

Kaiquan SHEN

Curriculum Vitae

Born on May 11, 1979, Married with one child

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Summary

Ph.D. degree with specialization in Neuroengineering, EEG Signal Processing, Neural Sensors, Neurophysiology, Machine Learning and Bioinstrumentation. Passion in both research and teaching.

Education

- ◇ Ph.D. National University of Singapore, 2008.
 - Research Topic* "Signal Processing Methods for Mental Fatigue Measurement and Monitoring Using EEG"
 - Advisors* Professor Xiaoping Li
Professor Einar P V Wilder-Smith
Associate Professor Chong-Jin Ong
 - CAP* 5.0/5.0
- ◇ B.S. (Hon.) University of Science and Technology of China, 2002.
 - Research Topic* "Instability of the Shear Layer in the Near Wake of a Circular Cylinder"
 - Advisors* Professor Xiyun Lu
Professor Lixian Zhuang

Employment

- Jul 2009 - Present
National University of Singapore
Research Fellow (A)
Department of Mechanical Engineering
- Jan 2007 - Jun 2009
National University of Singapore
Research Fellow (B)
Department of Mechanical Engineering

Selected Research Projects

Neural Sensors, Neural Signal Processing, Bioengineering Instrumentation

- ◇ **Automatic removal of muscular artifacts in EEG (2010 - Present)**
 - Invented a multiple time-lag linear subspace analysis method, which is well suited for automatic muscular artifact removal.

◇ **Research and development of human brain-machine integrated rapid image triage system (2008 - 2010)**

- Led the investigation of the feasibility of a cortically-coupled machine vision for rapid image search
- Invented two algorithms, aiming to improve the accuracy and realisability of rapid image triage system by exploiting both spatial and temporal patterns of single-trial ERPs.
- Implemented a prototype of rapid image triage system which has been field-tested by SAF.
- Follow-up project (\$600,000 from DSTA for another two years) is expected to start from late 2011.

◇ **Development of a human brain activity signature acquisition system (2006 - 2007)**

- Led the research and development of a real-time mental fatigue monitoring system.
- Invented a feature selection algorithm based on a novel idea of using sensitivity of posterior probability as a measure of feature importance. It was a winning method in world-wide NIPS feature selection competition.
- Proposed an ICA-based automatic artifact removal algorithm that is conceptually different from past methods, aiming to handle the inherent unbalanced nature of the problem and at the same time to accommodate structural information typically found in EEG artifact removal problems.
- Implemented a prototype of real-time mental fatigue monitoring system, demonstrating the feasibility of an automatic EEG method for assessing and monitoring mental fatigue at a time scale of 3-sec EEG epoch.

◇ **Study of unintentional sleep onset (2003 - 2004)**

- Pioneered the use of probabilistic multi-class SVM for unintentional sleep onset detection.
- Established the algorithm framework and detailed formulations for EEG preprocessing, blind signal separation/extraction, neural pattern recognition, and EEG realtime mapping systems.

Neurophysiology

◇ **Study of neurophysiological measure of pain perception (2009 - Present)**

- Proposed the use of heartbeat-evoked potential (ECG R-peak locked brain evoked potential) as an objective measure of pain perception.
- Investigated the relationship between heartbeat-evoked potential, unconscious/subconscious cardiac interoceptive process, and tonic cold pain.

◇ **Auditory discrimination following sleep deprivation - how diminished vigilance is manifested following sleep deprivation with regard to brain activation (2005 - 2006)**

- Developed the fMRI paradigm for investigation of brain activation associated with circadian mental fatigue.
- Proposed a novel working-memory vigilance task for measuring circadian mental fatigue.

Machine Intelligence and Computational Simulation

◇ **Feature selection for machine learning (2008 - 2009)**

- Developed a new wrapper-based feature selection method for popular support vector machines and multilayer perceptron neural networks with demonstrated improved performance compared with other state-of-the-art wrapper-based methods.

◇ **High-resolution computational simulation study of shear layer (2001 - 2002)**

- Supported by the National Natural Science Fund (No. 10125210), the Innovation Projects of the Chinese Academy of Science (CAS) (No. KJCX-SW-Lo4, KJCX2-SW-L2), China.
- Developed an numerical simulation system, aiming to predict reasonably the relation of the shear layer instability frequency with the Reynolds number by using high-order numerical schemes and high-resolution spectrum analysis.

