Evaluation Related to Finger Position and Rotation of Wearable Dual Band Inverted-F Finger Ring Antenna

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***Abstract*— This paper describes the simulated results of wearable dual band inverted-F finger ring antenna for BAN and evaluation related to finger position shift and rotation of wearable finger ring antenna. VSWR less than 2 at ISM band (2.4 – 2.5 GHz) and WMTS band (915 – 930 MHz) was obtained when the proposed antenna was mounted on finger. The influence of antenna rotation and position shift were clear.**

***Keywords*—component;Wearable antenna, Finger ring type antenna, Dual band antenna, Inverted –F antenna, Rotation, Position shift.**

I. Introduction

BAN antenna can be wearing on finger is desirable. So, wearable antennas for applicable to finger ring size were proposed by authors.[1],[2] These antennas were dual band use for UWB band (7.25-10.25 GHz) and ISM band (2.4 -2.5 GHz). And, these antennas were made of fabric cloth.

In this paper, we discuss the wearable dual band antenna made of conductor such as finger ring to transmit monitoring information of temperature, pulse and heart beat from sensors to finger ring antenna for WMTS band (915-930 MHz) and to transmit information from the finger ring antenna to outside network by using WiFi or wireless LAN for ISM band (2.4 - 2.5 GHz).

Details of the simulated VSWR results and evaluation related to finger position shift and rotation of the proposed antenna are presented.

VSWR less than 2 at ISM band (2.4-2.5 GHz) and WMTS band (915-930 MHz) was obtained when the proposed antenna was mounted on finger. The influence of antenna rotation and position shift are clear.

II. Antenna Configuration

Fig.1 shows the configuration of the proposed dual band wearable finger ring antenna mounted on finger with hand model. This antenna consisted of the two inverted-F antennas for WMTS band and ISM band. The antenna is made of conductor with thickness 0.5 mm and was formed on the cotton cloth with 0.5 mm thickness and $\varepsilon r = 1.2$. And antenna height is 3 mm. The length and width for ISM band are L1 and w1.The length and width for WMTS band are L2 and w1. The length and width of slit between the WMTS band antenna element and the ISM band antenna element is L3 and w3.This antenna was fed by a coaxial cable and its characteristic impedance was 50 Ω.

III. Simulated Results

The theoretical analysis was performed using Ansis-HFSS simulator. In this simulation, the permittivity $\varepsilon = 42.0$ and the conductivity $\sigma = 1.0$ was used in WMTS band. On the other hand, the permittivity $\varepsilon = 39.0$ and the conductivity $\sigma = 1.8$ was used in ISM band. Fig.2 shows the simulated VSWR as a parameter of the antenna element width w1. VSWR less than 2 was obtained at w1 = 3.5 mm in WMTS band. On the other hand, VSWR less than 2 was obtained at w1=4.5 mm in ISM band. The required band width was realized at both band.

VSWR less than 2 at required both band. To realize wide bandwidth, the feed line was shifted X-direction shown in Fig.3. Fig.4 shows the simulated VSWR as a parameter of feed line position X. VSWR less than 2 was obtained for both band at X = -1 mm.

It is necessary that influence of next finger must clear by finger ring antenna rotation. Fig.5 shows the antenna element rotation relative to finger. In this simulation, rotation angle are 0, 90, 180, 270 degrees was used. Fig.6 shows the simulated results. VSWR of the rotation angle 0 and 180 degrees are same results. On the other hand, VSWR of rotation angle 90 and 270 degrees are decreased and resonant frequency was shifted upper frequency.

Next, it is necessary that influence of antenna position shift on finger must clear. Fig.7 shows the antenna element position shift on finger. Fig.8 shows the simulated results as a parameter of antenna element position shift relative to on finger. VSWR was decreased when the antenna shift toward to hand and resonance frequency was shifted lower frequency. Fig.9 shows the simulated radiation pattern results as a YZ horizon directivity. Fig.10 shows the simulated results of current distribution on finger ring antenna with hand and finger. Strong currents were flowed on the fingers as well as on the finger ring antenna. So radiation efficiency was deteriorated as shown in Fig.9.

