POS1-58

Wideband Wearable Antenna

Akio Kuramoto Yukitsuna Furuya
NEC Corporation
1753, Shimonumabe, Nakahara-ku, Kawasaki, Kanagawa, 211-8666, Japan
E-Mail : akuramoto@bc.jp.nec.com

1. Introduction

Recently many kinds of wireless communication systems are provided. And some kinds of their services are usable at any place in the urban area, for example, mobile phone, wireless LAN and etc. On the other hand, their terminals tend to be compact and their antenna sensitivities also tend to be degraded. But the antenna is the most important key device in order to achieve the high speed data communications. In this trend, we think the wideband wearable antenna which is usable for multi-applications is one of the strong candidates in the next generation device [1][2][3][4].

This time, we tried to develop the wideband wearable antenna applicable for the specified low-power radio usable in 400MHz band and receiving the digital television broadcasting wave from 470MHz to 770MHz as the initial approach. Our approach for the wearable antenna was mainly implemented by the experimental work and the good results were obtained. This paper introduces its antenna construction, the return loss performance in some effective situations and the results of the receiving test for the broadcasting wave.

2. Target Application

As the first target application, we focused the specified low-power radio and receiving the digital television broadcasting wave. The specified low-power radio is useful at 422MHz in Japan and 446MHz in Europe as Personal Mobile Radio. The digital television broadcasting waves are broadcasted at the frequency band from 470MHz to 770MHz. Therefore the target band was decided from 420MHz to 770MHz. In this case, the bandwidth is 59%. And the recommended return loss is less than -9.5dB (VSWR<2.0). This means the trial wearable antenna must have the wideband performance necessarily.

3. Basic Antenna

The basic antenna as the first trial model is made of Flexible Printed Circuit (FPC). Its construction and photograph are shown in Fig.1 and Fig.2. The basic antenna consists of two right-angled triangular elements. Two triangular elements are set symmetrically along the horizontal side of the triangular element and the upper element is slid to left. The length of the horizontal side of the triangular element is 0.25 wave length at the lowest frequency. And the length of the perpendicular side is 0.17 wave length.

Regarding the fed position of the upper element, the distance “d” is slid from the right apex in order to match the input impedance. The measured return loss versus “d” is shown in Fig.3. It is understandable that the input impedance of this antenna is adjustable by “d” and the best value is 80mm. In this case, the measured return loss is less than -9.5dB from 360MHz to 780MHz. So it is confirmed that the basic antenna can be applicable to cover the target band from 422MHz to 770MHz.

ISBN: 978-4-88552-223-9 C3055©IEICE

4. Fabric Antenna

As a next stage, it confirmed the antenna made of the conductive fabric achieved the same performance as the basic antenna. The electrical conductivity of the conductive fabric is $2.8X10^{6}$ S/m. The construction and photograph of the fabric antenna are shown in Fig.4, Fig.5 and Fig.6. The different part from Fig.1 is that "Feed Conductor" shown in Fig.5 is used. Because the conductive fabric cannot be soldered, so "Feed Conductor" made of FPC is attached on it and is coupled with the conductive cloth capacitively. In this case, the thickness of the insulator in Fig.5, which is made of Polyimide, is 0.025mm and the capacitance is $1.3pF/mm^{2}$. "Feed Conductor" is fixed by sewing shown in Fig.6.

The measured return loss of the fabric antenna is shown in Fig.7. It is almost same as that of the basic antenna made of FPC.

Next the measured return loss of the fabric antenna put on the human body is shown in Fig.8. In this case, the wears whose total thickness is approximately 5mm are between the fabric antenna and the human body.

4. Performance of Wideband Wearable Antenna

As third stage, the performances of the fabric antenna were measured under the condition that the person wore the jacket with the antenna. The jacket with the fabric antenna is shown in Fig.9.

The measured return loss versus the human posture is shown in Fig.10. The standing posture, the lean front and the lean back postures are measured. The worst return loss in the target band is -8.9dB at the lean back posture. But the return loss at other postures is less than -9.5dB.

Table1 shows the results of the broadcasting wave receiving test. In order to compare the sensitivity, the standard dipole antenna was also measured. In these results, it is clear that the sensitivity of the basic antenna made of FPC and that of the fabric antenna in the free space are same levels. And both antennas are enough useful in comparison with the standard dipole antenna. But the sensitivity degraded approximately 7dB as the jacket with the antenna was worn because of the influence of the human body.

5. Conclusion

We described the wideband wearable antenna applicable for 400MHz band for the specified low-power radio and from 470MHz to 770MHz for receiving the digital television broadcasting wave in Japan.

This trial wearable antenna achieved the good wideband performance in the both conditions that the antenna is in the free space and on the jacket worn by human body. But the sensitivity degraded much as it on the human body.

As a next stage, we try to improve the sensitivity as it on the human body and measure the effective gain and the radiation pattern in each case.