Professional Activities

Guest Editor, International Journal of Computer Applications in Technology

Reviewer, IEEE Transactions on Biomedical Engineering

Reviewer, European Journal of Neuroscience

Reviewer, Neural Computing and Applications

Reviewer, Machine Learning

Reviewer, Pattern Analysis and Applications

Reviewer, International Journal of Computer Applications in Technology

Editor, International Journal of Applied Neuroscience and Neurotechnology (upcoming)

Organizing Committee, 1st International Conference on Neuroengineering and Neurotechnology, Singapore

Organizing Committee, 3rd International Forum on Systems and Mechatronics, Singapore

Invited Reviewer, International Multi-Conference on Complexity, Informatics and Cybernetics, Florida USA

Awards

- ◇ Session's Best Paper Award, International Multi-Conference on Complexity, Informatics and Cybernetics, Florida USA, 2010
- ◇ Session's Best Paper Award, International Forum on Systems and Mechatronics, Singapore, 2010
- ◇ Full Research Scholarship, 2003-2007
- ◇ Guanghua Scholarship Award, 2000
- ◇ Outstanding Student Scholarship Award, 1999
- ◇ Outstanding Student Scholarship Award, 1998

Teaching Experiences / Interests

Teaching Experiences

- ◇ Co-Lecturer, Quantitative Physiology Principles in Bioengineering (BN5104), NUS
- ◇ Lecturer, Neurosensors and Signal Processing (BN5209), NUS
- ◇ Teaching assistant, Engineering Principles in Medicine II (BN5102), NUS

Selected Publications

Journal Articles

- [1] Shiyun Shao, Kaiquan Shen, Ke Yu, Einar P V Wilder-Smith, and Xiaoping Li. Frequency-domain eeg source analysis for acute tonic cold pain perception. *Clinical Neurophysiology*, 2012. Accepted for publication,

Abstract: Objective: To investigate electrocortical responses to tonic cold pain by frequency-domain electroencephalogram (EEG) source analysis, and to identify potential electrocortical indices of acute tonic pain. Methods: Scalp EEG data were recorded from 26 healthy subjects under tonic cold pain (CP) and no-pain control (NP) conditions. EEG power spectra and the standardized low-resolution brain electromagnetic tomography (sLORETA) localized EEG cortical sources were compared between the two conditions in five frequency bands: 1 - 4 Hz, 4 - 8 Hz, 8 - 12 Hz, 12 - 18 Hz and 18 - 30 Hz. Results: In line with the EEG power spectral results, the source power significantly differed between the CP and NP conditions in 8 - 12 Hz (CP < NP) and 18 - 30 Hz (CP > NP) in extensive brain regions. Besides, there were also significantly different 4 - 8 Hz and 12 - 18 Hz source activities between the two conditions. Among the significant source activities, the left medial frontal and left superior frontal 4 - 8 Hz activities, the anterior cingulate 8 - 12 Hz activity and the posterior cingulate 12 - 18 Hz activity showed significant negative correlations with subjective pain ratings. Conclusions: The brain's perception of tonic cold pain was characterized by cortical source power changes across different frequency bands in multiple brain regions. Oscillatory activities that significantly correlated with subjective pain ratings were found in the prefrontal and cingulate regions. Significance: These findings may offer useful measures for objective pain assessment and provide a basis for pain treatment by modulation of neural oscillations at specific frequencies in specific brain regions.