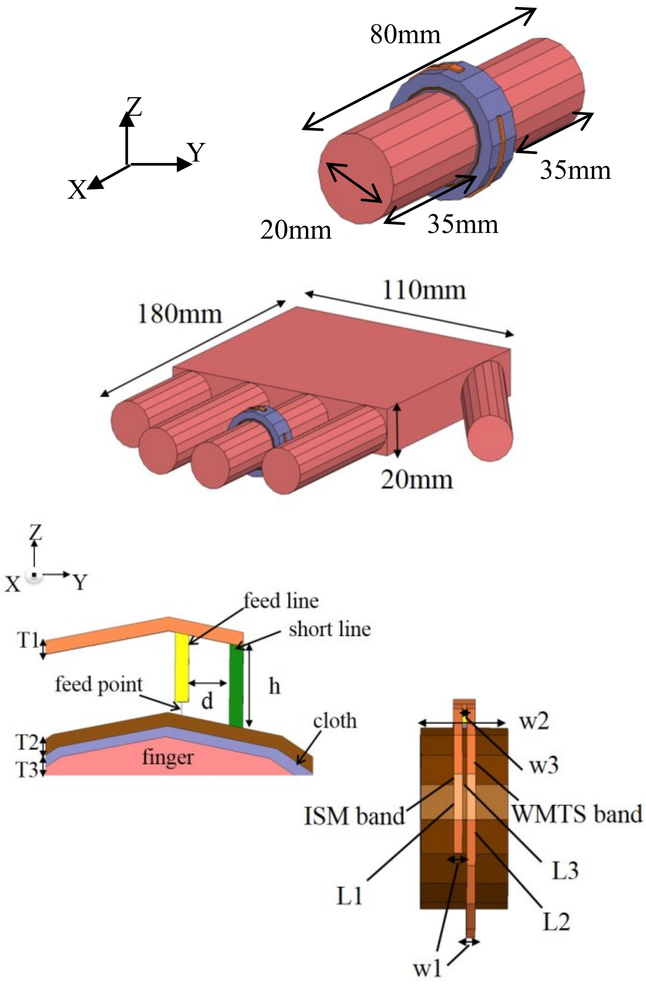
IV. CONCLUSION

This paper describes the simulated results of finger ring type wearable dual band inverted-F antenna for BAN. VSWR less than 2 was obtained at both ISM band (2.4-2.5 GHz) and WMTS band (915-930 MHz) when the proposed antenna was mounted on finger. The required characteristics of the proposed antenna could be achieved when the antenna was rotated and position shifted relative to finger.

REFERENCES

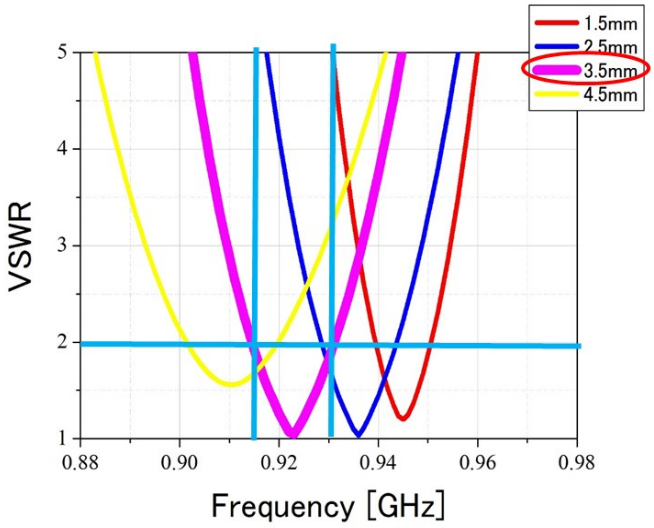
[1] Hiroyuki Sugiyama, Hiroki Goto and Hisao Iwasaki, " Wearable Dual Band Antenna Made of Fabric Cloth for BAN Use," APMC2012 Taiwan, 4D4, December 7, 2012.

[2] Tatsuki Mano and Hisao Iwasaki ,"Plaster Type Dual Band Antenna Made of Fabric Cloth for BAN Use," IEEE APWC2014, Session 18, pp113-116, 2014.