References

[1] K. Ogawa et al., "A shoulder mounted planar antenna for mobile radio application," IEEE Trans. on Vehicular Technology, vol.49, May 2000.

[2] M. Tanaka, J. H. Jang, "Wearable Microstrip Antenna," IEEE AP-S, International Symposium, Columbus, Ohio, USA, vol.2, pp704-707, June 2003.

[3] C. Cibin et al., "A Flexible Wearable Antenna," IEEE AP-S, Internal Symposium, Monterey, CA, USA, vol.4, pp3589-3592, June 2004

[4] Pekka Salonen, Jaehoon Kim, Yahya Rahmat-Samii, "Dual-Band E-Shaped Patch Wearable Textile Antenna," IEEE AP-S International Symposium, Washington, D.C., USA, vol.1A, pp466-469, July 2005.

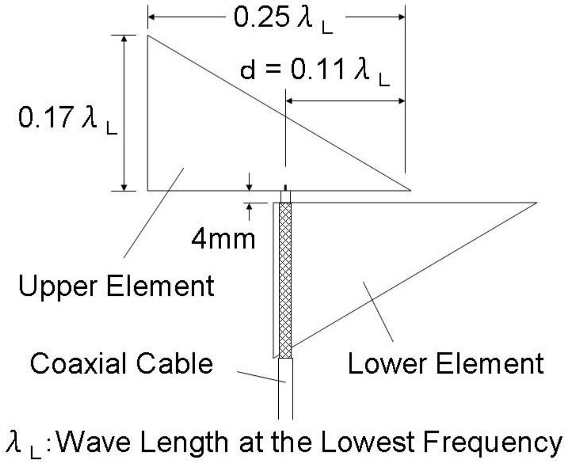

Figure 1: Construction of Basic Antenna

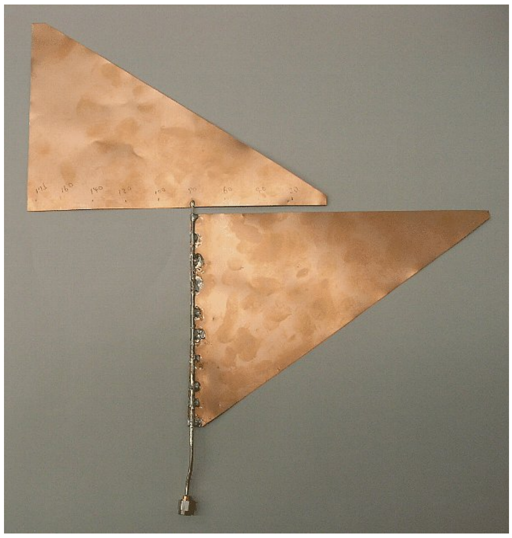

Figure 2: Photograph of Basic Antenna

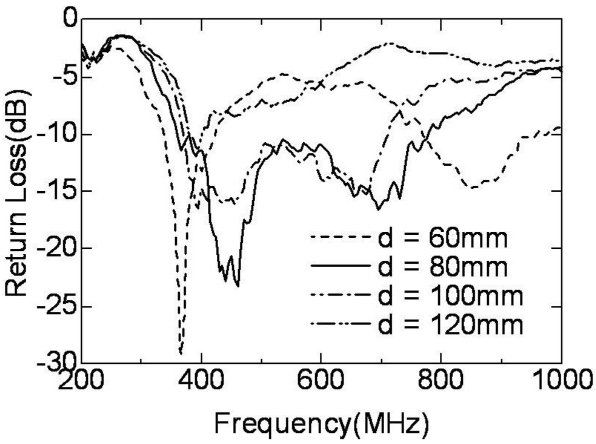

Figure 3: Return Loss versus “d”