- [2] Ke Yu, Kaiquan Shen, Shiyun Shao, Wu Chun Ng, Kenneth Kwok, and Xiaoping Li. A spatio-temporal filtering approach to denoising of single-trial erp in rapid image triage. *Journal of Neuroscience Methods*, 204:288–295, 2012. (Corresponding Author),

Abstract: Conventional search for images containing points of interest (POI) in large-volume imagery is costly and sometimes even infeasible. The rapid image triage (RIT) system which is a human cognition guided computer vision technique is potentially a promising solution to the problem. In the RIT procedure, images are sequentially presented to a subject at a high speed. At the instant of observing a POI image, unique POI event-related potentials (ERP) characterized by P300 will be elicited and measured on the scalp. With accurate single-trial detection of such unique ERP, RIT can differentiate POI images from non-POI images. However, like other brain-computer interface systems relying on single-trial detection, RIT suffers from the low signal-to-noise ratio (SNR) of the single-trial ERP. This paper presents a spatiotemporal filtering approach tailored for the denoising of single-trial ERP for RIT. The proposed approach is essentially a non-uniformly delayed spatial Gaussian filter that attempts to suppress the non-event related background electroencephalogram (EEG) and other noises without significantly attenuating the useful ERP signals. The efficacy of the proposed approach is illustrated by both simulation tests and real RIT experiments. In particular, the real RIT experiments on 20 subjects show a statistically significant and meaningful average decrease of 9.8% compared to that without the proposed approach.

- [3] Shi-Yun Shao, Kai-Quan Shen, Einar P. V. Wilder-Smith, and Xiao-Ping Li. Effect of pain perception on the heartbeat evoked potential. *Clin Neurophysiol*, 122(9):1838–1845, 2011.

Abstract: Objective: To investigate the effect of acute tonic pain on the heartbeat-evoked potential (HEP) and to test whether or not pain perception can be reflected by the HEP. Methods: Simultaneous electroencephalogram (EEG) and electrocardiogram (ECG) were recorded from 21 healthy young adults in three conditions: passive no-task control, no-pain control and cold pain. The HEP were obtained by using ECG R peaks as event triggers. Results: Prominent HEP latency deflection was observed in both control conditions mainly over frontal and central locations, while it was significantly suppressed in the cold pain condition over the right-frontal, right-central and midline locations. A comparison of the data in the first and last 5 min of cold pain condition showed that lower subjective pain ratings were accompanied by higher mean HEP magnitudes. Correlation analysis showed that the mean HEP magnitude over the midline locations was significantly negatively correlated with subjective pain ratings. Conclusions: Cold pain induces significant suppression of the HEP over a number of scalp locations, and the suppression is correlated with the level of pain. Significance: The HEP has the potential to serve as an alternative pain measure.

- [4] Ke Yu, Kai-Quan Shen, Shi-Yun Shao, Wu-Chun Ng, Kenneth Kwok, and Xiao-Ping Li. Common spatio-temporal pattern for single-trial detection of event-related potential in rapid image triage. *IEEE Transactions on Biomedical Engineering*, 58(9):2513–1520, 2011.

Abstract: Searching for objects of interest in large volume imagery is a challenging problem. A potentially promising solution, rapid image triage (RAIT), is essentially a cortically-coupled computer vision technique that relies on single-trial detection of event-related potentials (ERP). This paper presents a novel feature extraction method, termed common spatio-temporal pattern (CSTP), which is critical for robust single-trial detection of ERP. Unlike past methods such as conventional common spatial pattern (CSP) method whereby only spatial patterns of ERP are considered, the proposed method exploits both spatial and temporal patterns of ERP, providing complementary spatial and temporal features for high accurate single-trial ERP detection. Numerical study using data collected from 20 subjects demonstrates that the proposed method offers significant performance improvement over conventional CSP method (p -value < 0.01) for rapid image triage.

- [5] Ke Yu, Kaiquan Shen, Shiyun Shao, Wu Chun Ng, Xiaoping Li, and Kenneth Kwok. Single-trial event-related potential based rapid image triage system. *The Journal of Systemics, Cybernetics and Informatics*, 9:8–14, 2011.

Abstract: Searching for points of interest (POI) in large-volume imagery is a challenging problem with few good solutions. In this work, a neural engineering approach called rapid image triage (RIT) which could offer about a ten-fold speed up in POI searching is developed. It is essentially a cortically-coupled computer vision technique, whereby the user is presented bursts of images at a speed of 6-15 images per second and then neural signals called event-related potential (ERP) is used as the 'cue' for user seeing images of high relevance likelihood. Compared to past efforts, the implemented system has several unique features: (1) it applies overlapping frames in image chip preparation, to ensure rapid image triage performance; (2) a novel common spatial-temporal pattern (CSTP) algorithm that makes use of both spatial and temporal patterns of ERP topography is proposed for high-accuracy single-trial ERP detection; (3) a weighted version of probabilistic support-vector-machine (SVM) is used to address the inherent unbalanced nature of single-trial ERP detection for RIT. High accuracy, fast learning, and real-time capability of the developed system shown on 20 subjects demonstrate the feasibility of a brainmachine integrated rapid image triage system for fast detection of POI from large-volume imagery.

