Faculty of Information and Communication Technology

ENHANCEMENT OF MEDICAL IMAGE COMPRESSION ALGORITHM IN NOISY WLANS TRANSMISSION

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DECLARATION

I declare that this thesis entitled –Enhancement of Medical Image Compression Algorithm in Noisy WLANS Transmission" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Doctor of Philosophy.

Signature : ……

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Date : …….....

DEDICATION

To Allah S.W.T that always provides miracles and guidance in my life.

To my family, for their love, caring, sacrifice, and support during the process of achieving this milestone in my life.

To my teachers who never stop teach and directing to this achievement.

ABSTRACT

Advances in telemedicine technology enable rapid medical diagnoses with visualization and quantitative assessment by medical practitioners. In healthcare and hospital networks, medical data exchange-based wireless local area network (WLAN) transceivers remain challenging because of their growing data size, real-time contact with compressed images, and range of bandwidths requiring transmission support. Prior to transmission, medical data are compressed to minimize transmission bandwidth and save transmitting power. Researchers address many challenges in improving performance of compression approaches. Such challenges include energy compaction, computational complexity, high entropy value, drive low compression ratio (CR) and high computational complexity in real-time implementation. Thus, a new approach called Enhanced Independent Component Analysis (EICA) for medical image compression has been developed to boost compression techniques; which transform the image data by block-based Independent Component Analysis (ICA). The proposed method uses Fast Independent Component Analysis (FastICA) algorithm followed by developed quantization architecture based zero quantized coefficients percentage (ZQCP) prediction model using artificial neural network. For image reconstruction, decoding steps based the developed quantization architecture are examined. The EICA is particularly useful where the size of the transmitted data needs to be reduced to minimize the image transmission time. For data compression with suitable and effective performance, enhanced independent components analysis (EICA) is proposed as an algorithm for compression and decompression of medical data. A comparative analysis is performed based on existing data compression techniques: discrete cosine transform (DCT), set partitioning in hierarchical trees (SPIHT), and Joint Photographic Experts Group (JPEG 2000). Three main modules, namely, compression segment (CS), transceiver segment (TRS), and outcome segment (OTS) modules, are developed to realize a fully computerized simulation tool for medical data compression with suitable and effective performance. To compress medical data using algorithms, CS module involves four different approaches which are DCT, SPIHT, JPEG 2000 and EICA. TRS module is processed by low-cost WLANs with low-bandwidth transmission. Finally, OTS is used for data decompression and visualization result. In terms of compression module, results show the benefits of applying EICA in medical data compression and transmission. While for system design, the developed system displays favorable outcomes in compressing and transmitting medical data. In conclusion, all three modules (CS, TRS, and OTS) are integrated to yield a computerized prototype named as Medical Data Simulation System (Medata-SIM) computerized system that includes medical data compression and transceiver for visualization to aid medical practitioners in carrying out rapid diagnoses.

ABSTRAK

Kemajuan dalam teknologi teleperubatan membolehkan pakar perubatan membuat diagnosis perubatan dengan lebih pantas menggunakan visualisasi dan penaksiran kuantitatif. Dalam rangkaian penjagaan kesihatan dan perubatan, pemancar-terima rangkaian tanpa wayar kawasan setempat (WLAN) berasaskan pertukaran data perubatan masih kekal sebagai suatu cabaran disebabkan saiz data yang semakin besar, sentuhan masa nyata dengan imej mampat, dan julat jalur lebar yang memerlukan sokongan penghantaran. Sebelum dihantar, data perubatan dimampatkan untuk meminimumkan jalur lebar penghantaran dan menjimatkan kuasa penghantaran. Para penyelidik mengenalpasti pelbagai cabaran dalam menambah baik pendekatan pemampatan. Antara cabaran yang dihadapi termasuk pemadatan tenaga, pengkomputeran kompleks, nilai entropi tinggi, pacuan nisbah mampatan (CR) rendah serta kekompleksan pengkomputeran tinggi dalam pelaksanaan masa nyata. Oleh itu, pendekatan baharu yang dinamakan Analisis Komponen Tak Bersandar Dipertingkat (EICA) bagi pemampatan imej perubatan telah dibangunkan untuk mempertingkatkan teknik pemampatan dengan menukar data imej melalui ICA berasaskan blok. Kaedah yang dicadangkan menggunakan algoritma Analisis Komponen Tak Bersandar Pantas (FastICA) diikuti oleh pembangunan model ramalan peratus pekali terkuantum sifar (ZQCP) berasaskan seni bina pengkuantuman lanjut dengan menggunakan rangkaian neural buatan. Bagi pembinaan semula imej, langkah penyahkodan berdasarkan seni bina pengkuantuman lanjut diteliti. EICA adalah khususnya berguna apabila saiz data yang dihantar perlu dikurangkan untuk meminimumkan masa penghantaran imej. Bagi pemampatan data dengan prestasi berkesan dan sesuai, analisis komponen tak bersandar dipertingkat (EICA) adalah disyorkan sebagai algoritma untuk memampat dan menyahmampat data perubatan. Analisis perbandingan dilakukan berdasarkan teknik pemampatan data sedia ada: jelmaan kosinus diskret (DCT), pemetakan set dalam pepohon berhierarki (SPIHT), dan Kumpulan Pakar Fotografi Bersama (JPEG 2000). Tiga modul utama, iaitu modul segmen pemampatan (CS), segmen pemancar-terima (TRS), dan segmen hasil (OTS), dibangunkan untuk memperoleh alat simulasi komputer sepenuhnya bagi pemampatan data perubatan dengan prestasi berkesan dan sesuai. Bagi memampatkan data perubatan dengan menggunakan algoritma, modul CS melibatkan empat pendekatan berlainan iaitu DCT, SPIHT, JPEG 2000 dan EICA. Modul TRS diproses oleh WLAN kos rendah dengan penghantaran jalur lebar rendah. Akhir sekali, OTS digunakan untuk pemampatan data dan keputusan secara visual. Dari segi modul pemampatan, keputusan menunjukkan manfaat menggunakan EICA dalam pemampatan dan penghantaran data perubatan. Sementara dari segi reka bentuk sistem, sistem yang dibangunkan menunjukkan hasil menggalakkan dalam pemampatan dan penghantaran data perubatan. Kesimpulannya,semua tiga modul (CS, TRS dan OCS) digabungkan untuk menghasilkan prototaip sistem komputer iaitu Sistem Simulasi Data Perubatan (Metadata-SIM) yang merangkumi pemampatan data perubatan dan pemancar-terima untuk visualisasi bagi membantu pengamal perubatan membuat diagnosis dengan pantas.