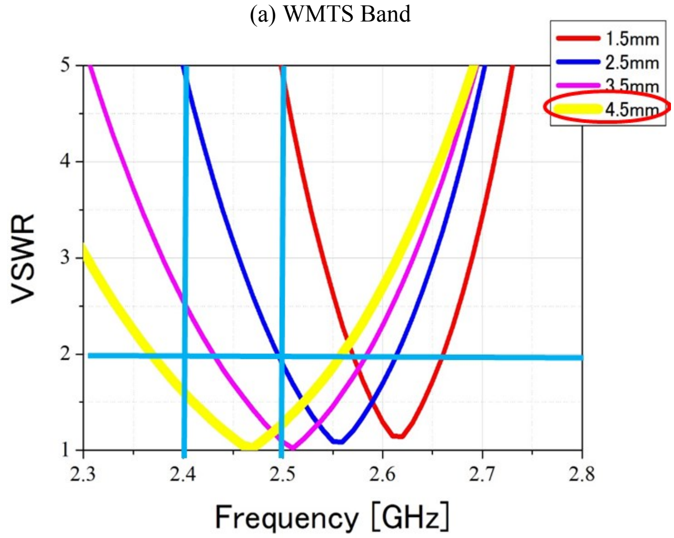


h=3.0,d=2.0,T1=0.5,T2=0.5,T3=0.5,Finger=20.0,w1=parameter,w2=10.0,L1=29.8,L2=76.6,L3=23.8(mm)

Fig. 1. Proposed antenna configuration with finger and hand.



(a) WMTS Band



(b) ISM Band

Fig.2.Simulated results as a parameter of the antenna element width w1.

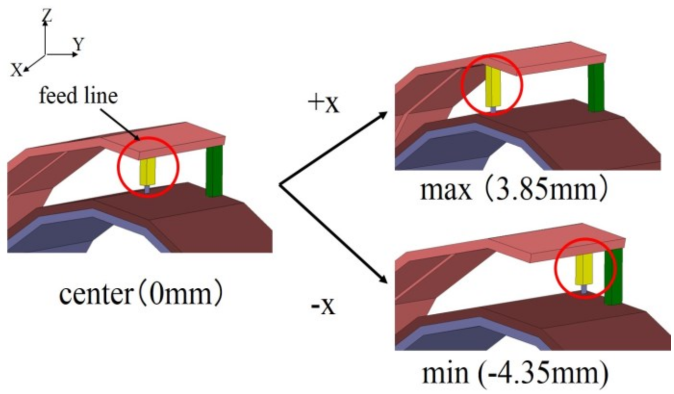
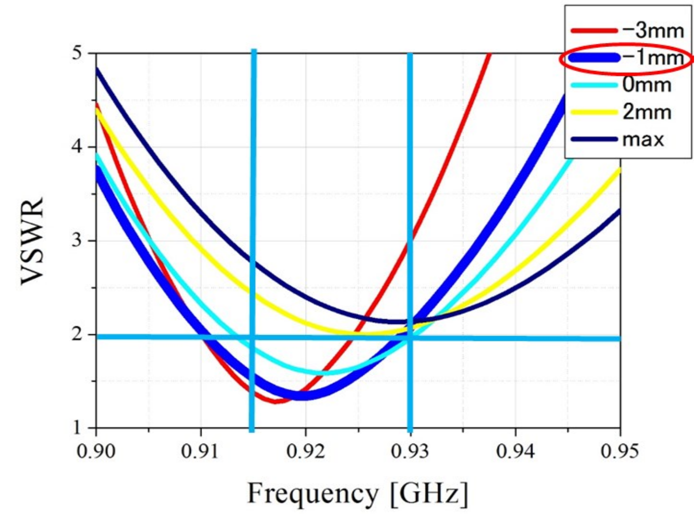
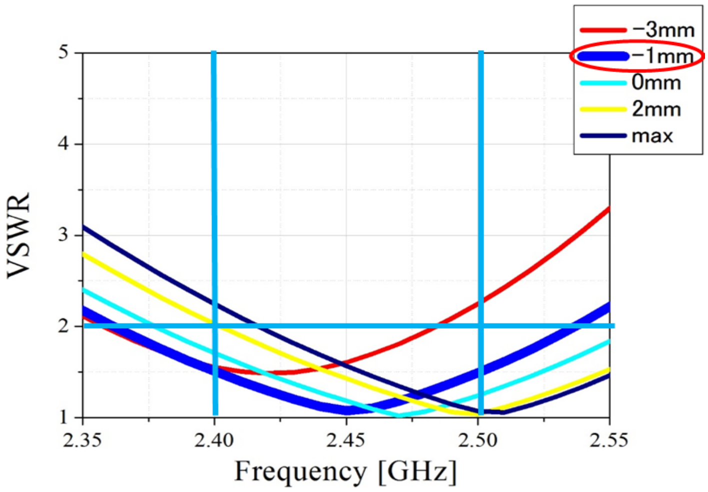


Fig. 3. Feed line position was shifted at toward X-direction.



(a) WMTS Band



(b) ISM Band

Fig.4 Simulated results as a parameter of feed line position X from -4.35 mm to 3.85 mm.

