A Compact Polyhedron Dipole Antenna for Multi-Band Mobile Communication

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***Abstract* – In this paper, we present a new compact antenna with multi-band characteristics for mobile communication. The antenna structure has a polyhedron shape as a 3D geometry. It is a modified dipole structure to have cooperatively coupled resonant current paths printed on both the sides of an FR-4 substrate. The basic design is carried out by 3D electromagnetic simulating software and the multi-band antenna performance is verified by the fabrication and measurement.**

***Index Terms* —Multi-band antenna, Modified dipole antenna, Coupling**

I. INTRODUCTION

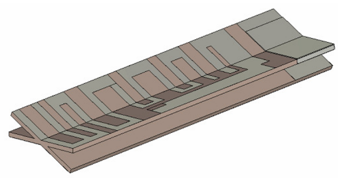
Recently, antennas are desired to have the features of multiband or broad band, easy impedance matching toward the feed line, low profile, etc. for the use in various wireless communication applications. In particular, the mobile industry requires antenna designers to meet the specifications on the size limitation.

Z. D. Hung et al filed a patent of a multi-band dipole [1]. It creates resonance at 2 GHz and 5 GHz with a simply bent metal arms on the top of the dielectric slab, which can't cover low frequencies as below 1 GHz. S.-Y. Lin showed a 3D folded conductor mounted on the top edge of the ground [2]. Its volume is much bigger than the current standard. As a way to decrease the volume and hold more bands, S. Kahng introduced a modified monopole antenna creating the necessary and independent resonant paths in a compact body [3]. Metamaterials can make multi-bands due to the negative- and zeroth order resonance modes as in [4, 5].

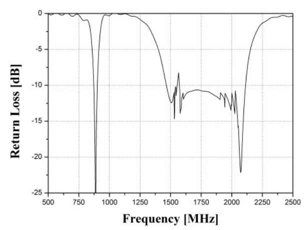
In this paper, we present a single layer multiband printed dipole antenna looking very different from [1-3] for LTE applications. The single arm of the dipole antenna is designed for the lower operating band (910-MHz area), and the ground arm is for the upper operating band (1.7-GHz region). The details of the design of the proposed antenna and the experimental results of the constructed prototype are presented.

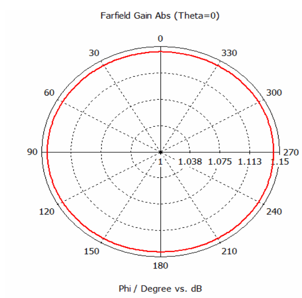
II. DESIGN AND TEST RESULTS

The geometry of the proposed antenna is shown in Fig. 1(a). It is a polyhedron. The meandered arm of the top V-shaped surface is designed for the lower operating band (860MHz~960MHz), and that of the bottom V-shaped surface is for the upper operating band (1.5GHz~1.8GHz). And these arms are cooperatively coupled for multi-band resonance. These patterns are all printed on a 0.8mm-thick FR4 substrate. Each of the two V-shaped surfaces has the substrate as large as $60*15mm^2$, and the acute angle between is 30^o, which can increase the degree of freedom in the design to avoid the unnecessary EM interaction from one resonance path to another. Fig.'s 1(b), and (c) show the simulated return loss and the 2D plots of the radiation pattern.



(a)

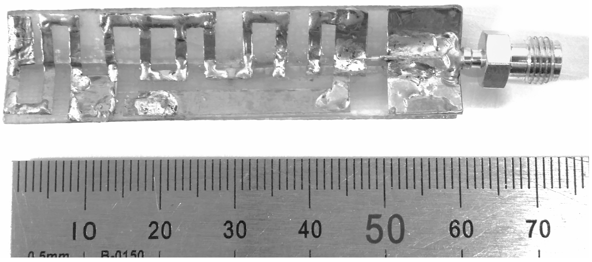




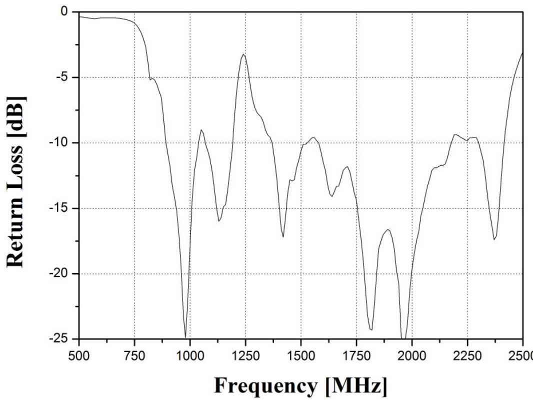
(C)

Fig. 1. Simulated characteristics (a) 3D view of the proposed antenna (b) return loss (c) Omni-directional beam-pattern of the lower band

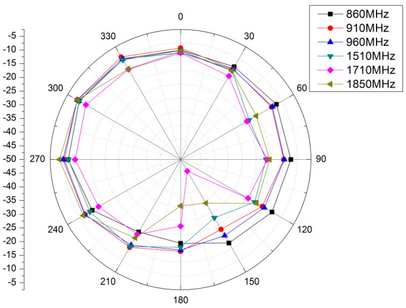
The simulation shows the design follows the properties of the dipole antenna. This is fabricated and measured. The photo of the prototype is given with the measured S_{11} as in Fig. 2. (a) and (b). S_{11} is below -7.36dB (VSWR 2.5:1) as desired and similar to the simulation. Fig. 2. (c) and (d) present the measured radiation patterns for the proposed antenna. The omni-directional feature of the proposed antenna is observed from the two cuts. And the peak gain of antenna is 2.13dB for the lower band, and 1.78dB for the upper band.



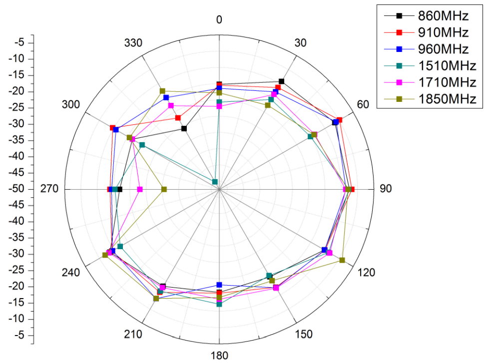
(a)



(b)



(c)



(d)

Fig. 2. Measured results of the proposed antenna (a) Photograph of the prototype (b) Measured return loss of the antenna (c) φ=90°-plane of the radiation pattern (d) θ=90°-plane of the radiation pattern

III. Conclusion

The multi-band antenna is designed to work in 860MHz~960MHz and 1.5GHz~1.8GHz. To satisfy these bands by suppressing unwanted interaction between the structural elements within the geometry, the metal patterns are printed on the surfaces of a polyhedron geometry. The design results present the multi-band performance and the omni-directional patterns in the target frequency bands. This antenna can be adopted to mobile communication.

References

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