ENSEMBLE APPROACH ON ENHANCED COMPRESSED NOISE EEG DATA SIGNAL IN WIRELESS BODY AREA SENSOR NETWORK

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Abstrak

Rangkaian penderiaan kawasan badan tanpa wayar (WBASN) digunakan untuk komunikasi di antara nod pengesan pada atau didalam badan manusia untuk memantau parameter dan pergerakan. Salah satu aplikasi penting WBASN adalah pemantauan kesihatan penyakit kronik seperti serangan epilepsi. Kebiasaannya, data serangan epilepsi elektroensefalograf (EEG) dikumpul dan dipadatkan untuk mengurangkan masa penghantarannya. Namun, pada masa yang sama, keadaan ini mencemarkan keseluruhan data dan merendahkan klasifikasi kejituaannya. Kajian terkini juga tidak mengambil kira data EEG yang besar. Akibatnya, data EEG adalah bersifat intensif jalur lebar. Dengan demikian, tujuan utama kajian ini adalah untuk mereka bentuk satu kesatuan rangka kerja mampatan dan klasifikasi data EEG sebagai menangani isu data bersaiz besar dengan memampatkannya sebelum penghantaran. Satu lagi matlamat adalah untuk menyusun semula data yang telah dimampat dan mengenal pasti kemudiannya. Kerana itu, teknik *Noise Signal Combination* (NSC) dicadangkan untuk pemampatan EEG data yang dihantar dan meningkatkan klasifikasi kejituan di sebelah penerimaan dalam keadaan data hingar dan tidak lengkap. Rangka kerja yang dicadangkan ini menggabungkan penderiaan mampatan dan transformasi konsinus diskret (DCT) untuk mengurangkan jumlah saiz penghantaran data. Tambahan itu, model hingar Gaussian juga digunakan dalam rangka kerja tersebut. Di sebelah penerima, NSC yang dicadangkan direka bentuk bersandarkan kepada wajaran undian menggunakan empat teknik klasifikasi iaitu rangkaian neural buatan, Naïve Bayes, k-Nearest Neighbour, dan Support Vector Machine sebagai input kepada NSC. Keputusan eksperimen telah menunjukkan bahawa teknik yang dicadangkan melangkaui kejituan tertinggi dari teknik konvensional untuk data besar kurang dan tanpa hingar. Tambahan lagi, rangka kerja tersebut berjaya melaksanakan peranan penting dalam mengurangkan saiz data dan pada masa sama meningkatan kejituan untuk kedua-dua data kurang dan tanpa hingar. Sumbangan utama kajian ini adalah kesatuan rangka kerja dan NSC. Keputusan menunjukkan keberkesanan rangka kerja yang dicadangkan dan menyediakan beberapa manfaat yang boleh dipercayai termasuk mudah dan meningkatkan ketepatan kejituan. Akhir sekali, kajian ini dapat menambah baik maklumat klinikal berkaitan bukan sahaja mengenai pesakit yang mengalami epilepsi, tetapi juga gangguan neurologi, masalah mental atau fisiologi.

Katakunci: Rangkaian Pengesan Kawasan Tubuh Tanpa Wayar, Kejituan Klasifikasi, Pengelas Gabungan, Data EEG.

Abstract

The Wireless Body Area Sensor Network (WBASN) is used for communication among sensor nodes operating on or inside the human body in order to monitor vital body parameters and movements. One of the important applications of WBASN is patients' healthcare monitoring of chronic diseases such as epileptic seizure. Normally, epileptic seizure data of the electroencephalograph (EEG) is captured and compressed in order to reduce its transmission time. However, at the same time, this contaminates the overall data and lowers classification accuracy. The current work also did not take into consideration that large size of collected EEG data. Consequently, EEG data is a bandwidth intensive. Hence, the main goal of this work is to design a unified compression and classification framework for delivery of EEG data in order to address its large size issue. EEG data is compressed in order to reduce its transmission time. However, at the same time, noise at the receiver side contaminates the overall data and lowers classification accuracy. Another goal is to reconstruct the compressed data and then recognize it. Therefore, a Noise Signal Combination (NSC) technique is proposed for the compression of the transmitted EEG data and enhancement of its classification accuracy at the receiving side in the presence of noise and incomplete data. The proposed framework combines compressive sensing and discrete cosine transform (DCT) in order to reduce the size of transmission data. Moreover, Gaussian noise model of the transmission channel is practically implemented to the framework. At the receiving side, the proposed NSC is designed based on weighted voting using four classification techniques. The accuracy of these techniques namely Artificial Neural Network, Naïve Bayes, k-Nearest Neighbour, and Support Victor Machine classifiers is fed to the proposed NSC. The experimental results showed that the proposed technique exceeds the conventional techniques by achieving the highest accuracy for noiseless and noisy data. Furthermore, the framework performs a significant role in reducing the size of data and classifying both noisy and noiseless data. The key contributions are the unified framework and proposed NSC, which improved accuracy of the noiseless and noisy EGG large data. The results have demonstrated the effectiveness of the proposed framework and provided several credible benefits including simplicity, and accuracy enhancement. Finally, the research improves clinical information about patients who not only suffer from epilepsy, but also neurological disorders, mental or physiological problems.

