



**UNIVERSITI PUTRA MALAYSIA**

***PERFORMANCE ENHANCEMENT OF HIGH DATA RATE REAL-TIME  
WIRELESS TRANSMISSION SYSTEM USING SUPERPOSITION CODING  
AND UNEQUAL ERROR PROTECTION***

**YASEEN HASAN TAHIR AL-HASAN**

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By

**YASEEN HASAN TAHIR AL-HASAN**

**Thesis Submitted to the School Graduate Studies, Universiti Putra Malaysia, in  
Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

**August 2011**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

((وَجَعَلْنَا بَيْنَهُمْ وَبَيْنَ الْقُرَى الَّتِي بَارَكْنَا فِيهَا قُرَى ظَاهِرَةً وَقَدَرْنَا فِيهَا السَّيْرَ سِيرُوا فِيهَا لَيَالِيَ وَأَيَّامًا آمِنِينَ))

سبأ 18

## DEDICATION

*To my  
dear Parents,  
for their prayers, love,  
care, and endless encouragement  
To all my brothers and sisters for their great love  
To the dear memory of my brother (Adnan) and sister (Nadia)  
To my darling wife, for her patience and supports  
And to my lovely kids (Hasan,  
Ali, Tahir, and Tahirah)  
To all of them I say  
Thank you*

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment  
of the requirement for the degree of Doctor of Philosophy

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By

**YASEEN HASAN TAHIR AL-HASAN**

**August 2011**

**Chairman: Nor Kamariah Noordin, PhD**

**Faculty: Engineering**

Supporting high system capacity and transmission reliability are among the most challenging issues of the next generation wireless communication systems. The fast growing demand for wireless services coupled with the limitations and high cost of wireless spectrum, further magnify these challenges. In an attempt to solve these challenges, researchers developed various broadband wireless access (BWA) schemes that can share the available bandwidth to transmit multiple signals simultaneously. Despite the marked successes by some of these schemes, the need for further improvements remains high. With this in mind, this thesis proposes novel design frameworks to maximize channel efficiency and enhance the performance of real-time visual data transmission with overloaded Code Division Multiple Access (CDMA) systems.

The first part of this thesis proposes new adaptive real-time visual transmission schemes to maximize the transmission reliability, increase data rate, and improve the error performance. It also addresses issues to combat detection ambiguity problem among the visual data layers by employing superposition coding, unequal error protection (UEP) and special diversity techniques. A new Adaptive Modulation and Coding (AMC) techniques have been proposed by which the system adapts its Modulation and Coding Scheme (MCS) to better match the instantaneous channel quality in order to attain high transmission reliability and maximize obtainable data rate.

In the second part of this thesis, a novel design of overloaded CDMA framework is proposed to increase the user capacity (number of users which can be accommodated synchronously) and data rate of the direct sequence CDMA (DS-CDMA) systems. In addition to maximizing the user capacity, the proposed scheme combats the detection ambiguity problem among the user signals and improves the error performance of overloaded CDMA multiuser systems by combining the superposition coding and UEP technique within the DS-CDMA. This technique is referred to as superposition coding CDMA (SPC-CDMA). Multiple access interference (MAI) issues in the multiuser CDMA system are also investigated. The proposed SPC-CDMA scheme does not only addresses the near-far problem of the

multiuser system but also exploits this phenomenon to further improve the performance of multiuser DS-CDMA system.

The proposed schemes for both the real-time visual data transmission and the overloaded CDMA system are then simulated over both the AWGN and fading channels using MATLAB 7.4. Based on the simulation results, the proposed schemes provide 12 dB SNR gain, up to 46% data rate increment, and at least two-fold increment in channel capacity or data rate compared to the existing schemes as well provide high transmission reliability by mitigate the MAI among the different transmitted signals without requiring extra recourses.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENAMBAHBAIKAN KADAR DATA TINGGI BAGI SISTEM  
PENGHANTARAN TANPA WAYAR MASA-NYATA MENGGUNAKAN  
PERKODAN TINDIHAN DAN PERLINDUNGAN RALAT TAKSMA**

Oleh

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**Ogos 2011**

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**Fakulti: Kejuruteraan**

Menyokong kapasiti sistem tinggi dan keboleharapan penghantaran merupakan antara isu-isu yang paling mencabar untuk sistem komunikasi generasi hadapan. Peningkatan permintaan yang mendadak terhadap perkhidmatan wayarles serta pelbagai penghadan dan kos spektrum wayarles yang tinggi, menjadikan cabaran-cabaran ini lebih besar. Di dalam satu percubaan untuk menyelesaikan cabaran-cabaran tersebut, para penyelidik membangunkan pelbagai skim capaian wayarles jalur lebar (BWA) yang mampu berkongsi lebar jalur sedia ada untuk menghantar beberapa isyarat secara serentak. Walaupun sesetengah skim ini menunjukkan keberhasilan, keperluan untuk meningkatkan lagi penambahbaikan masih tinggi. Maka dengan itu, tesis ini mencadangkan rangka kerja rekabentuk baru untuk

memaksimumkan kecekapan saluran dan meningkatkan prestasi penghantaran data visual masa nyata dan sistem capaian pelbagai bahagian kod (CDMA).

