A High Port Isolation MIMO Antenna System for 2-6 GHz Wide-Band AP Applications

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\textbf{Abstract} - A novel wide-band multiple-input multiple-output (MIMO) antenna system with high port isolation is proposed. The antenna system consists of three equally spaced antennas mounted on a hollowed triangle ground. The antenna system was designed to operate at frequency bands between 2 and 6 GHz. Each antenna mainly comprises of a shorted, inverted wide L (shorted iWL, a unique feeding design), sitting on a vertical ground attached to the horizontal plane of triangular shape. From simulation and experimental results, the proposed MIMO system exhibited superb characteristics at 2.4, 3.5 and 5 GHz bands, with significant isolation performance due to the design of the practical and novel ground structure.

\textbf{Index Terms} — Wide-band Antennas, MIMO antenna, Polarization, Port isolation.

\section{I. INTRODUCTION}
Recently, the multi-band or broadband antennas have attracted intense interest in antenna design for wireless communication systems [1, 2]. The planar monopole antenna is a good candidate because of its simple structure, low cost, and easy-to-manufacture characteristics. There are also many published studies on antenna designs for wireless local area network (WLAN) and World Interoperability for Microwave Access (WiMAX) at 2.4 GHz (2.4–2.48GHz), 3.5 GHz(3.4-3.6 GHz), and 5 GHz (5.15–5.85GHz) bands [3, 4].

Many 802.11n wireless products, which utilize the multi-band or broadband antennas, are in fact available in the marketplace [5, 6], and some of them utilized multi-input multi-output (MIMO) technology on their designs [7, 8]. Numerous research papers on MIMO antennas embedded in mobile devices, i.e. the client end, have also been reported [9]. However, only a few studies, which address access-point (AP) application, i.e., the server end, were published [10]. In this article, we present a MIMO antenna design, consisting of three antennas with 3-D metal structures, for AP applications.

Design and experimental results for the proposed MIMO antenna are presented in the following sections.

\section{II. ANTENNA DESIGN}

Fig. 1 shows the geometry of the proposed MIMO antenna. The system consists of three antennas denoted as ant-1, 2, 3 and are 120° apart. The three antennas are mounted on separated vertical ground planes, which sit on a horizontal hollowed triangular plane. The vertical ground size is about 50×40 mm\textsuperscript{2}. The antennas were all formed of a rectangular patch, which size was 41×20 mm\textsuperscript{2} and bent for miniaturization purpose. The antennas were grounded by a fine metal piece for impedance matching, Fig. 1c. The MIMO antennas were each excited by a mini coaxial-line. The hollowed triangular ground was designed to achieve in-band isolation.

\section{III. EXPERIMENT AND RESULTS}

The measured return losses of the antennas are shown in Fig. 2. The antenna are shown to have good matching ($S_{\text{NN}}$) and isolation ($S_{\text{MN}}$) characteristics ($S_{\text{NN}}$ < -10 dB and $S_{\text{MN}}$< -20 dB, M, N=1, 2, 3) over the frequency bands.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{fig1.png}
\caption{Configuration, photo, and dimensions of the proposed antenna.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{fig2.png}
\caption{Measured S-parameter ($S_{\text{NN}}$/$S_{\text{MN}}$) of the proposed MIMO antenna.}
\end{figure}
IV. CONCLUSION

A novel wide-band MIMO antenna system with high port isolation is proposed. The antenna consists of three antennas for MIMO AP applications. They sit on a vertical ground attached to a hollowed, triangular, horizontal ground designed to achieve high in-band isolation. The antenna has a unique feed structure, i.e., a shorted, inverted wide L (iWL).

The antenna have good matching and isolation characteristics ($S_{11}$ < -10 dB and $S_{12}$< -20 dB, M, N=1, 2, 3) over a wide frequency range of 2.3-5.9 GHz. The antenna yields peak gains varied from 3 to 5 dBi, and antenna radiation efficiency were about 80-90 % at the operating bands. The antenna port Envelope Correlation Coefficient (ECC) was less than about 0.03. Moreover, the antenna is easy to fabricate and suitable for any access point (AP, i.e., hot spot) applications at the WLAN/WiMAX bands.

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