Keywords: Wireless Body Area Sensor Network, Classification Accuracy, Ensemble Classifier, Bio-signal.

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List of Abbreviations

Abbreviation	Meaning
AC_i	Classifier Accuracy
ANN	Artificial Neural Network
APSNS	Adaptive Particle Swarm Negative Selection
ASAp	Adaptive Sampling Approach
AWC	Application-specific WBASN Communication
BLDA	Bayesian Linear Discriminant Analysis
CCM	Classifier Confusion Matrix
CD(s)	Chronic Disease(s)
COPD	Chronic Obstructive Pulmonary Disease
CR	Compression Ratio
CS	Compressive Sensing
DAC	Detection And Classification
dB	decibel
DCT	Discrete Cosine Transform
DE	Differential Evolution
DF	Data Fusion
DWT	Discrete Wavelet Transform
ECG	Electrocardiogram
EEG	Electroencephalogram
EMD	Empirical Mode Decomposition
EMG	Electromyography
FFT	Fast Fourier Transformation

FN	False Negatives
FP	False Positives
HARMONI	Healthcare-oriented Adaptive Remote Monitoring
iDCT	inverse DCT
IMFs	Intrinsic Mode Functions
KF	Kalman Filter
k-NN	K-Nearest Neighbor
LR	Logistic Regression
LS-SVM	Least Square SVM
MAC	Media Access Control
ME	Mixture of Experts’
MLPNN	Multilayer Perceptron Neural Network
MV	Majority Voting
NB	Naïve Bayesian
NDE	Non-Destructive Evaluation
NSC	Noise-aware Signal Combination
nu-SVC	nu-Support Vector Classification
OS	Operating System
PDA	Personal Digital Assistant
PRD	Percentage Root-mean-square Difference
PR_i	Class Precision
PSO	Particle Swarm Optimization
RBFNs	Radial Basis Function Neural Networks
R-CSP	Regularized Common Spatial Patterns
RE_i	Class Recall

RF	Radio frequency
RM	Random Matrix
S	Samples
SAP	Sensing And Preprocessing
SCC	Sensor-based Compression and Classification
SNR	signal-to-noise-ratio
SSC	Signal Strength-based Combining
SSS	Small Sample Setting
SVM	Support Vector Machine
TN	True Negatives
TP	True Positives
WBASNs	Wireless Body Area Sensor Networks
WHO	World Health Organization
Wi-Fi	Wireless Fidelity
WSNs	Wireless Sensor Networks

CHAPTER ONE
INTRODUCTION

1.1 Overview

Networks of wireless sensor devices are being deployed to collectively monitor and disseminate information about a variety of phenomena of interest. A wireless sensor device is a battery-operated device, capable of sensing physical measurements. In addition to sensing, it is capable of wireless communication, data storage, and a limited size of computation and signal processing. Advances in integrated circuit design are continually reducing the size, weight and cost of sensor devices, while simultaneously improving their resolution and accuracy. A wireless sensor network (WSN) consists of a large number of wireless-capable sensor devices working collaboratively to achieve a common objective. A WSN has one or more base-stations, which collect data from all sensor devices. These base-stations are the interface through which the WSN interacts with the outside world [1].

A WSN is an infrastructure-less networks that consists of a number of self-configuring wireless devices capable of sensing vital signs for characterizing contemporary phenomena. A WSN consists of wireless nodes, which measure physical conditions using sensors, digitize it and keep or distribute the measured data over the network. Typical applications include, but are not limited to, data collection, monitoring, and medical telemetry [2]. Several applications have been intended for WSN. These range in scope from military applications, environmental monitoring and medical applications. For instance, WSNs can form a critical part of military command, control, communications, computing, intelligence, surveillance, reconnaissance, and

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