Research of Wideband Wearable Antenna Integrated on the Clothing

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1. Introduction

Recently, portable telecommunication devices have been equipped with various wireless communication functions. Consequently, the user has come to be able to access various information networks with those equipments. At the same time, the wearable computer technologies have been also researched actively. In the wearable computing, information is transmitted across the wireless applications worn on the clothing. The mobile communication is inferior to the motionless communication at both transmission rate and information amount. However, a recent technical improvement has succeeded to improve transmission rate greatly in the short distance. In fact like that, there has been much attempt to realize broadband communication by wearable technologies.

On the other hand, the antenna is indispensable existence to the wireless communication system. Furthermore, because the wireless communication system had become a familiar item, the antenna came to be used in more the vicinity of the human body. By the way, antennas are ever needed for only wireless applications, but there will be increasingly several cases that they are used near human body. The antenna performances are badly deteriorated near human body. Hence, so wearable antenna, which has good characteristics in this situation is not ever little reported. Therefore, in this report, we will provide one prototype of the wideband wearable antenna for terrestrial digital broadcasting.

2. The basic antenna for wearable applications

2.1. Numerical approach to the basic antenna design

In the terrestrial digital broadcasting, the frequency of UHF band from 470 MHz to 770 MHz is used. Because the relative bandwidth is approximately 50 %, it is demanded that the antenna is broadband. This report proposes that a plate antenna shown in Fig. 1 is applied as wearable antenna. The fundamental principle performance of this antenna is reported proposed [1] ~ [4].

The install position for the antenna is an important parameter, which decides the success or failure of that performance. In addition, do not disturb the activity of the user by wearable antenna.

Therefore, proposal antenna is mounted on the back of user's neck. This idea of locating it on this position is original one, which is not ever presented in reports.

On the other hand, wearable antenna should demonstrate the highest performance near the human body. The detail of human body and antenna is shown in Fig. 2. This basic antenna located near human body is evaluated using numerical analysis by the finite difference time domain (FDTD) method. The parameters of the FDTD calculation employed in this paper are as follows. The cell size is 2 mm for *x* and *y* directions, and 2.5 mm for *z* direction respectively. The time step of the FDTD calculation is 4.11 ps. Liao's method is used for the absorbing boundary condition. The antenna performances about input and radiation properties are shown in Fig. 3 as follows.

According to these data, input properties in the band used for terrestrial digital broadcasting system satisfies Return loss < -7.5 dB in Fig. 3(a). Additionally, the radiation gain obtains over 0 dBi on the x direction at the center frequency 620 MHz. An antenna gain as a function of frequency is shown for Fig. 3(b). The antenna gain becomes to 0 dBi within the range of the frequency from 470 MHz to 470 MHz. In addition, the radiation pattern in 620 MHz is shown in Fig. 3(c). It is proven that the proposal antenna has an enough potentiality as wearable antenna according to the data of Fig. 3.

2.2. The practicable type antenna

In this chapter, the composition process of the wearable antenna based numerical design is described in details. The material that composes wearable antenna should have high electro-conductivity, and it should be flexible. While what substances the wearable antenna consists of influence its characteristics, flexible, conductive, and fabricated easily substances are desired in terms of the implementation. In addition, it should be strong to friction. Consequently, we constructed a wearable antenna by the high conductive cloth. There is a feed point at the bottom of the vertical slit. However, there is no necessity to set balun circuit there.

3. The suggestion of actually implementable hood-type model

Thus based on the result of the previous chapter, it was attempted to mount soft antenna on hood of clothes. A concrete situation is illustrated below in Fig. 4, and measurement done in Fig. 5. The input and radiation properties are measured in this situation.