Bahagian pertama tesis ini mencadangkan skim penghantaran visual masa nyata suai baru bagi memaksimumkan keboleharapan penghantaran, meningkatkan kadar data dan memperbaiki prestasi ralat. Ia juga memberi perhatian terhadap isu-isu untuk menghapuskan masalah kekaburan pengesanan di antara lapisan-lapisan data visual dengan menggunakan pengekodan superposisi, perlindungan ralat tak sama (UEP) dan teknik-teknik kepelbagaian khas. Satu teknik modulasi dan pengekodan suai (AMC) baru telah dicadangkan dimana sistem ini menyesuaikan skim modulasi dan pengekodan (MCS) untuk lebih menepati kualiti saluran seketika bagi mencapai keboleharapan penghantaran yang tinggi dan kadar data boleh capai maksimum.

Di dalam bahagian kedua tesis ini, satu rekabentuk rangka kerja baru bagi CDMA terlebih beban dicadangkan untuk meningkatkan kapasiti pengguna (bilangan pengguna yang boleh ditampung secara serentak) dan kadar data sistem CDMA jujukan langsung (DS-SS-CDMA). Sebagai tambahan bagi memaksimumkan kapasiti pengguna, skim yang dicadangkan menghapuskan masalah kekaburan pengesanan di antara isyarat-isyarat pengguna dan menambahbaik prestasi ralat sistem multi-pengguna CDMA terlebih beban dengan menggabungkan pengekodan superposisi dan teknik UEP di dalam DS-SS-CDMA. Teknik ini dipanggil CDMA pengekodan superposisi (SPC-SS-CDMA). Isu-isu gangguan berbilang capaian (MAI) di dalam sistem CDMA multi-pengguna juga dikaji. Skim SPC-SS-CDMA yang dicadangkan



bukan sahaja memberi perhatian kepada masalah dekat-jauh sistem multi-pengguna, tetapi juga mengeksploitasi fenomena ini untuk memperbaiki lagi prestasi sistem DS-CDMA multi-pengguna.

Skim-skim yang dicadangkan bagi kedua-dua penghantaran data visual masa nyata dan sistem CDMA terlebih beban kemudiannya disimulasikan terhadap AWGN dan saluran pemudaran menggunakan MATLAB 7.4. Berdasarkan hasil simulasi, skim-skim yang dicadangkan menyedia gandaan SNR sebanyak 12 dB, peningkatan kadar data sehingga 46% dan sekurang-kurangnya dua kali ganda peningkatan kapasiti saluran atau kadar data berbanding sistem sedia ada di samping menyedia kebolehharian penghantaran yang tinggi dengan mengurangkan MAI di antara isyarat-isyarat terhantar berlainan tanpa memerlukan sumber tambahan.

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I certify that a Thesis Examination Committee has met on 18 August 2011 to conduct the final examination of Yaseen Hasan Tahir Al-Hasan on his thesis entitled "Performance enhancement of high data rate real-time wireless transmission system using superposition coding and unequal error protection" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the degree of Doctor of Philosophy

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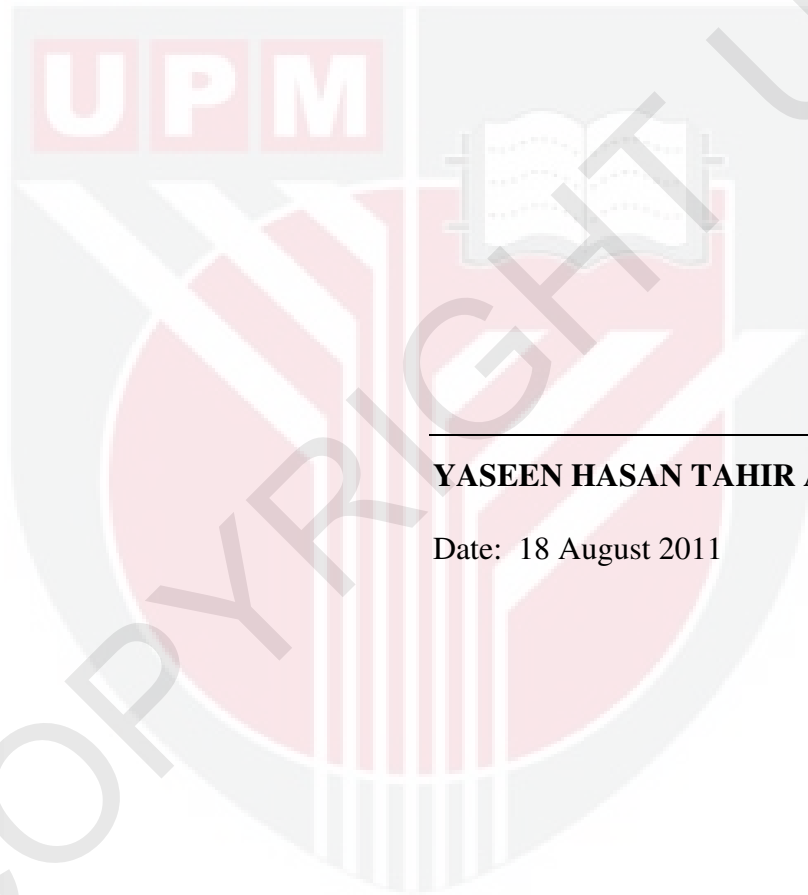
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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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**YASEEN HASAN TAHIR AL-HASAN**

Date: 18 August 2011

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