Multiband Antenna Composed of 1 Monopole and 4 Parasitic Poles for In-building Mobile Communication

Sung-min Kim[1] and Kyeong-sik Min[1],
[1]Department of radio communication engineering, Korea Maritime and Ocean University,
727 Teajong-ro, Youngdo-ku, 606-791 Busan Korea

***Abstract* - This paper presents a multiband antenna composed of one monopole and four parasitic poles for the in-building mobile system including a firefighting radio band. A center pole is resonated at 450 MHz of the firefighting band, parasitic poles are considered for the multi-resonance and the beam direction control. The measured results such as the reflection coefficients and the radiation patterns of a fabricated antenna are agreed well with the simulation results.**

***Index Terms* — Multiband, Monopole Antenna, Firefighting Radio Service, In-building Mobile Communication.**

I. Introduction

Recently, the mobile communication applications are rapidly developing and also demanded the in-building mobile services [1, 2 ,3]. Furthermore, the firefighting radio system at the in-building is strictly required in Korea. A proposed antenna includes the mobile communication band as well as the firefighting radio band. The detailed dimension such as the disc diameter of a ground plane, the height of center pole and parasitic pole, and distance between center pole and parasitic pole creates a considerable impact to the multi resonant frequency of antenna the bandwidth and the matching input impedance. The radiation pattern direction can be controlled by adjustment of the parasitic pole parameters. The simulation results of a proposed antenna are shown reasonable agreement with the measured results.

II. Antenna Design

Fig. 1 shows the simulation antenna structure. The main circular pole located on the center of antenna is resonated at 450 MHz of the firefighting band, and four circular parasitic poles are considered for multi-resonance such as 890 MHz band of the LTE, 1.8 GHz band of the PCS, 2.0 GHz band of the WCDMA, and 2.45 GHz band of the Wi-Fi. The FR-4 substrate with the relative permittivity of 4.4+j0.02 is used for antenna design. The limited size of a ground plane is 200 mmØ. The diameter of the whole poles is unified by10 mmØ. Table 1 shows the optimized parameters such as pole length, pole diameter, and distance between center pole and parasitic pole.

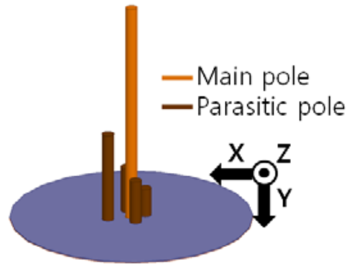


Fig. 1. An optimized antenna structure.

TABLE I
The optimized parameters by iterative simulation

Parameter	Center pole	Parasitic pole # A	Parasitic pole # B	Parasitic pole # C	Parasitic pole # D
Length	183 mm	76 mm	37.5 mm	40 mm	25 mm
Diameter	10 mm	10 mm	10 mm	10 mm	10 mm
Distance between center pole	20 mm	12 mm	12 mm	13 mm	12 mm

III. Measurement Results

Fig. 2 shows a photograph of the fabricated antenna structure. Center pole is directly fed by the feeding power and connected by the SMA connector of 3.5 mmØ. Parasitic poles are connected with the substrate on the ground plane.

Fig. 2. A photograph of a fabricated antenna structure.

Fig. 3 shows the simulated and the measured reflection coefficients for the antenna with only center pole, and for the antenna with one center pole and four parasitic poles. The antenna with only center pole is resonated at 450 MHz band in simulation. However, the measured data of the antenna with only center pole show regular interval resonance. The measured results of the antenna with one center pole and four parasitic poles appears a reasonable agreement with the simulation results. Especially, the measured results are better than the simulated ones at the Wi-Fi band.

