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出國報告（ 出國類別：其他 (國際會議) ）

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出席 2015 天線與傳播及無線電科學聯合國際會議心得報告

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服務機關：國立暨南國際大學電機工程學系
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派赴國家：加拿大

出國期間：104 年 7 月 19 日至 104 年 7 月 24 日

報告日期：104 年 10 月 19 日

摘要

國立暨南國際大學電機工程學系翁偉中副教授參加於 2015 年 07 月 19 日至 24 日於加拿大、溫哥華市舉行之 2015 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting (2015 天線與傳播及無線電科學聯合國際會議)。本心得報告介紹本研討會性質、參加會議期間之過程、並對參加此次研討會提出心得及建議。

藉由參加此次國際會議提供了與其他相關學者彼此溝通、交流新知的機會，可增廣見聞，還可開闊視野，對於個人未來的研究十分有幫助，可說是獲益良多，不虛此行。

目次

頁數

目的：

1. 參加 “2015 天線與傳播及無線電科學聯合國際會議 ” 並發表論文。
2. 積極與各國學者交換意見，尋求合作的機會。了解各國的研究動態，以擴展研究視野。

過程：

此次參加之研討會爲 2015 IEEE 天線與傳播及無線電科學聯合國際會議 (2015 APS) 於 2015 年 07 月 19 日至 24 日於 加拿大、溫哥華市 Westin Bayshore Hotel 舉行。本人於 7 月 18 日上午前往桃園機場搭乘飛機，飛往會議地點加拿大、溫哥華市，歷經約 13 個小時的飛行時間，於當地時間晚上約 6 時抵達溫哥華國際機場，隨即赴旅館下榻休息。在前往旅館之途中經過溫哥華市區，對市區道路整潔美觀，四周充滿著英式歷史建築及現代化建築印象深刻。