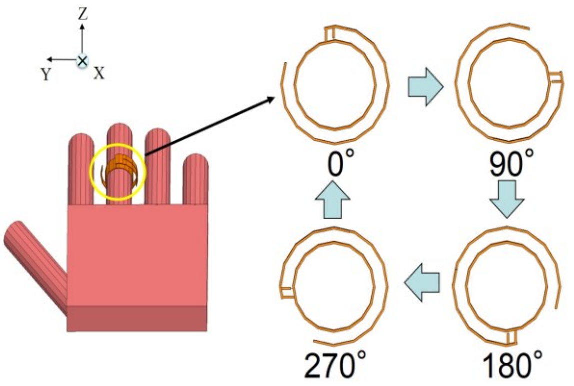
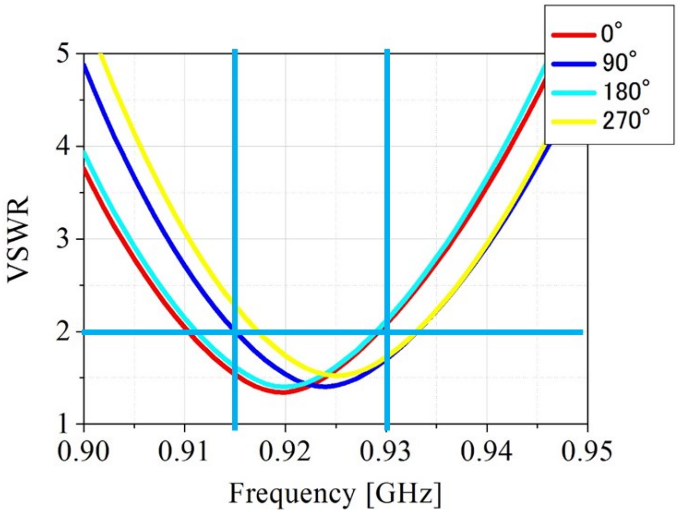
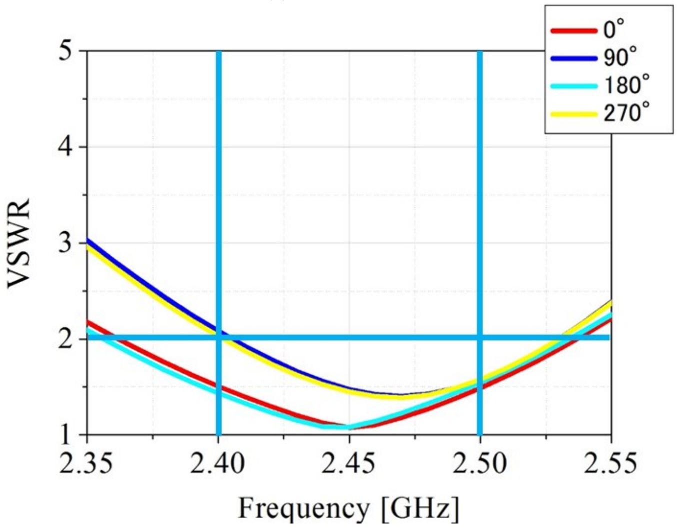


Fig.5 The antenna element rotation relative to finger.



(a) WMTS Band



(b) ISM Band

Fig.6 Simulated results as a parameter of antenna rotation angle.