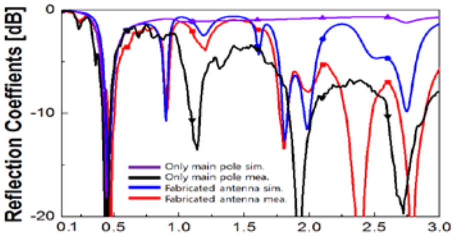
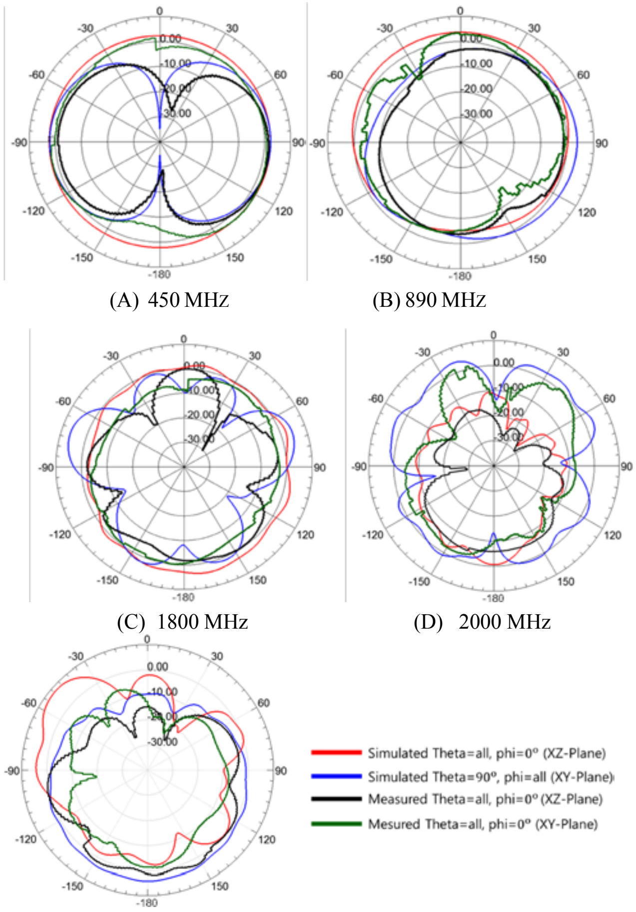


Fig. 3. Simulated and measured reflection coefficients.

Fig. 4 shows the measured radiation pattern and the simulation results at the interested band. It shows very good agreement with each other. However, it has a problem of beam pattern variation at higher mode. In order to solve this problem, the ESPAR technology for direction pattern radiation control is considered and the optimization of the parasitic elements are performed [4].



(A) 450 MHz (B) 890 MHz

(C) 1800 MHz (D) 2000 MHz

(E) 2450 MHz

Fig. 4. Simulated and measured radiation patterns.

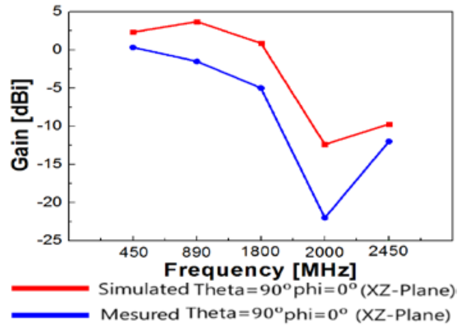


Fig. 5. Comparison between the simulated and the measured gain when theta equals to 90 ° in the XZ-plane.

Fig. 5 shows Comparison between the simulated and the measured gain when theta equals to 90 ° in the XZ-plane. It shows reasonable gain at the interested band except for the WCDMA band. It is the future work.

IV. CONCLUSION

The multiband antenna composed of one monopole and four parasitic poles for the in-building mobile system including a firefighting radio band is proposed in this paper. A center pole is resonated at 450 MHz of the firefighting band, parasitic poles are considered for the multi-resonance and the beam direction control. The measured results such as the reflection coefficients and the radiation patterns of a fabricated antenna are agreed well with the simulation results.

The return loss improvement at the Wi-Fi band and the optimum beam direction control by using parasitic elements remain as a future work.

ACKNOWLEDGMENT

This work (Grats No. S2128775) was supported by Korean Small Business Innovation Research Program and Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education (No. 2013R1A1A 2059944)

REFERENCES

[1] Youngki Lee. Deuk Hyeon Ga, Taeho Song and Jaehoon Choi, "Design of a Wideband Indoor Repeater Antenna With High Isolation for 3G System, *Antennas and Wireless Propagation Letters,* 2010, pp. 697-700

[2] Y.K Lee, J.P Kim, J.P Ja and J.H cho, "Design of a microstrip patch array antenna for WCDMA indoor repeater systems", *2009 Electromagetics in Advanced Application*, 2009 Torino, pp.361~3564

[3] Y-S Lee, "The design of bent monopole anteena for 400MHz ISM bnad application", *Korea Navigation Institute journal*, 2011, pp. 189-196

[4] Bashir Alshami and Gasan Aboulnour, "Design of a Broadband ESPAR Antenna", *2009 Mediternannean Microwabe Symposium Tangier*, Morocoo, 2009, pp.1-6.