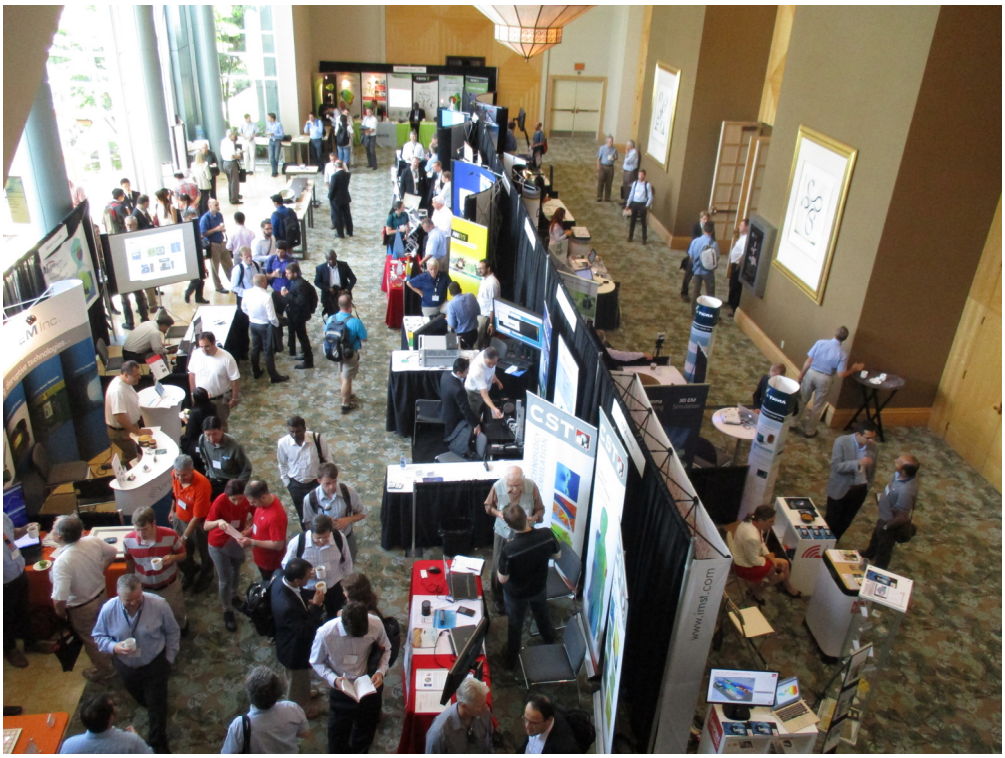
溫哥華市區街景之一

溫哥華市區街景之二

隔天一早即前往會議地點 Westin Bayshore Hotel 領取會議相關資料，並熟悉會場的環境與標記重要議程。會議期間筆者每天即根據自己的專長及興趣，分別前往各個不同的場次聆聽論文發表，有時並向演講者發問或互相討論。IEEE 天線與傳播及無線電科學聯合國際會議爲電波領域中最大型及最重要的國際會議，主要特色爲在天線設計及電波傳播領域之最新發展及技術，每年與 URSI 會議聯合於美加地區舉行，每次皆有約上千篇論文發表，領域涵蓋天線、微波、計算電磁、高頻方法、最佳化方法、電磁建模、RFID 系統與應用等電磁、及通訊等。會議參與者主要來自全世界地區國家學術單位及相關業者。今年會議參加者相當踴躍，估計約有六百多人與會。

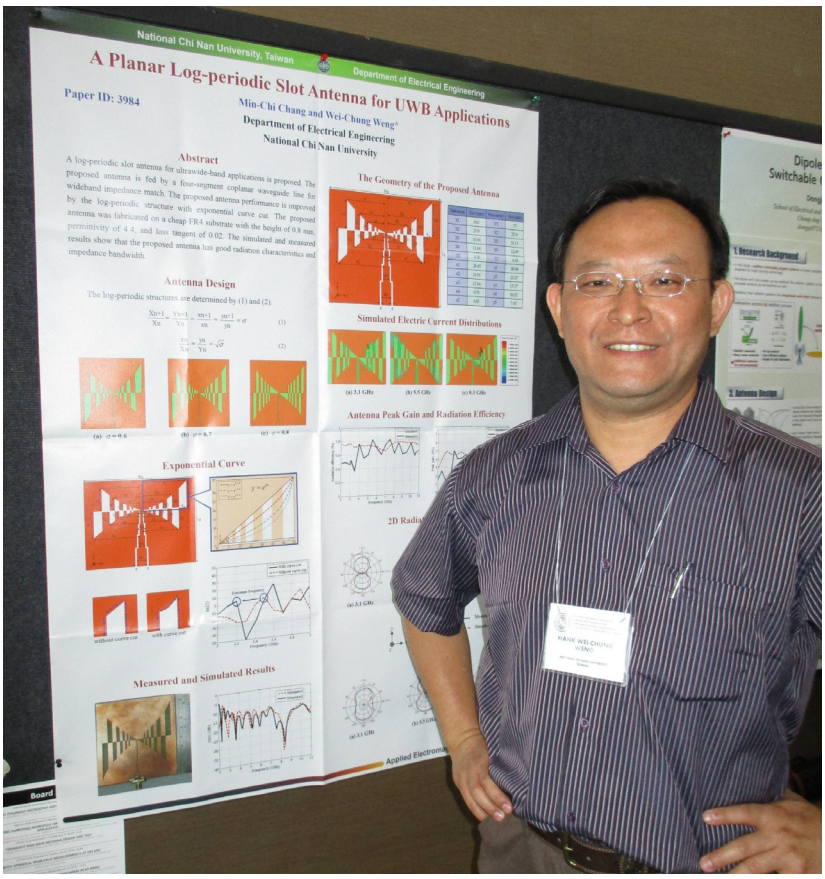
會議地點 Westin Bayshore Hotel

會議報到處領取資料



會場業界展出情形

本人此次在會議中共發表兩篇論文，一篇論文安排在 7 月 22 日 15:20 - 15:40 的 oral session 發表，論文題目爲『A Printed Multi-band Slot Antenna for LTE/WLAN Applications』，另外一篇論文安排在同日 14:40 - 16:20 的 poster session 發表，論文題目爲 『A Planar Log-periodic Slot Antenna for UWB Applications』。在本人發表兩篇論文期間有學者對所題提出論文提出寶貴及具體建議，對提升論文的研究價值有莫大幫助。另外，在會議期間，本人也抽空瀏覽其他的論文海報，並與一些作者對其論文討論、交換意見。除了在會議中發表兩篇論文之外，本人也參加審稿人會議 (Reviewer meeting)，並且與其他審稿專家交換意見。在大會精心安排下，會議過程進行緊湊而充實，也由於各界專家學者的共襄盛舉，讓整個會議過程圓滿順利。在參加完 6 日的議程後，本人前往機場搭機返回台灣。



