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Radiation Characteristics of Dual Planar Elements for Wireless Terminal

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I. INTRODUCTION

An omni-directional antenna such as a whip antenna is suitable for wireless terminals. However, omni-directional radiation pattern cannot avoid influence of human body at talk position. Advantage of a directional antenna is demonstrated [1]. This study concludes that a directional antenna contributes to reduce affects of nearby a human body behind the antenna. Despite of this directional merit, antenna designers encounter difficulties to realize directionality when they face limited antenna space such as wireless terminals.

To overcome this issue, we think that behavior of high-frequency current on a conductive body is a key role. Previous studies are followings. Some investigates isolating radiation from a conductive body [2]. Other investigate that giving different phases on a conductive body change radiation patterns [3]. Moreover, a notch on a conductive body is studied [4]. In this study, a quarter-wavelength notch from a feed point by a quarter-wavelength distance acts as a current choke on a conductive body. Thus, current beyond the notch is reduced significantly. Most of these studies, however, have not mention controlling radiation patterns by current phases on a conductive body.

The purpose of this paper is to propose a novel approach to realize directional radiation by controlling current distribution on a conductive body. We put planar elements to a conductive body with a quarter-wavelength monopole antenna. The elements are shortened to a conductive body at a quarter-wavelength point. The proposed antenna has directional patterns in its horizontal plane. Numerical results show the radiation pattern in a horizontal direction.

II. DESIGN CONCEPT

Essential requirement in wireless terminals is that the antennas should be small but have directional patterns. We propose dual planar elements incorporated into a conductive body to control current distribution. The design method of an array antenna is needed to achieve our proposal.

Figure 1 shows simple models of wireless terminals. These models are comprised of monopole antennas, conductive bodies, a set of dual planar elements and a shorted plane. Monopole antennas are located at one side of each of conductive bodies.

Figure 1(a) shows that a conventional wireless terminal comprised of a monopole antenna mounted on a conductive body. In figure 1(b), length of planar elements #1 and #2 are quarter wavelengths, respectively. These planar elements #1 and #2 are shorted to a conductive body apart from a

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quarter-wavelength distance from a feed point. Widths of both elements are the same.

Figure 2 shows that conventional and proposed antennas with current distribution on wireless terminal. Amplitude levels are the same and phases are opposite between current on the planar element #1 and #2. At the point of its current distribution, the proposed antenna resembles two small dipoles that are closely arrayed in y direction. Directivity of the antenna is controlled by its relative phases and amplitudes of each element dipole. When space between element #1 and #2 are small, amplitude levels of them are the same and phases are opposite. This current distribution is nearly same as an endfire type array antenna [5]. In our proposed approach, directional patterns on y-axis are realized in spite of small antenna volume.

III. RESULTS OF CALCULATION

Numerical approach is done to verify the proposed method. Figure 3 shows simulation models of conventional and proposed wireless terminals. To simplify the model to calculate, minor components such as batteries and shielded boxes are ignored. The test frequency is 2GHz. The size of the conductive board is 120mm x 40mm x10mm (L x W x D). The length of the monopole antenna is 35 mm and its feed point is named point A. The length of Lg is 35 mm. A wire grid is used to simulate the conductive cavities that are typical method of Numerical Electromagnetics code-2 (NEC2), which is a moment method code. The radius of wires is 0.4 mm.

Figure 4 shows current distribution Iz of i1 and i2 elements on the proposed wireless terminals. It is reasonable that this configuration leads to linear element model's operation. The amplitude level of current is normalized at the feed point. The planar elements #1 and #2 acts as a choke circuit at the feed point. Therefore, there is second amplitude peak on the short plane. The currents flowing on the planar elements #1 and #2 are equal in amplitude and opposite in phase. A radiation pattern resembles an endfire type array antenna.

Figure 5 shows radiation patterns (E_θ) in z-y plane of the conventional and the proposed wireless terminals. Radiation intensity is normalized to the maximum value in the z-y plane. The dash line shows the Model A. The separated beam is weaker than that of the maximum value by 13[dB] at θ=90 [degress]. Influence of the current distribution on the conducting body is shown. The solid line shows the Model B. Obviously, gain on y direction is increased by counter current flow.

IV. CONCLUSIONS

This paper describes the dual planar elements that fit fore wireless terminals. The dual planar structure gives choke function at a feed point that leads directional radiation patterns. Simulation is done by NEC2 and each of elements has equal current amplitudes and opposite phases. The proposed antenna is adequate for vicinity of an operator, which requires directional radiation patterns.