- [6] Shi-Yun Shao, Kai-Quan Shen, Chong-Jin Ong, Einar P. V. Wilder-Smith, and Xiao-Ping Li. Automatic EEG artifact removal: a weighted support-vector-machine approach with error correction. *IEEE Trans Biomed Eng*, 56(2):336–344, 2009.

Abstract: An automatic electroencephalogram (EEG) artifact removal method is presented in this paper. Compared to past methods, it has two unique features: 1) a weighted version of support vector machine formulation that handles the inherent unbalanced nature of component classification and 2) the ability to accommodate structural information typically found in component classification. The advantages of the proposed method are demonstrated on real-life EEG recordings with comparisons made to several benchmark methods. Results show that the proposed method is preferable to the other methods in the context of artifact removal by achieving a better tradeoff between removing artifacts and preserving inherent brain activities. Qualitative evaluation of the reconstructed EEG epochs also demonstrates that after artifact removal inherent brain activities are largely preserved.

- [7] Rohit Tyagi, Kai-Quan Shen, Shi-Yun Shao, and Xiao-Ping Li. A novel auditory working-memory vigilance task for mental fatigue assessment. *Safety Science*, 47(7):967–972, 2009.

Abstract: An auditory working-memory vigilance task (AWVT), which involves higher mental abilities of a person, like working-memory and decision-making, in addition to vigilance, is presented for measuring human mental fatigue in this paper. A 25-h sleep deprivation study, with hourly testing by AWVT (3 min), PalmPVT (5 min) and self-report of sleepiness, is conducted on eight healthy subjects. The trend of mental fatigue level as measured by a specially proposed score, AWVT Fatigue Index (AFI), during the 25-h study shows very similar pattern to those of PalmPVT lapses and self-report sleepiness. AFI even shows closer correspondence to self-report sleepiness than PalmPVT lapses. This suggests that AWVT is able to measure performance decrement due to sleep deprivation, and it can even provide better measurement of mental fatigue than PalmPVT. AWVT shows a learning curve of less than 3 trials indicating that no skill is required in performing AWVT. Furthermore, repeat studies are done on five of the eight subjects. Pearson's correlation analysis and other statistical exhibits suggest that AWVT has good test-retest reliability and within subject consistency, which are even better than those of PalmPVT. These results suggest that the AWVT can be used as a reliable objective measure of mental fatigue, and it can even track mental fatigue more accurately than PalmPVT in the real world where most tasks require not just a reaction time type response, but also higher mental abilities.

- [8] Jian-Bo Yang, Kai-Quan Shen, Chong-Jin Ong, and Xiao-Ping Li. Feature selection for mlp neural network: The use of random permutation of probabilistic outputs. *IEEE Transactions on Neural Networks*, pages 1911–1922, 2009.

Abstract: This paper presents a new wrapper-based feature selection method for multilayer perceptron (MLP) neural networks. It uses a feature ranking criterion to measure the importance of a feature by computing the aggregate difference, over the feature space, of the probabilistic outputs of the MLP with and without the feature. Thus, a score of importance with respect to every feature can be provided using this criterion. Based on the numerical experiments on several artificial and real-world data sets, the proposed method performs, in general, better than several selected feature selection methods for MLP, particularly when the data set is sparse or has many redundant features. In addition, as a wrapper-based approach, the computational cost for the proposed method is modest.

- [9] Mervyn V. M. Yeo, Xiao-Ping Li, Kai-Quan Shen, and Einar P. V. Wilder-Smith. Can SVM be used for automatic EEG detection of drowsiness during car driving? *Safety Science*, 47:115–124, 2009.