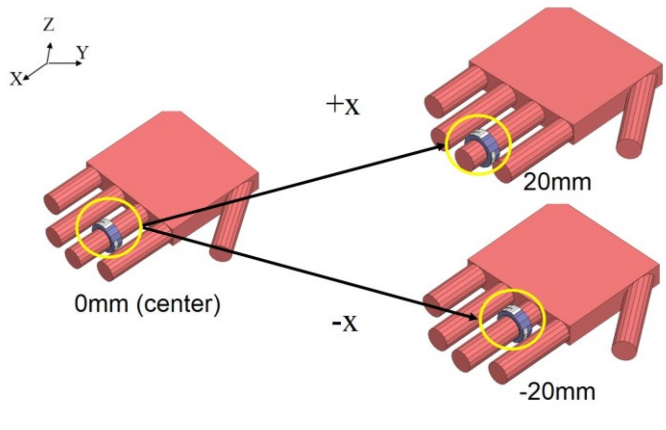
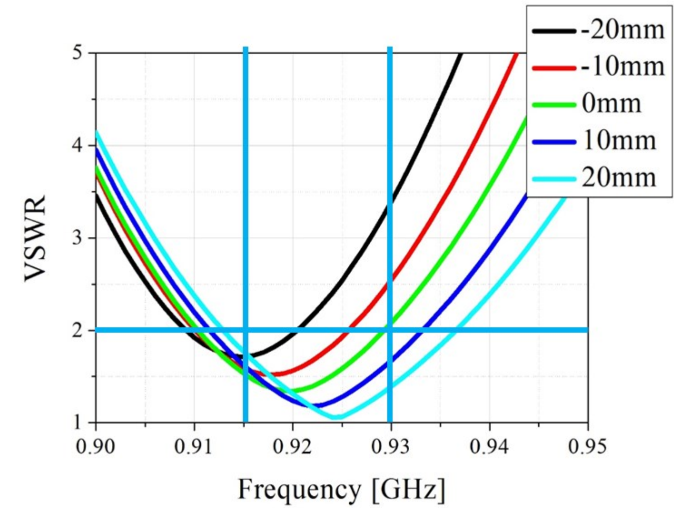
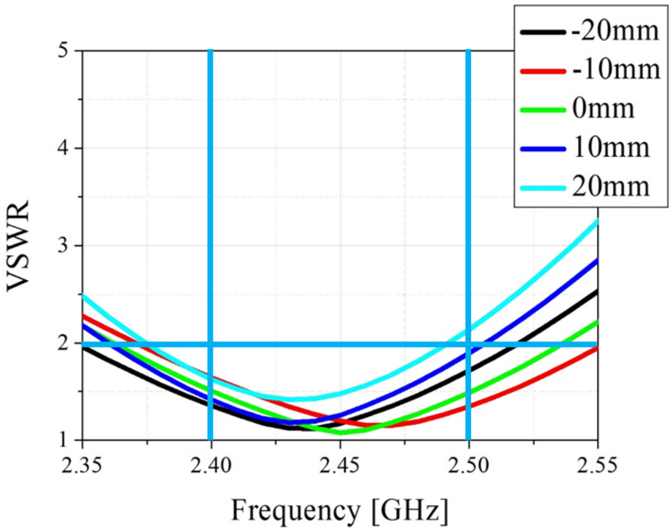


Fig.7 The antenna element position shift on finger.



(a) WMTS Band



(b) ISM Band

Fig.8 Simulated results as a parameter of antenna element position shift relative to on finger.

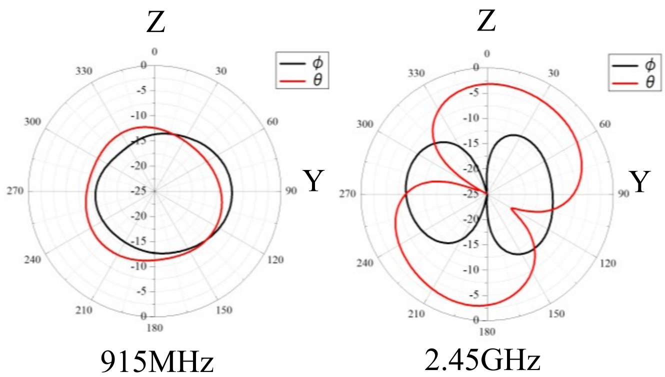


Fig.9 Simulated radiation pattern results as a YZ horizon directivity.

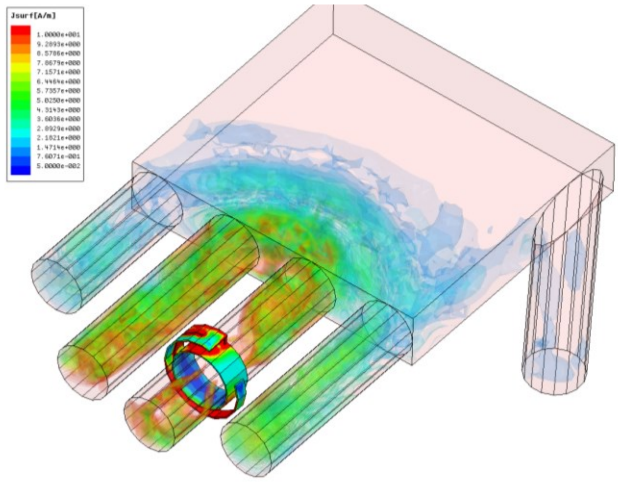


Fig.10 Simulated result of current distribution on finger ring antenna with hand and finger.