筆者於 poster session 發表論文之會場照片

會場情形之一

心得及建議事項：

與會心得:

由於主辦單位的努力，此次研討會可說是歷年來研究成果最爲豐碩的一次，在六天的行程中，此次參加會議，主要是報告被錄取的論文、聽取其他與會者的論文發表，並與其交換心得。筆者不僅觀摩各國學術方面的研究成果，也嗅到了未來的研究方向與產業的趨勢。筆者發現與會者來自世界各地區，其中來自亞洲地區的與會者大多來自日本、中國、新加坡、臺灣等國。筆者感受到唯有與世界接軌，透過良性的競爭，多與各國學者聯繫互動，多認識了解各國的研究動態，才得以擴展研究視野。由於此會議主題涵蓋電磁領域之最新發展，參與此次會議可說是獲益良多，不虛此行。此類國際會議提供了相關學者彼此溝通、交流新知的機會，對於個人未來的研究十分有幫助，藉由參加國際會議、並積極地研讀此次會議的諸多論文，可吸取新知並觸發新的想法，對我們實驗室未來發展更成熟完備的技術的目標深有助益。

會場情形之二

建議事項：

本人著實感謝本校及研發處提供經費補助，使我能出國參加此會議，除了吸收新知、擴展視野以外，發表個人的論文也意味著所從事的研究受到國際的肯定。因此，也期待本校、科技部、或政府相關機構未來能繼續補助支持教師及學生參加此類國際學術會議。

攜回資料名稱及內容：

1. 2015 IEEE 天線與傳播及無線電科學聯合國際會議議程摘要一本。
2. 2015 IEEE 天線與傳播及無線電科學聯合國際會議論文集 USB 碟一支。

附錄：發表論文

1. 『 A Printed Multi-band Slot Antenna for LTE/WLAN Applications』
2. 『A Planar Log-periodic Slot Antenna for UWB Applications』

A Printed Multi-band Slot Antenna for LTE/WLAN Applications

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***Abstract*—A multi-band printed slot antenna for applications of Long Term Evolution and wireless local area network has been designed. The proposed antenna operates at the quarter-wavelength resonant mode by using two open-ended, U-shaped slots to reduce the required antenna size. The proposed antenna can excite the multi resonant frequencies to cover the operating bands of LTE (700 MHz; 2600 MHz) and WLAN (2.45 GHz; 5.5 GHz). The antenna is compact with the substrate size of 46.8 mm by 10.0 mm. Simulated results show that the proposed antenna has good impedance bandwidth and good radiation characteristics in operating bands.**

I. INTRODUCTION

With the development of wireless communication systems, the services of third-generation (3 G) communication could not enough for people to use. Hence, Long Term Evolution (LTE) [1], whose spectrums are 700 MHz (698 - 787 MHz) and 2600 MHz (2500 - 2690 MHz), has been developing to replace the 3 G system and has been receiving much attention recently [2]–[5].

Since the wireless local area network (WLAN) has still been using [6]–[9], antennas in mobile devices operating in LTE and WLAN bands are desired. However, the design of the multi-band antenna is a challenging task especially when the size of the antenna is compact.

In this study, a multi-band antenna with two open-ended, U-shaped slots is designed for the LTE and WLAN applications. The proposed antenna operates at the quarter-wavelength resonant modes while the size of the antenna is still compact. Simulated and measured results show that the proposed antenna can cover the spectrum of LTE (700 MHz and 2.6 GHz) and WLAN (2.45 GHz, and 5.5 GHz).

II. ANTENNA DESIGN

Fig. 1 shows the geometry of the proposed slot antenna. The antenna is fabricated on an FR4 substrate with a thickness of 1.6 mm, relative permittivity (ε_r) of 4.4, and loss tangent of 0.02. The proposed antenna consists of two U-shaped, open-ended slots on the ground plane and a microstrip fed line. The open-ended slot configuration is adopted to reduce the antenna size required since it operates at the quarter-wavelength