Abstract: This study aims to develop an automatic method to detect drowsiness onset while driving. Support vector machines (SVM) represents a superior signal classification tool based on pattern recognition. The usefulness of SVM in identifying and differentiating electroencephalographic (EEG) changes that occur between alert and drowsy states was tested. Twenty human subjects underwent driving simulations with EEG monitoring. Alert EEG was marked by dominant beta activity, while drowsy EEG was marked by alpha dropouts. The duration of eye blinks corresponded well with alertness levels associated with fast and slow eye blinks. Samples of EEG data from both states were used to train the SVM program by using a distinguishing criterion of 4 frequency features across 4 principal frequency bands. The trained SVM program was tested on unclassified EEG data and subsequently checked for concordance with manual classification. The classification accuracy reached 99.3%. The SVM program was also able to predict the transition from alertness to drowsiness reliably in over 90% of data samples. This study shows that automatic analysis and detection of EEG changes is possible by SVM and SVM is a good candidate for developing pre-emptive automatic drowsiness detection systems for driving safety.

- [10] K. Q. Shen, X. P. Li, C. J. Ong, S. Y. Shao, and E. P. Wilder-Smith. EEG-based mental fatigue measurement using multi-class support vector machines with confidence estimate. *Clin Neurophysiol*, 119(7):1524–33, 2008.

Abstract: Objective: Automatic measurement and monitoring of mental fatigue are invaluable for preventing mental-fatigue related accidents. We test an EEG-based mental-fatigue monitoring system using a probabilistic-based support vector-machines (SVM) method. Methods: Ten subjects underwent 25-h sleep deprivation experiments with EEG monitoring. EEG data were segmented into 3-s long epochs and manually classified into 5 mental-fatigue levels, based on subjects' performance on an auditory vigilance task (AVT). Probabilistic- based multi-class SVM and standard multi-class SVM were compared as classifiers for distinguishing mental fatigue into the 5 mental-fatigue levels. Results: Accuracy of the probabilistic-based multi-class SVM was 87.2%, compared to 85.4% using the standard multi-class SVM. Using confidence estimates aggregation, accuracy increased to 91.2%. Conclusions: Probabilistic-based multi-class SVM not only gives superior classification accuracy but also provides a valuable estimate of confidence in the prediction of mental fatigue level in a given 3-s EEG epoch. Significance: The work demonstrates the feasibility of an automatic EEG method for assessing and monitoring of mental fatigue. Future applications of this include traffic safety and other domains where measurement or monitoring of mental fatigue is crucial.

- [11] Kai-Quan Shen, Chong-Jin Ong, Xiao-Ping Li, and Einar P V Wilder-Smith. Feature selection via sensitivity analysis of SVM probabilistic outputs. *Machine Learning*, 70:1–20, 2008.

Abstract: Feature selection is an important aspect of solving data-mining and machinelearning problems. This paper proposes a feature-selection method for the Support Vector Machine (SVM) learning. Like most feature-selection methods, the proposed method ranks all features in decreasing order of importance so that more relevant features can be identified. It uses a novel criterion based on the probabilistic outputs of SVM. This criterion, termed Feature-based Sensitivity of Posterior Probabilities (FSPP), evaluates the importance of a specific feature by computing the aggregate value, over the feature space, of the absolute difference of the probabilistic outputs of SVM with and without the feature. The exact form of this criterion is not easily computable and approximation is needed. Four approximations, FSPP₁-FSPP₄, are proposed for this purpose. The first two approximations evaluate the criterion by randomly permuting the values of the feature among samples of the training data. They differ in their choices of the mapping function from standard SVM

output to its probabilistic output: FSPP₁ uses a simple threshold function while FSPP₂ uses a sigmoid function. The second two directly approximate the criterion but differ in the smoothness assumptions of criterion with respect to the features. The performance of these approximations, used in an overall feature-selection scheme, is then evaluated on various artificial problems and real-world problems, including datasets from the recent Neural Information Processing Systems (NIPS) feature selection competition. FSPP₁₋₃ show good performance consistently with FSPP₂ being the best overall by a slight margin. The performance of FSPP₂ is competitive with some of the best performing feature-selection methods in the literature on the datasets that we have tested. Its associated computations are modest and hence it is suitable as a feature-selection method for SVM applications.