The data of Fig. 6 are proof where hood-type antenna has high utility as wearable antenna. Unfortunately, input properties of hood-type antenna are deteriorated compared with design guideline (Return loss < -7.5 dB) of wearable antenna. However, the deterioration of such input properties can be improved. Concretely, horizontal slot has the function to readjust for the input properties deterioration. In this radiation properties, gain for the x direction is obtained 0 dBi or more at the center frequency 620 MHz.

4. Conclusion

A comprehensive study of wearable antenna performances was carried out in this paper.

Especially, the antenna performance in the vicinity of the human body was investigated in detail. Moreover, the antenna composition method with the electro-conductive cloth was researched in detail. Those research results were compiled and hood-type antenna was achieved. A demonstration of this wearable antenna shows that its gain possesses higher value than portable equipment's antenna for terrestrial digital broadcasting system.

References

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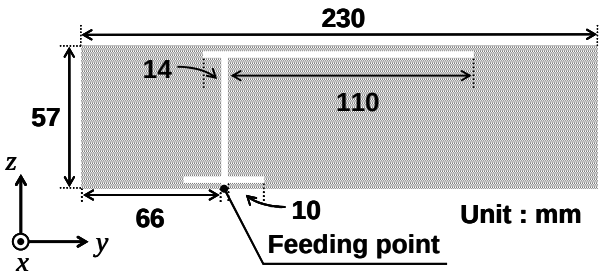


Fig. 1 Antenna structure.

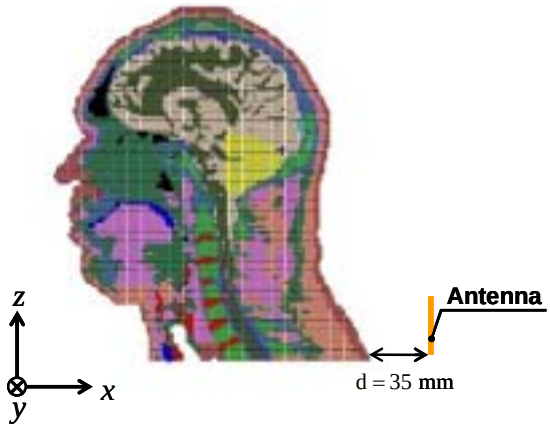
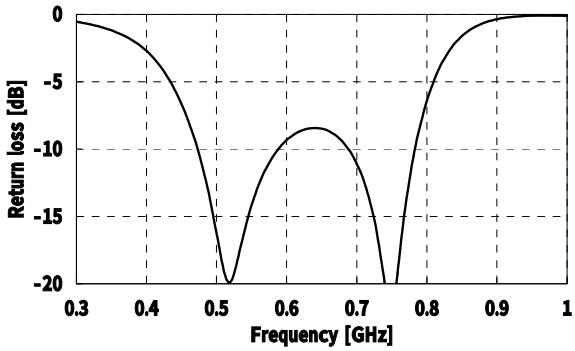
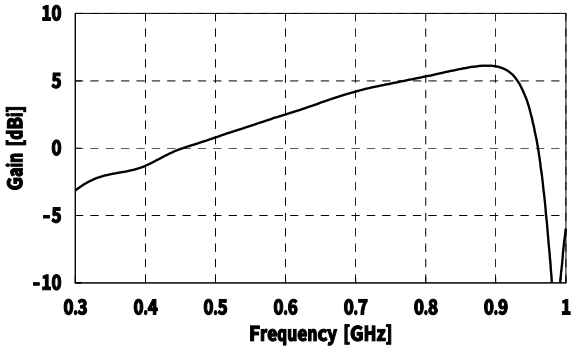


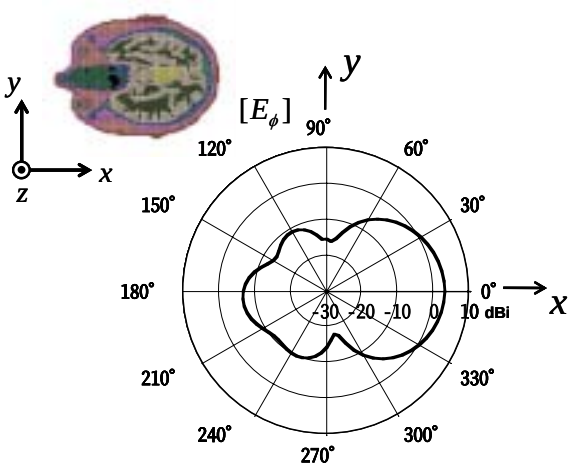
Fig. 2 Simulation model of the antenna near the human body.



