適應性 MIMO-OFDM 系統
於 FPGA 與 DSP 之實現

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摘要

正交分頻多工(OFDM)技術因可提供高速數據傳輸，且適合操作在多重路徑所引起之頻率選擇性通道下，故能在未來無線通訊系統中成為一種備受矚目之技術；另一方面，多輸入多輸出(MIMO)技術具有極大潛力可提升傳輸率及鏈路品質。當 OFDM 技術與 MIMO 技術結合後，將變得更適於下一代無線通訊系統，而這也激發吾人進行硬體實現工作之意願，而非僅止於理論分析。在本論文中，吾人將提出一個針對建置 MIMO-OFDM 系統於 MP3CF 硬體平台之完整解決方案。此硬體平台裝設有 FPGA 與 DSP 模組，透過適當分配不同功能區塊於 FPGA 與 DSP 模組，吾人得以在此平台上實現一個 4×4 MIMO-OFDM 系統。在此系統中，吾人採用了三種不同之時空演算法，分別為 STBC、V-BLAST，及 G-STBC。由於任何一種時空演算法均無法在多變通道下穩定地保持良好品質，因此吾人針對此系統提出一種模式選擇機制以決定最適於目前通道特性之時空演算法。實驗結果顯示，具有適應性能力之 4x4 MIMO-OFDM 系統比不具適應性能力之相同系統具有較高的傳輸率。

FPGA and DSP Realization of an Adaptive MIMO-OFDM System

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Abstract

For future wireless communication systems, orthogonal frequency division multiplexing (OFDM) is a promising technique, enabling high data rate transmission, and is suitable for frequency selective channels caused by multipath propagation. On the other hand, multiple-input multiple-output (MIMO) technique has a great potential of delivering either a dramatic increase of throughput or improvement of link quality. Combined with the MIMO technique, OFDM systems become more suited to next generation wireless communications, and this inspires us to perform the task of hardware realization instead of pure theoretical analysis. In this thesis, we propose a total solution for building up a MIMO-OFDM system on a hardware platform, Aptix MP3CF, where FPGA and DSP modules are installed. By mapping different functional blocks onto the FPGA and DSP respectively, we can realize a 4×4 MIMO-OFDM system on the platform. There are three space-time algorithms adopted in our system, including Space-Time Block Coding (STBC), Vertical Bell Labs Layered Space-Time (V-BLAST), and Group Wise STBC (G-STBC). In view of the fact that no single space-time algorithm can always perform well under various channel conditions, we propose a mode selection scheme for the system to determine the most suitable space-time algorithm under the present channel. The experimental results show that the adaptive 4×4 MIMO-OFDM system can perform better than the same system without incorporating the adaptive mechanism