- [12] K. Q. Shen, C. J. Ong, X. P. Li, Z. Hui, and E. P. Wilder-Smith. A feature selection method for multilevel mental fatigue EEG classification. *IEEE Trans Biomed Eng*, 54(7):1231–7, 2007.

Abstract: Two feature selection approaches for multilevel mental fatigue electroencephalogram (EEG) classification are presented in this paper, in which random forest (RF) is combined with the heuristic initial feature ranking scheme (INIT) or with the recursive feature elimination scheme (RFE). In a “leave-one-proband-out” evaluation strategy, both feature selection approaches are evaluated on the recorded mental fatigue EEG time series data from 12 subjects (each for a 25-h duration) after initial feature extractions. The latter of the two approaches performs better both in classification performance and more importantly in feature reduction. RF with RFE achieved its lowest test error rate of 12.3% using 24 top-ranked features, whereas RF with INIT reached its lowest test error rate of 15.1% using 64 top-ranked features, compared to a test error rate of 22.1% using all 304 features. The results also show that 17 key features (out of 24 top-ranked features) are consistent between the subjects using RF with RFE, which is superior to the set of 64 features as determined by RF with INIT.

- [13] Kai-Quan Shen, Chong-Jin Ong, Xiao-Ping Li, Hui Zheng, and Einar P V Wilder-Smith. Feature selection using SVM probabilistic outputs. *Lecture notes in Computer Science*, 4232:782–791, 2006.

Abstract: A ranking criterion based on the posterior probability is proposed for feature selection on support vector machines (SVM). This criterion has the advantage that it is directly related to the importance of the features. Four approximations are proposed for the evaluation of this criterion. The performances of these approximations, used in the recursive feature elimination (RFE) approach, are evaluated on various artificial and real-world problems. Three of the proposed approximations show good performances consistently, with one having a slight edge over the other two. Their performances compare favorably with feature selection methods in the literature.

- [14] Lian-Yi Zhang, Chong-Xun Zheng, Xiao-Ping Li, and Kai-Quan Shen. Feasibility study of mental fatigue grade based on kolmogorov entropy. *Space Medicine & Medical Engineering*, 18(5):375–380, 2005.

Abstract: Objective: To investigate the relation between electroencephalogram (EEG) and physiological central fatigue; To find a feasible and useful index for physiological central fatigue grading. Method: Kolmogorov entropy (KE) was applied to measure the chaotic degree of physiological central fatigue and the changes of KE of different subjects’ EEG under different mental fatigue status were analyzed. Result Corresponding to the physiological central fatigue status, the average values of KE were in certain range; the grade of physiological central fatigue based on KE might be not affected by circadian rhythm; those whose circadian rhythms were almost same had similar KE values during the same period. Conclusion: It is feasible to grade the physiological central fatigue with KE. This

study may provide a new method for mental fatigue grading. This method can further be applied in practice to develop and implement countermeasures to fatigue and sleepiness, especially in transportation industry.

- [15] Kaiquan Shen, Genjin Dong, and Xiyun Lu. Instability of the shear layer in the near wake of a circular cylinder. *Progress in Natural Science*, 13(4):259–265, 2003.

Abstract: The instability of the shear layer separated from a circular cylinder is studied with the Reynolds number (Re) of $3000 \sim 10^4$ by numerically solving the two-dimensional Navier-Stokes equations. In the wake of the cylinder, primary vortex shedding with natural frequency f_s occurs, and the instability of the shear layer with frequency f_t develops, which leads to mixing layer eddies and interacts with the primary shedding vortices. However, there remains some uncertainties regarding to the variation of the shear layer characteristic frequency with the Reynolds number. Based on the previous experimental work, several relationship of f_t/f_s with Re has been proposed including $f_t/f_s \sim Re^{0.5}$ by Boor, $f_t/f_s \sim Re^{0.87}$ by Wei and Smith and $f_t/f_s \sim Re^{0.67}$ by Prasad and Williamson. The objective of this study is to predict reasonably the relation of the shear layer instability frequency with the Reynolds number based on the present accurate calculation with the high-order schemes and high-resolution spectrum analysis. According to our calculated results, a variation for the normalized shear-layer frequency of the form $f_t/f_s \sim Re^{0.69}$ is predicted numerically, which is in good agreement with a recent experimental measurement of $Re^{0.67}$ and physical prediction of $Re^{0.7}$.