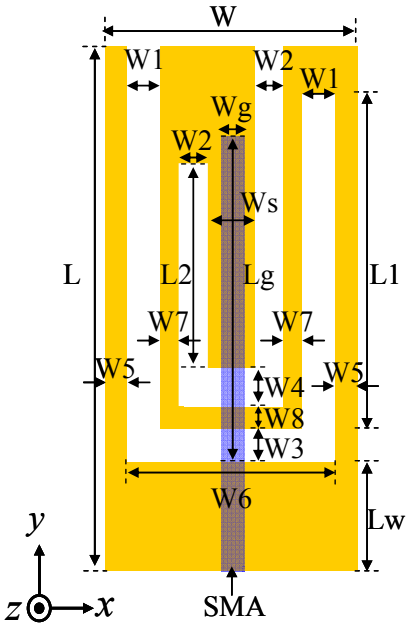

Fig. 1. The geometry of the proposed antenna.

resonant modes. In Fig. 1, the longer slot can excite lower resonant frequencies while the shorter slot can excite higher ones, hence, multi resonant frequencies are excited to form wider impedance bandwidth at the operating bands by using the proposed antenna configuration. The proposed slot antenna is fed by a microstrip with the width of Wg and length of (Lw + Lg). The microstrip is connected to a 50 Ω standard miniature adapter (SMA). Table I lists the dimensions of the proposed slot antenna. The size of the antenna is 46.8 mm by 10.0 mm.

Fig. 2 shows the measured and simulated reflection coefficients |S11| of the proposed antenna. The simulated and measured results are obtained by a finite element method based simulator, Ansoft HFSS and by a vector network analyzer, Agilent 8753D, respectively. A reasonable agreement can be seen in Fig. 2. The measured impedance bandwidths (-6 dB) of the three operating bands are 30 MHz (4.2 %), 870 MHz (35.5 %), and 1320 MHz (24 %). Fig. 3 shows the simulated

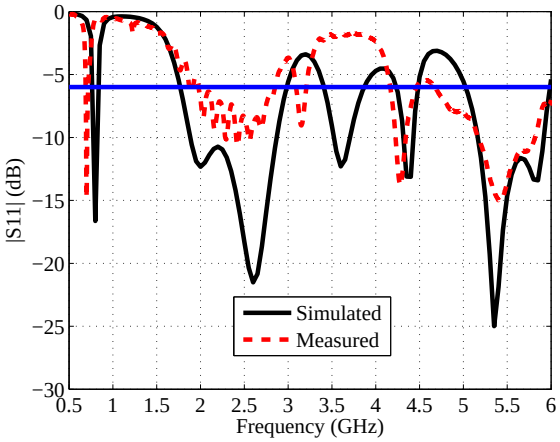

Fig. 2. |S11| results of the proposed antenna.

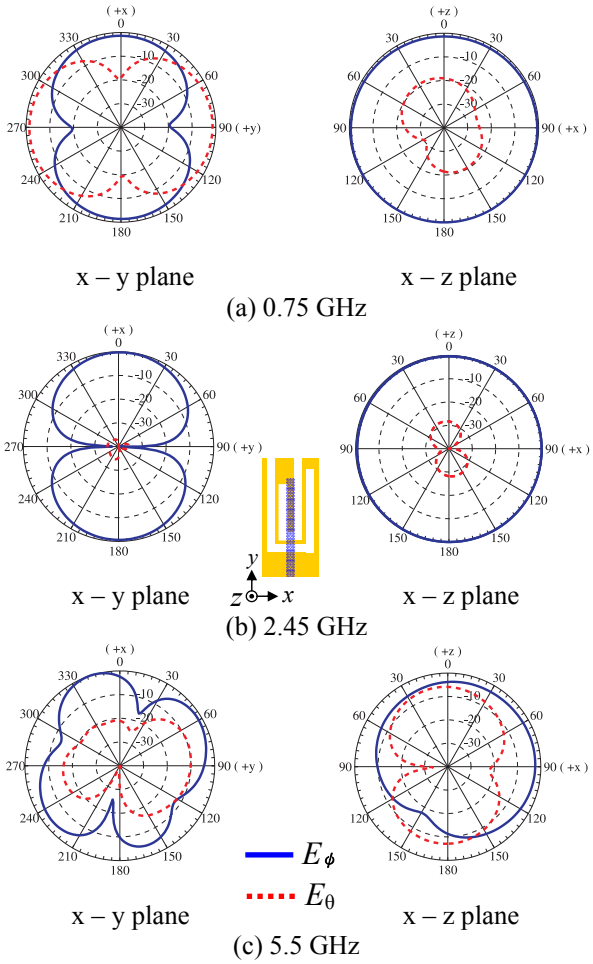

Fig. 3. Simulated radiation patterns of the proposed antenna.

