

**ENHANCED ADAPTIVE CONFIDENCE-BASED Q ROUTING
ALGORITHMS FOR NETWORK TRAFFIC**

By

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

October 2004

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirements for the Degree of Master of Science

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October 2004

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Two new adaptive routing algorithms named Enhanced Confidence-based Q (ECQ) and Enhanced Confidence-based Dual Reinforcement Q (ECDRQ) Routing Algorithms are proposed in this thesis. These two adaptive routing algorithms enhance the existing Confidence-based Q (CQ) and Confidence-based Dual Reinforcement Q (CDRQ) Routing Algorithms.

In CQ Routing Algorithm, the confidence value (C value) can be used to improve the quality of exploration in Q Routing Algorithm. However, the C value incompletely evaluates how closely the Q value represents the current state of the network, which is measured in terms of estimated delivery time for a packet to arrive at its destination. An integrated solution for the above problem is the ECQ Routing Algorithm. ECQ Routing Algorithm is integrates the Variable of Decay Constant and Update All Q Value

approaches for updating the C values of non-selected Q values. Using these C values would make those non-selected Q values more competitive in order to achieve updated and more reliable values.

The CDRQ Routing Algorithm provides a solution to the problem addressed above by integrating the advantages of CQ Routing Algorithm and Dual Reinforcement Learning. The CQ Routing Algorithm is intended to improve the quality of actions made in exploration phase while dual reinforcement learning emphasises on increasing the number of actions occurred in exploration phase. However, the introduction of Confidence value and Backward Exploration may provide a solution to the problem stated above but it falls to another shortcoming known as the partially learning cycle problem, which is presented in this thesis.

The ECDRQ Routing Algorithm integrates the ECQ and Dual Reinforcement Q (DRQ) Routing Algorithms with Alternative Q Value Approach to minimise the effect of partially learning cycle. By comparison, the proposed routing algorithms, ECQ and ECDRQ Routing Algorithms are more superior to its ancestors CQ and CDRQ Routing Algorithms in terms of average packet delivery time and average number of packets delivered. The ECDRQ and ECQ Routing Algorithms are tested against CDRQ and CQ Routing Algorithms respectively on an irregular 6 x 6 nodes network grid.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**ALGORITMA PENGHALAAN ADAPTIF Q TERUBAHSUAI
BERASASKAN KEYAKINAN UNTUK RANGKAIAN TRAFIK**

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Dua algoritma penghalaan adaptif baru yang bernama Algoritma Penghalaan Q yang berasaskan Keyakinan Terubahsuai (ECQ) dan Dwi Memperteguh Q yang berasaskan Keyakinan Terubahsuai (ECDRQ) telah dicadangkan di dalam tesis ini. Kedua-dua algoritma penghalaan penyesuaian ini telah mengubahsuaikan algoritma penghalaan yang sedia ada iaitu Algoritma Penghalaan Q yang berasaskan Keyakinan (CQ) dan Dwi Memperteguh Q yang berasaskan Keyakinan (CDRQ).

Di dalam Algoritma Penghalaan CQ, nilai Keyakinan (nilai C) boleh digunakan untuk meningkatkan kualiti penjelajahan di dalam Algoritma Penghalaan Q. Walau bagaimanapun, nilai C ini tidak dinilai sepenuhnya betapa tepat nilai Q mewakili situasi terkini rangkaian di mana nilai Q ini dinilai dari segi nilai jangkaan masa penghantaran untuk paket sampai ke

destinasinya. Satu penyelesaian bersepadu untuk menyelesaikan masalah tersebut ialah Algoritma Penghalaan ECQ. Algoritma Penghalaan ECQ mengintegrasikan pendekatan Pembolehkan Penyusut Malar dan Mengemaskinikan Semua Nilai Q untuk mengemaskini nilai C untuk nilai - nilai Q yang tidak terpilih. Dengan menggunakan nilai C ini untuk menjadikan nilai - nilai Q yang tidak terpilih itu lebih berdaya saing untuk mendapat peluang mengemaskini dan lebih dipercayai.

Di dalam Algoritma Penghalaan CDRQ, ia memberi satu penyelesaian kepada masalah yang dinyatakan sebelum ini dengan mengintegrasikan kelebihan Algoritma Penghalaan CQ dan pelajaran Dwi Memperteguh. Algoritma Penghalaan CQ diharapkan dapat meningkatkan kualiti tindakan yang dihasilkan di dalam fasa penjelajahan sementara pelajaran dwi memperteguh memberi penekanan pada peningkatan bilangan tindakan yang wujud semasa fasa penjelajahan. Walau bagaimanapun, pengenalan bagi nilai C dan penjelajahan terbalik ini mungkin memberi satu penyelesaian bagi masalah yang dinyatakan sebelum ini tetapi ia mungkin terperangkap kepada kelemahan lain yang dipanggil sebagai kitar pembelajaran separa yang dikemukakan di dalam tesis ini.

Algoritma Penghalaan ECDRQ ialah mengintegrasikan Algoritma Penghalaan ECQ dan Dwi Memperteguh Q (DRQ) dengan pendekatan Alternatif Nilai Q untuk mengurangkan kesan kitar pembelajaran separa. Perbandingan di antara algoritma - algoritma penghalaan yang telah

dikemukakan, ECQ dan ECDRQ adalah lebih unggul daripada Algoritma - algoritma Penghalaan CQ dan CDRQ dengan bandingan purata masa penghantaran paket dan purata bilangan paket disampaikan. Algoritma - algoritma Penghalaan ECDRQ dan ECQ masing - masing akan dibanding terhadap Algoritma - algoritma Penghalaan CDRQ dan CQ pada satu rangkaian grid nod 6 x 6 yang tidak tersusun.

ACKNOWLEDGEMENTS

First of all, I would like to thank my supervisor Assoc. Prof. Dr. Mohamed Othman and my supervisory committee members Dr. Rozita Johari and Rohaya Latip for their valuable time, advices and guidance throughout this study. I would also like to thank Shailesh Kumar for his valuable advices, interesting ideas and constructive suggestions.

Finally, this work is dedicated to my family for their continuous support and to all the persons in the world who dedicate their lives in improving human life.

Soon Teck,

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I certify that an Examination Committee met on 20th October 2004 to conduct the final examination of Yap Soon Teck on his Master of Science thesis entitled " An Adaptive Routing Algorithm: Enhanced Confidence-based Dual Reinforcement Q Routing Algorithm in Network Traffic" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledge. I also declare that it is has not been previously or concurrently submitted for any other degree at UPM or any other institutions.

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