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AES	-	Advanced Encryption Standard
AMPS	-	Advanced Mobile Phone Service
AP	-	Access Point
AWGN	-	Additive White Gaussian Noise
BDF	-	Bio Semi Data Format
BER	-	Bit Error Rate
CR	-	Compression Ratio
CS	-	Compression Segment
CSMA/CA	-	Carrier Sense Multiple Access/Collision Avoidance
CT	-	Computed Tomography
DBPSK	-	Differential Binary Phase-Shift Keying
DCT	-	Discrete Cosine Transform
DFT	-	Discrete Fourier Transform
DICOM	-	Digital Imaging and Communications in Medicine
DQPSK	-	Differential Quadrature Phase-Shift Keying
DSSS	-	Direct Sequence Spread Spectrum
E_b/N_o	-	Energy Per Bit To Noise Power Spectral Density Ratio
EDF	-	European Data Format
EICA	-	Enhanced Independent Components Analysis

EMI	-	Electromagnetic Interference
E_s/N_o	-	Energy Per Symbol To Noise Power Spectral Density Ratio
ETSI	-	European Telecommunications Standards Institute
EZW	-	Embedded Zero Tree Wavelet
FCC	-	Federal Communications Commission
FHSS	-	Frequency Hopping Spread Spectrum
FM	-	Frequency Modulation
GSM	-	Global System for Mobile communications
HDTV	-	High Definition Television
ICA	-	Independent Component Analysis
IEEE	-	Institute of Electrical and Electronics Engineers
ISM	-	Industrial Scientific And Medical
JPEC	-	Joint Photographic Experts Group Committee in 2000
LLC	-	Logical Link Control
LMDS	-	Local Multipoint Distribution System
MAC	-	Medium Access Control
MC	-	Mobile Client
MDCT	-	Modified Discrete Cosine Transforms
MDS	-	Medical Data Simulation
MIMO	-	Multiple Inputs, Multiple Outputs
MMS	-	Multimedia Messaging Service
MRI	-	Magnetic Resonance Imaging

MSE	-	Mean Square Error
NHANES	-	National Health And Nutrition Examination Survey
NIH	-	National Institutes Of Health
NLM	-	National Library Of Medicine
OFDM	-	Orthogonal Frequency Division Multiplexing
OFDM	-	Orthogonal Frequency-Division Multiplexing
OTS	-	Outcome Segment
PACS	-	Picture Archiving and Communication System
PDA	-	Personal Digital Assistants
PET	-	Positron Emission Tomography
PHY	-	Physical Layer
PLCP24	-	Physical Layer Convergence Procedure
PMD	-	Physical Medium Dependent
PSNR	-	Peak Signal Noise Ratio (PSNR)
QoS	-	Quality of Service
RGB	-	Red, Green, Blue
SNR	-	Signal-To-Noise Ratio
SPI	-	Synchronous Peripheral Interface
SPIHT	-	Set Partitioning in Hierarchical Tree
SPP/IPP/ISP	-	Significant Pixel Pass/ Insignificant Pixel Pass/ Insignificant Set Pass
TRS	-	Transmission & Receiver Segment
WECA	-	Wireless Ethernet Compatibility Alliance