TABLE I. THE DIMENSIONS OF THE PROPOSED ANTENNAS. (UNIT: MM)

Parameter	L	L1	W1	L2
Size	46.8	12.4	0.7	12.0
Parameter	W2	W3	W4	Lg
Size	1.5	1.85	1.85	24.0
Parameter	Wg	Lw	W5	W6
Size	1.1	14.0	0.5	9.0
Parameter	W7	W8	Ws	W
Size	0.9	0.9	3.4	10.0

radiation patterns in the x-z plane and in the x-y plane at 0.75 GHz, 2.45 GHz, and 5.5 GHz, respectively. The proposed antenna has omni-directional radiation patterns in the x-z plane at 0.7 GHz and 2.45 GHz. The simulated peak gains of the proposed antenna are 0.28 dBi, 1.32 dBi, and 0.45 dBi at 0.75 GHz, 2.45 GHz, and 5.5 GHz, respectively.

III. CONCLUSION

A printed multi-band slot antenna for LTE and WLAN applications was successfully achieved. The antenna has a compact antenna size of 46.8 mm by 10.0 mm. The antenna has good characteristics of impedance bandwidths and radiation patterns in the bands of interest.

ACKNOWLEDGEMENT

This work was supported by the National Science Council under Grants 101-2221-E-260-020.

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A Planar Log-periodic Slot Antenna for UWB Applications

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A log-periodic slot antenna for ultra-wideband applications is proposed as shown in Fig. 1. The proposed antenna consists of a coplanar waveguide (CPW) line and log-periodic slots. The proposed antenna is to be fabricated on a cheap FR4 substrate with the height of 0.8 mm, permittivity of 4.4, and loss tangent of 0.02. The CPW line has four segments for wideband impedance match. The geometry of the slots is determined by exponential curves, which can be achieved by formulas of $Xn+1 = \sigma Xn$, $xn+1 = \sigma xn$, $Yn+1 = \sigma Yn$, and $yn+1 = \sigma yn$, where σ is set to 0.7 in this study. The length of (X1 + Y1) is about half wavelength of the lowest frequency in the band of interest.

Fig. 2 shows the measured and simulated |S11| of the proposed slot UWB antenna. The two results agree well with each other. The measured |S11| shows that the frequency range (|S11| below -10 dB) is from 2.9 GHz up to 11 GHz, which covers the UWB spectrum (3.1 – 10.6 GHz). The simulated peak gain shows that the proposed antenna has stable gain about 4.5 dBi in the UWB band. Therefore, the proposed antenna is a good candidate for the UWB applications. Other results such as design procedure, parametric study, current distribution, and radiation pattern of the proposed log-periodic slot UWB antenna will be presented in the meeting.

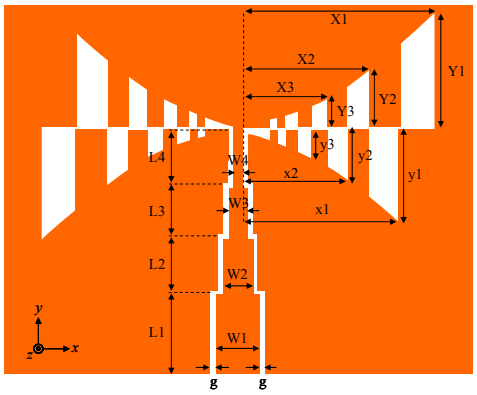

Fig. 1. The geometry of the proposed log-periodic slot UWB antenna.

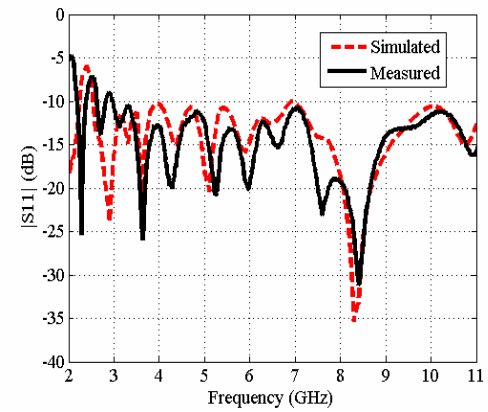

Fig. 2. The measured and simulated |S11| of the proposed antenna.