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Date:

Place: IIT (BHU), Varanasi *(**Nitesh Singh Malan**)*

LIST OF ABBREVIATIONS AND SYMBOLS

ABC	Artificial Bee Colony
BSC	Bayesian Classifier
BCI	Brain-Computer Interface
CCA	Canonical Correlation Analysis
CCA	Canonical Correlation Analysis
CNS	Central Nervous System
CAR	Common Average Reference
CSSSP	Common Sparse Spectral Spatial Pattern
CSP	Common Spatial Pattern
CSSP	Common Spatio-Spectral Pattern
CFS	Correlation-based Feature Selection
DE	Differential Evolution
DFBCSP	Discriminative Filter Bank Common Spatial Pattern
DTCWT	Dual-Tree Complex Wavelet Transform
ECoG	Electrocorticography
EEG	Electroencephalogram
ERD	Event-Related Desynchronization
ERP	Event-Related Potentials
ERS	Event-Related Synchronization
EB	Eyeblink
FFT	Fast Fourier Transform
FBCSP	Filter Bank Common Spatial Pattern
FIR	Finite Impulse Response

FA	Firefly Algorithm
fNIRS	Functional Near-Infrared Spectroscopy
GA	Genetic Algorithm
HMM	Hidden Markov model
ICA	Independent component Analysis
IT-CCA	Individual Template-based CCA
ITR	Information Transfer Rate
IPD	Instantaneous Phase Difference
KNN	K-nearest neighbours
LLAP	Large Laplacian derivation
LDA	Linear Discriminant Analysis
LR	Logistic Regression
MEG	Magnetoencephalography
MD	Mahalanobis distance
MPD	Mean Phase Difference
MWT	Morlet Wavelet Transform
MI	Motor Imagery
Multi-set CCA	Multi-set CCA
MwayCCA	Multi-way CCA
NN	Neural network
OAs	Ocular Artifacts
PSO	Particle swarm optimization
PCCA	Phase Constrained CCA
PLV	Phase Locking Value
PET	Positron Emission Tomography

PSD	Power spectral density
PSDA	Power Spectrum Density Analysis
PCA	Principal Component Analysis
RNCA	Regularized NCA
SMR	Sensorimotor Rhythms
STFT	Short-Time Fourier Transform
SSA	Singular Spectrum Analysis
SCP	Slow Cortical Potentials
SLAP	Small Laplacian Derivation
SSVEP	Steady-State Visual Evoked Potential
SBCSP	Sub-Band Common Spatial Patterns
SVM	Support Vector Machine
SLD	surface Laplacian derivation
VEP	Visually Evoked Potentials
WPD	Wavelet Packet Decomposition
$\emptyset$	Hilbert Transform
ω	Wavelet Coefficient
T	Threshold Value
λ	RNCA Regularization Parameter
p_0	Classification Accuracy
L	RNCA Hyperparameter
mV	mili Volts
uV	micro Volts

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PREFACE

The research work presented in this thesis is divided into eight chapters as follows. In chapter 1, motor imagery (MI)- based and steady-state visual evoked potentials (SSVEP)-based brain-computer interfaces (BCIs) are introduced, incorporating the explanation of key components required to design a practical BCI device. The objectives of this thesis are briefly explained. Chapter 2 reviews state-of-the-art signal processing techniques in MI and SSVEP EEG-based BCIs a with specific attention on the feature extraction, feature selection, and classification techniques used. The first objective of this thesis is covered in chapter 3. We have proposed the use of dual-tree complex wavelet transform (DTCWT) with quantum-inspired adaptive wavelet threshold algorithm for the elimination of OAs from single-channel EEG signal. Chapter 4 comprises the second objective of this work and proposes a novel method to regularize neighborhood component analysis (NCA) to select the MI data. In chapter 5, we covered the third objective and designed a dual-tree complex wavelet transform-based filter bank to filter the EEG into sub-bands instead of traditional filtering methods, which improved the spatial feature extraction efficiency. Chapter 6 covers the fourth objective and presents a novel multi-view feature selection method based on regularized neighbourhood component analysis to simultaneously optimize time windows and frequency bands. In chapter 7, we have presented the work for the fifth objective; we propose a class labeling method where a classifier is trained against the non-target class. Chapter 8- presents a summary and conclusions of the experimental work and suggests scope for further work.

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