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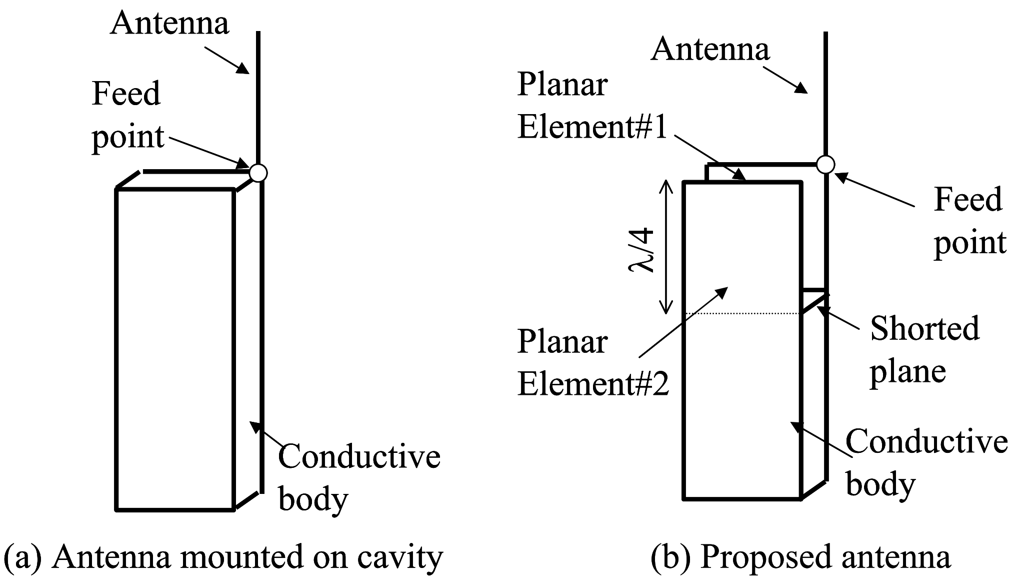

Fig. 1 Simple model of the conventional and the proposed antenna.

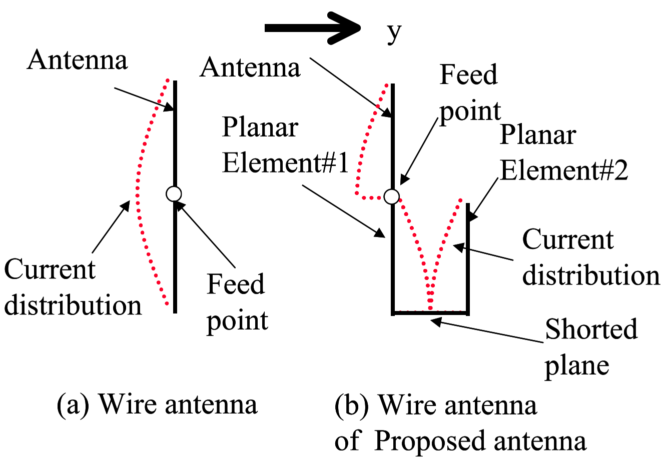

Fig. 2 Current distribution on conductive cavities.

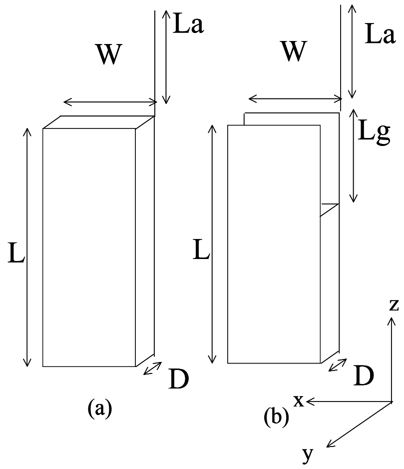

Fig. 3 Simulation models of the conventional and the proposed wireless terminals.

