × 70 mm × 35 mm. Minimum and maximum cell size are 0.1 mm×0.1 mm×0.1mm, and 1.0 mm×1.0mm×1.0 mm, respectively. The absorbing boundary condition is the eight-layers perfectly matched layer (PML). In our study, the SAR distribution of the flip phone placed on the dielectric and simple phantom is calculated, as shown in Figure 3. The observation plane is 0.5 mm from the surface of the phantom model. Table 1 shows the physical properties of the simple phantom model, the dielectric model and parts of flip phone model. Analytical region for this case is 240 mm × 200 mm × 53 mm. Cell sizes and the absorbing boundary condition are the same as those for the free-space condition. The SAR calculation condition of the PIFA is the same as the flip phone.

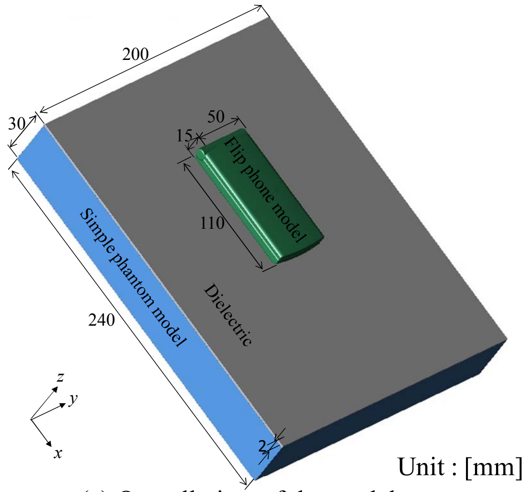


(a) Overall view of the antenna

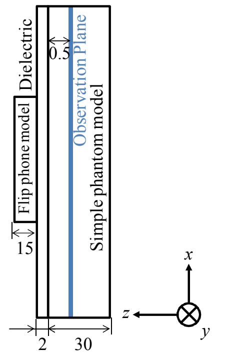


(b) Side view of the antenna

Figure 2: The view of antenna in the flip phone model.



(a) Overall view of the model



(b) Side view of the model

Figure 3: The Calculation model.

Table 1: Physical properties.

Frequency	900 MHz			2 GHz		
	Relative permittivity	Electrical conductivity [S/m]	Density [kg/m^3]	Relative permittivity	Electrical conductivity [S/m]	Density [kg/m^3]
Simple phantom model	54.6	0.99	1000	51.7	1.52	1000
Dielectric	3.0	0	1000	3.0	0	1000
Metal parts (flip phone)	Perfect conductor		0	Perfect conductor		0
Not metal parts (flip phone)	3.0	0	0	3.0	0	0

3. Result

Figure 4 shows the reflection coefficient of the antenna. It can be confirmed that the operating frequency bands of the antenna are of the targeted values. Figure 5 shows the SAR distributions in the simple phantom model. We calculate SAR distribution using flip phone model and PIFA at 900 MHz and 2 GHz in our study. The SAR values around the antennas are relatively high. The SAR values of the PIFA are higher than those of the flip phone model. In addition, the electric current also flows on the chassis, therefore, the range of SAR distributions are wider than the flip phone.

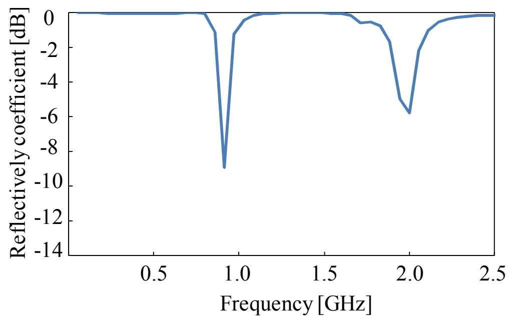
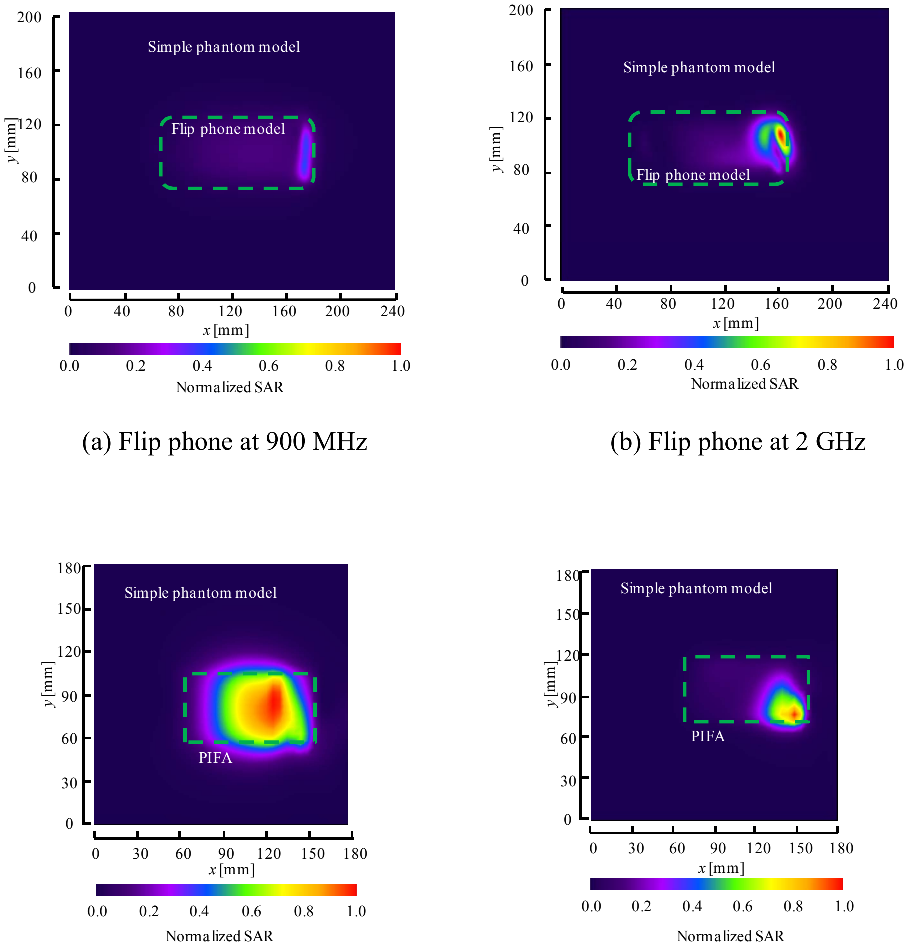


Figure 4: Reflection coefficient of the antenna in flip phone.



(a) Flip phone at 900 MHz (b) Flip phone at 2 GHz

(c) PIFA at 900 MHz (d) PIFA at 2 GHz

Figure 5: SAR distributions in the simple phantom model.

4. Conclusion

In this study, we constructed the realistic model of flip phone and calculated the reflection coefficient of the antenna. As the results, the operating frequencies of the antenna agree with the targeted value (900 MHz, 2GHz). In addition, we made the comparison of the SAR distributions in a simple phantom model for a flip phone model and PIFA. From the result, we confirmed the SAR distributions of PIFA are wider than that of high resolution model and SAR values of PIFA are higher than that of high resolution model. To calculate more accurately, it is necessary to construct higher resolution model. In the future, the high resolution human model and other devices will be studied.

Acknowledgments

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References

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