Monographs

- [16] Shiyun Shao, Kai Quan Shen, Wu Chun Ng, Wee Sin Tan, Einar P. V. Wilder-Smith, Xiaoping Li, and Chong Jin Ong. Electroencephalographic study of gender difference in brain's response to cold pain. In *BRAIN TOPOGRAPHY AND MULTIMODAL IMAGING*, pages 109–112. Kyoto University Press, 2009.
- [17] Kai Quan Shen, Shiyun Shao, Ee Min Ho, Wu Chun Ng, Ke Yu, Kenneth Kwok, Veerappa Gounder Boopathi, and Xiaoping Li. Single-trial ERP detection for rapid image triage. In *BRAIN TOPOGRAPHY AND MULTIMODAL IMAGING*, pages 59–62. Kyoto University Press, 2009.

Proceedings and Conference Presentations

- [18] Ke Yu, Kaiquan Shen, Shiyun Shao, Kenneth Kwok, and Xiaoping Li. Twisted spatio-temporal filtering for single-trial denoising in rapid image triage. In *14th European Congress on Clinical Neurophysiology and 4th International Conference on Transcranial Magnetic and Direct Current Stimulation*, Rome, 21-25 June 2011. Accepted.
- [19] Shiyun Shao, Kaiquan Shen, Einar P. V. Wilder-Smith, Chong-Jin Ong, and Xiaoping Li. The heartbeat evoked potential: a neural correlate of pain. In *3rd International Forum on Systems and Mechatronics*, Singapore, Sep 6–9 2010.
- [20] Ke Yu, Kaiquan Shen, Shi-Yun Shao, Wu-Chun Ng, Kenneth Kwok, and Xiaoping Li. Single-trial event-related potential based rapid image triage system. In *3rd International Forum on Systems and Mechatronics*, Singapore, Sep 6–9 2010.
- [21] Wu Chun Ng, Shiyun Shao, Ke Yu, Kaiquan Shen, and Xiaoping Li. A reliable method to minimize the timing error of the event marker for erp application using visual stimuli. In *the Fifteenth International Congress on Event-Related Potentials of the Brain*, Indiana University, Bloomington, United States, April 22–25 2009.

