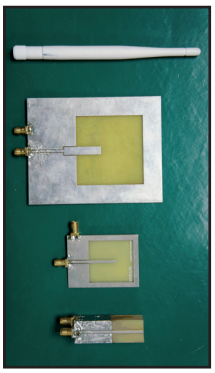


2.4 GHz MIMO antennas from Tsinghua University

FURTHER READING

http://oa.ee.tsinghua.edu.cn/~zjzhang/indexe.htm

Y. Li, Z. Zhang, J. Zheng, and Z. Feng, 'Dual polarised monopole-slot co-located MIMO antenna for small-volume terminals', 2011, *Electron. Lett.*, **47**, (23), pp. 1259–1260

MIMO wraps up

Researchers at Tsinghua University have taken a 3D approach to MIMO antennas and have built a 2.4 GHz MIMO antenna for WLAN applications that is much smaller than previous designs but still has high isolation and good omnidirectional coverage.

The isolation issue

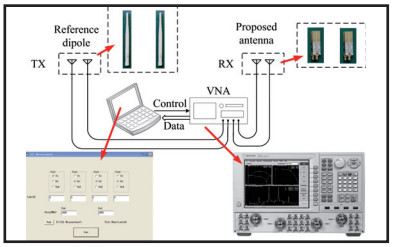
The spectrum efficiency and transmission quality of wireless communication systems are improved through the use of multiple antennas at both the transmit and receive ends. MIMO antennas are being widely researched at the moment as they enable the use of the spatial degree of freedom in a wireless multipath channel, and they form a key technology for future wireless communication systems such as 3GPP, LTE, WiMAX 802.16, IEEE 802.20 and IMT-Advanced.

At the moment MIMO antennas are only adopted in some large static base stations. This is because in these space-separated antenna arrays, nearly half of the wavelength is needed to achieve acceptable isolation; about 15 dB for most situations. In modern communication systems, the space is limited in both the base stations and the mobile terminals, and as the antennas shrink in size, the mutual coupling between the elements increasingly restricts the performance. The design of antennas for a space-limited MIMO system is therefore still a challenge.

A couple of challenges

Two previous methods have been used to reduce the size. First, decoupling circuits with lumped components reduce the mutual coupling between elements, but the space between two antennas can only be reduced to slightly less than half a wavelength, high loss is introduced, and it is a complicated arrangement. Secondly, two antenna elements can be arranged orthogonally, and antennas with different polarisations can be arranged together to save on space. However, the size of the orthogonal array is still large, and cannot be decreased without deterioration of the mutual coupling, and the feeding network is difficult to design in a compact structure.

The group from the State Key Lab of Microwaves and Communications at Tsinghua University has focused on MIMO antenna design for about the last 20 years. To address the latest requirements of MIMO systems, they have designed different 2.4 GHz dual-polarised antennas. Having previously worked on orthogonal antenna arrangements, they took a different approach in their Letter which appeared in the last issue (23) of *Electronics Letters*, and designed a co-located MIMO antenna using a monopole and a slot element.



ABOVE: A testbench system is composed of a Vector network analyser, transmit and receive antennas, a computer and RF cables. Two reference dipoles are utilised as the transmit antennas (TX), and two test antennas are used as the receive antennas (RX). The 2 × 2 antennas are connected to the 4 ports of the VNA

ABOVE TOP: The Tsinghua group have recently developed several 2.4 GHz dual-polarised antennas. Top to bottom: Two reference dipole with single polarisation; dual-polarised slot antenna with bidirectional radiation patterns; same antenna as previously but with a loop element rather than a slot element; and the co-located MIMO antenna

Space saving

In order to reduce the volume of the antenna, the researchers folded the ground of the monopole to create a 3D column structure. This gave them the dimensions of $50 \times 16 \times 16$ mm^3 ($0.4\ \lambda_0 \times 0.128\ \lambda_0 \times 0.128\ \lambda_0$, where λ_0 is the wavelength in free space). They were able to enhance the isolation to over 24 dB by creating a perfectly symmetrical structure from the monopole and the slot.

Another merit of this design is the omnidirectional radiation pattern for both polarisations, which is required by omnidirectional coverage of base stations. For a typical dual-polarised MIMO antenna design, the antenna is unidirectional or bidirectional due to the large ground. The Tsinghua team showed that their folded ground design also achieves a good omnidirectional coverage and it can be mounted in portable access points with better performance than dipole antennas of single polarisation.

As the performance of MIMO antennas is dependent on their environment, the team next plan to measure the channel capacity of a 2 × 2 MIMO system in different indoor scenarios, for which they have designed their own measurement system.

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