(a) Input characteristic



(b) Gain on the x direction



(c) Radiation characteristic viewed on the top

Fig. 3 Antenna performances of the basic model.

Fig. 4 Hood-type antenna mounted on a neck back.

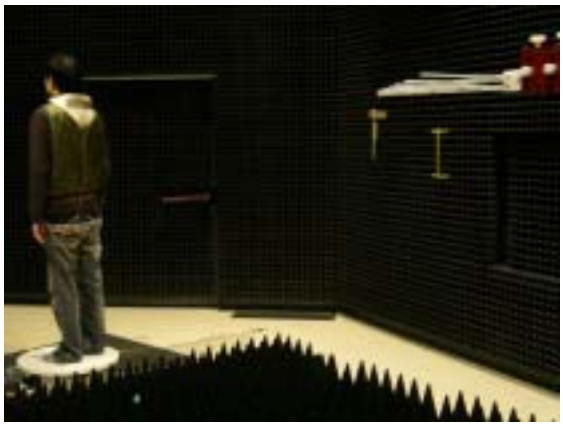
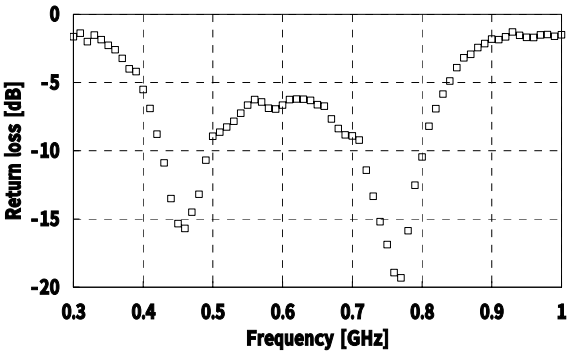
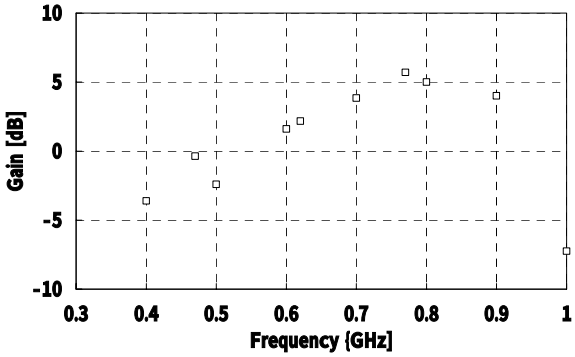


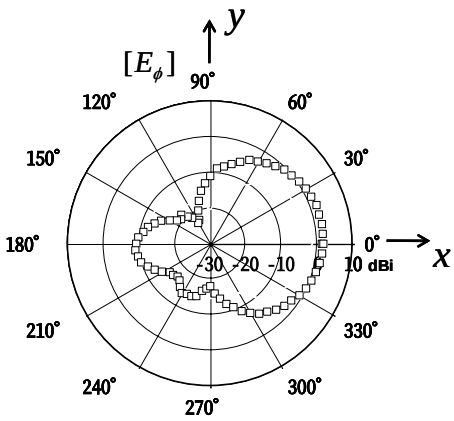
Fig. 5 Measurement environment of antenna property.



(a) Input characteristic



(b) Gain on the x direction



(c) Radiation characteristic on the E plane

Fig. 6 Antenna performances of the hood-type model.