- [22] Shiyun Shao, Kaiquan Shen, Wu Chun Ng, Ke Yu, Chong Jin Ong, and Xiaoping Li. A single-trial erp detection method based on constrained independent component analysis. In *the Fifteenth International Congress on Event-Related Potentials of the Brain*, Indiana University, Bloomington, United States, April 22–25 2009.
- [23] Kaiquan Shen, Shiyun Shao, Wu Chun Ng, Ke Yu, Chong Jin Ong, Einar P V Wilder-Smith, and Xiaoping Li. Robust single-trial erp detection for rapid image triage. In *the Fifteenth International Congress on Event-Related Potentials of the Brain*, Indiana University, Bloomington, United States, April 22–25 2009.
- [24] Shiyun Shao, Kaiquan Shen, Wu Chun Ng, Wee Sin Tan, Einar P.V. Wilder-Smith, Xiaoping Li, and Ong Chong Jin. Electroencephalographic study of gender difference in brain's response to cold pain. In *18th Meeting of the International Society for Brain Electromagnetic Topography (ISBET)*, Kyoto, Japan, 29 Sep – 2 Oct 2009.
- [25] Kaiquan Shen, Shiyun Shao, Ee Min Ho, Wu Chun Ng, Ke Yu, Kenneth Kwok, Veerappa Gounder Boopathi, and Xiaoping Li. Single-trial erp detection for rapid image triage. In *18th Meeting of the International Society for Brain Electromagnetic Topography (ISBET)*, Kyoto, Japan, 29 Sep – 2 Oct 2009.
- [26] Shi-Yun Shao, Kai-Quan Shen, Chong-Jin Ong, Xiao-Ping Li, and Einar P. V. Wilder-Smith. Automatic identification and removal of artifacts in eeg using a probabilistic multi-class svm approach with error correction. In *Systems, Man and Cybernetics, 2008. SMC 2008. IEEE International Conference on*, pages 1134–1139, Singapore, 12-15 Oct 2008.
- [27] Kai-Quan Shen, Chong-Jin Ong, Xiao-Ping Li, and Einar P.V. Wilder-Smith. Novel multi-class feature selection methods using sensitivity analysis of posterior probabilities. In *IEEE International Conference on Systems, Man and Cybernetics, 2008 (SMC 2008)*, pages 1116–21, Singapore, 12-15 Oct 2008. IEEE.
- [28] Jian-Bo Yang, Kai-Quan Shen, Chong-Jin Ong, and Xiao-Ping Li. Feature selection via sensitivity analysis of MLP probabilistic outputs. In *2008 IEEE International Conference on Systems, Man and Cybernetics. (SMC 2008)*, pages 1116–21, Singapore, 12-15 Oct 2008. IEEE.
- [29] Kai Quan Shen, Chong Jin Ong, Xiao Ping Li, Hui Zheng, and Einar P.V. Wilder-Smith. Feature selection using svm probabilistic outputs. In *13th International Conference on Neural Information Processing (ICONIP 2006)*, pages 782–91, Hong Kong, China, 3-6 Oct 2006. Springer-Verlag.
- [30] C. Cao, X. P. Li, H. Zheng, K. Q. Shen, Y. Y. Pang, and E. P. V. Wilder-Smith. A novel simulation platform for validation of eeg signal processing methods. In *57th Annual Meeting of the American Academy of Neurology (AAN)*, pages A185–A185, Miami, Florida, United States, April 9–16 2005.
- [31] Y. Y. Pang, X. P. Li, K. Q. Shen, H. Zheng, W. Zhou, and E. P. V. Wilder-Smith. An auditory vigilance task for mental fatigue detection. In *Engineering in Medicine and Biology Society, 2005. IEEE-EMBS 2005. 27th Annual International Conference of the*, pages 5284–5286, Shanghai, China, 1-4 Sep 2005.
- [32] Yuanyuan Pang, Xiaoping Li, Kaiquan Shen, Hui Zheng, Wei Zhou, and Einar P V Wilder-Smith. Mental fatigue measurement using eeg. In *The 12th International Conference on Biomedical Engineering*, volume 12, Singapore, 1-6 Aug 2005.
- [33] K. Q. Shen, X. P. Li, W. L. P. M. Pullens, H. Zheng, C. J. Ong, and E. P. V. Wilder-Smith. Key feature extraction for fatigue identification using random forests. In *Engineering in Medicine and Biology Society, 2005. IEEE-EMBS 2005. 27th Annual International Conference of the*, pages 2044–2047, Shanghai, China, 1-4 Sep 2005.
- [34] Hui Zheng, Xiaoping Li, Kaiquan Shen, Ong Chong Jin, and Einar P V Wilder-Smith. Lie detection using eeg and support vector machine. In *The 12th International Conference on Biomedical Engineering*, volume 12, Singapore, 1-6 Aug 2005.

- [35] Cheng Cao, Xiaoping Li, Yuanyuan Pang, Kaiquan Shen, and Hui Zheng. Automatic eeg artifact removal based on independent component analysis and stationary wavelet transform de-noising. In *11th Asian & Oceanic Congress of Neurology (AOCN)*, Singapore, 26-28 Nov 2004.
- [36] Yuanyuan Pang, Xiaoping Li, Wei Zhou, Cheng Cao, and Kaiquan Shen. Development of a new method for screening of mental fatigue. In *11th Asian & Oceanic Congress of Neurology (AOCN)*, Singapore, 26-28 Nov 2004.
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Patent

- ◇ PTC Patent, No. PCT/SG2006/000046
 Title "A system and method for monitoring mental fatigue"
 Inventors X. Li, X. Qian, N. Ning, W.C. Ng, K. Shen
 Filing Date 8 March 2006

Last updated: Feb 01, 2012

<http://serve.me.nus.edu.sg/neurosensors/>