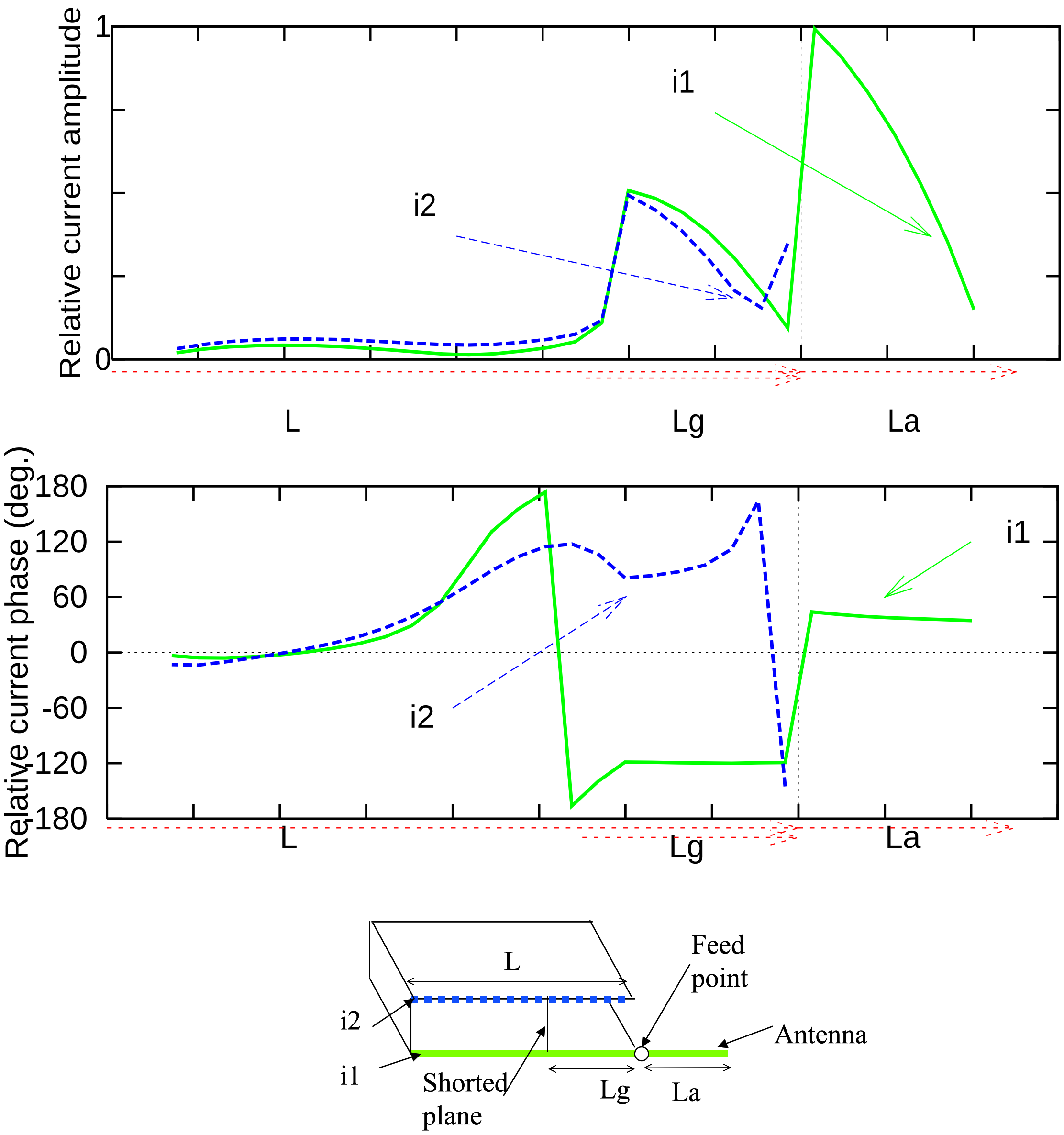

Fig. 4 Current distribution on the proposed wireless terminal.

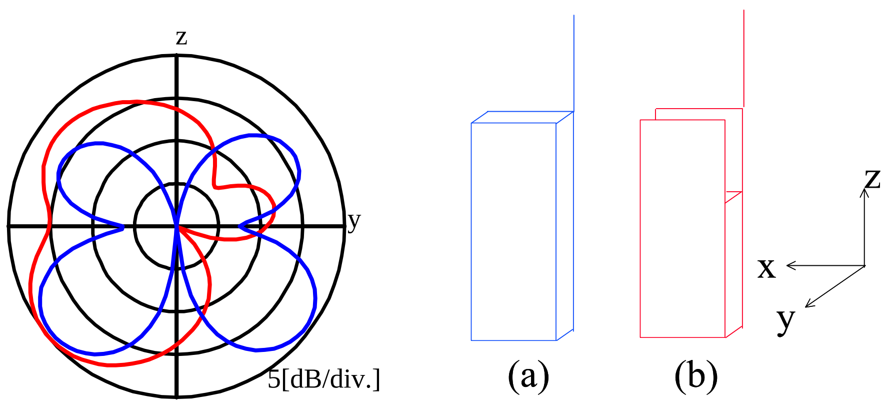

Fig. 5 Radiation pattern of the conventional and the proposed wireless terminals.