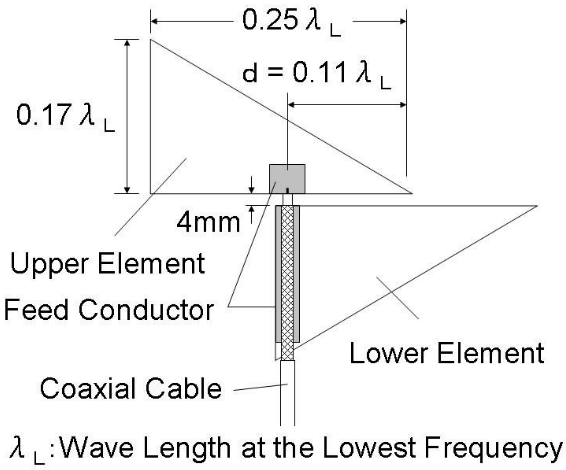

Figure 4: Construction of Fabric Antenna

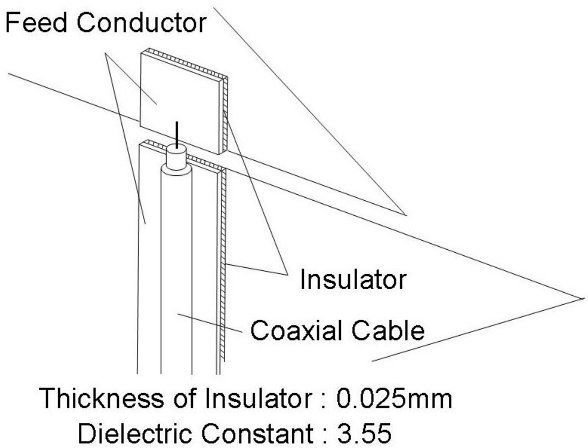

Figure 5: Construction of Feed Part

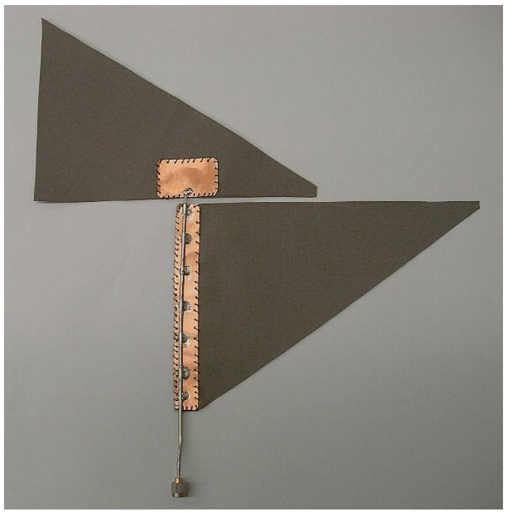

Figure 6: Photograph of Fabric Antenna

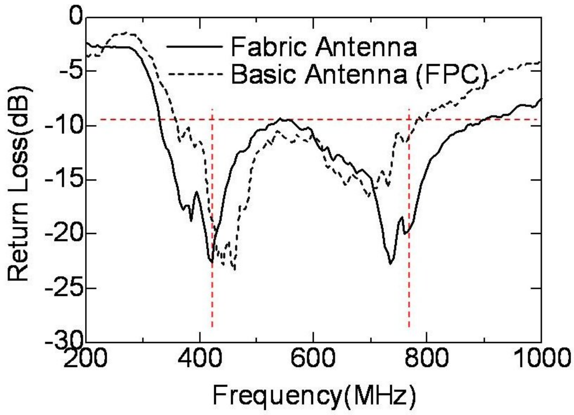

Figure 7: Return Loss of Fabric Antenna

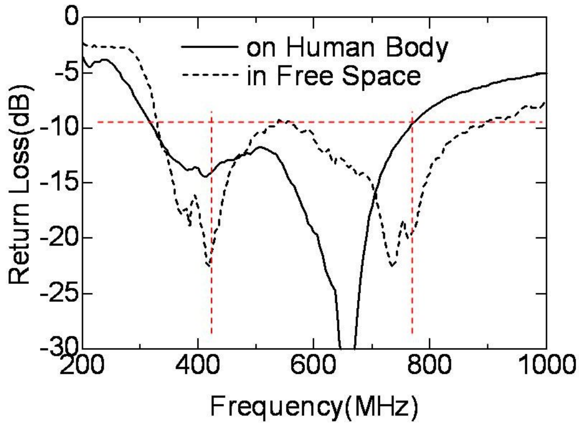

Figure 8: Return Loss on Human Body

Figure 9: Photograph of Wideband Wearable Antenna

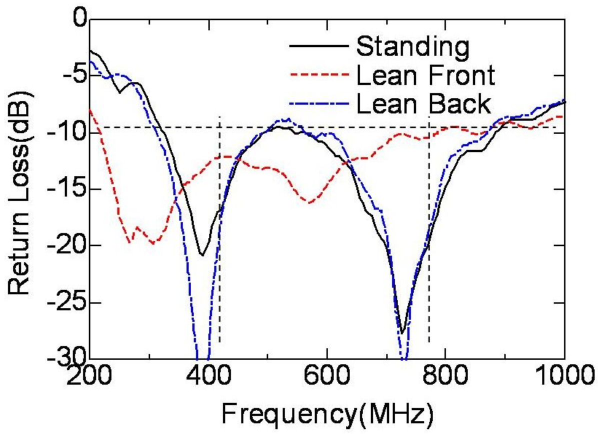

Figure 10: Return Loss versus Human Posture

Table 1: Results of Receiving Test

Antenna Type		Condition	Reciving Level
Standard Dipole Antenna		in Free	−56.2dBm to −60.3dBm
Wideband Wearable Antenna	FPC Type	in Free	−53.5dBm to −58.5dBm
	Fabric Type	in Free	−53.8dBm to −59.2dBm
	Wear Type (Standing Posture)	on Human Body	−61.2Bm to −66.5dBm

Recived Wave Frequency (Broadcasting) : 489.25MHz