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| EPRO SP - 001 | Reliable Security Algorithm for Drones Using Individual Characteristics from an EEG Signal |
|---|---|

Unmanned aerial vehicles (UAVs) have been applied for both civilian and military applications; scientific research involving UAVs has encompassed a wide range of scientific study. However, communication with unmanned vehicles are subject to attack and compromise. Such attacks have been reported as early as 2009, when a Predator UAV's video stream was compromised. Since UAVs extensively utilize autonomous behavior, it is important to develop an autopilot system that is robust to potential cyber-attack. In this paper, we present a biometric system to encrypt communication between a UAV and a computerized base station. This is accomplished by generating a key derived from a user's EEG Beta component. We first extract coefficients from Beta data using Legendre's polynomials. We perform encoding of the coefficients using Bose-Chaudhuri-Hocquenghem encoding and then generate a key from a hash function. The key is used to encrypt the communication between XBees. Also we have introduced scenarios where the communication is attacked. When communication with a UAV is attacked, a safety mechanism directs the UAV to a safe home location. This system has been validated on a commercial UAV under malicious attack conditions.

| EPRO SP - 002 | A Novel Signal Modeling Approach for Classification of Seizure and Seizure-Free EEG Signals |
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This paper presents a signal modeling-based new methodology of automatic seizure detection in EEG signals. The proposed method consists of three stages. First, a multirate filterbank structure is proposed that is constructed using the basis vectors of discrete cosine transform. The proposed filterbank decomposes EEG signals into its respective brain rhythms: delta, theta, alpha, beta, and gamma. Second, these brain rhythms are statistically modeled with the class of self-similar Gaussian random processes, namely, fractional Brownian motion and fractional Gaussian noises. The statistics of these processes are modeled using a single parameter called the Hurst exponent. In the last stage, the value of Hurst exponent and autoregressive moving average parameters are used as features to design a binary support vector machine classifier to classify pre-ictal, inter-ictal (epileptic with seizure free interval), and ictal (seizure) EEG segments. The performance of the classifier is assessed via extensive analysis on two widely used data set and is observed to provide good accuracy on both the data set. Thus, this paper proposes a novel signal model for EEG data that best captures the attributes of these signals and hence, allows to boost the classification accuracy of seizure and seizure-free epochs.

| EPRO SP - 003 | A Review on EEG-Based Automatic Sleepiness Detection Systems for Driver |
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Electroencephalography-based sleepiness detection system (ESDS) is a brain-computer interface that evaluates a driver's sleepiness level directly from cerebral activity. The goals of ESDS research are to estimate and produce a timely warning to prevent declines in performance efficiency and to inhibit sleepiness-related accidents. We first, review different types of measures used in sleepiness detection systems (SDSs) and presents their advantages and drawbacks. Second, the review includes several techniques proposed in ESDSs to optimize the number of EEG electrodes, increasing the sleepiness level resolution and incorporation of circadian information. Finally, the review discusses future direction that can be considered in the development of ESDS.

| EPRO SP - 004 | Toward Drowsiness Detection Using Non-hair-Bearing EEG-Based Brain-Computer Interfaces |
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Drowsy driving is one of the major causes that lead to fatal accidents worldwide. For the past two decades, many studies have explored the feasibility and practicality of drowsiness detection using electroencephalogram (EEG)based brain-computer interface (BCI) systems. However, on the pathway of transitioning laboratory-oriented BCI into real-world environments, one chief challenge is to obtain high-quality EEG with convenience and long-term wearing comfort. Recently, acquiring EEG from non-hair-bearing (NHB) scalp areas has been proposed as an alternative solution to avoid many of the technical limitations resulted from the interference of hair between electrodes and the skin. Furthermore, our pilot study has shown that informative drowsiness-related EEG features are accessible from the NHB areas. This study extends the previous work to quantitatively evaluate the performance of drowsiness detection using cross-session validation with widely studied machine-learning classifiers. The offline results showed no significant difference between the accuracy of drowsiness detection using the NHB EEG and the whole-scalp EEG across all subjects ($p = 0.31$). The findings of this study demonstrate the efficacy and practicality of the NHB EEG for drowsiness detection and could catalyze explorations and developments of many other real-world BCI applications.

| EPRO SP - 005 | Surrogate-Based Artifact Removal from Single-Channel EEG |
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Objective: the recent emergence and success of electroencephalography (EEG) in low-cost portable devices, has opened the door to a new generation of applications processing a small number of EEG channels for health monitoring and brain-computer interfacing. These recordings are, however, contaminated by many sources of noise degrading the signals of interest, thus compromising the interpretation of the underlying brain state. In this paper, we propose a new data-driven algorithm to effectively remove ocular and muscular artifacts from single-channel EEG: the surrogate-based artifact removal (SuBAR). Methods: by means of the time-frequency analysis of surrogate data, our approach is able to identify and filter automatically ocular and muscular artifacts embedded in single-channel EEG. Results: in a comparative study using artificially contaminated EEG signals, the efficacy of the algorithm in terms of noise removal and signal distortion was superior to other traditionally-employed single-channel EEG denoizing techniques: wavelet thresholding and the canonical correlation analysis combined with an advanced version of the empirical mode decomposition. Even in the presence of mild and severe artifacts, our artifact removal method provides a relative error 4 to 5 times lower than traditional techniques. Significance: in view of these results, the SuBAR method is a promising solution for mobile environments, such as ambulatory healthcare systems, sleep stage scoring, or anesthesia monitoring, where very few EEG channels or even a single channel is available.

| EPRO SP - 006 | Deep Convolution Neural Network and Auto encoders-Based Unsupervised Feature Learning of EEG Signals |
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Epilepsy is a health problem that seriously affects the quality of humans for many years. Therefore, it is important to accurately analyze and recognize epilepsy based on EEG signals, and for a long time, researchers have attempted to extract new features from the signals for epilepsy recognition. However, it is very difficult to select useful features from a large number of them in this diagnostic application. As the development of artificial intelligence progresses, unsupervised feature learning based on the deep learning model can obtain features that can better describe identified objects from unlabeled data. In this paper, the deep convolution network and autoencoders-based model, named as AE-CDNN, is constructed in order to perform unsupervised feature learning from EEG in epilepsy. We extract features by AE-CDNN model and classify the features based on two public EEG data sets. Experimental results showed that the classification results of features obtained by AE-CDNN are more optimal than features obtained by principal component analysis and sparse random projection. Using several common classifiers to classify features obtained by AE-CDNN model results in high accuracy and not inferior to the research results from most recent studies. The results also showed that the features of AE-CDNN model are clear, effective, and easy to learn. These features can speed up the convergence and reduce the training times of classifiers. Therefore, the AE-CDNN model can be effectively applied to feature extraction of EEG in epilepsy.

| EPRO SP - 007 | Highly Efficient Compression Algorithms for Multichannel EEG |
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The difficulty associated with processing and understanding the high dimensionality of electroencephalogram (EEG) data requires developing efficient and robust compression algorithms. In this paper, different lossless compression techniques of single and multichannel EEG data, including Huffman coding, arithmetic coding, Markov predictor, linear predictor, context-based error modeling, multivariate autoregression (MVAR), and a low complexity bivariate model have been examined and their performances have been compared. Furthermore, a high compression algorithm named general MVAR and a modified context-based error modeling for multichannel EEG have been proposed. The resulting compression algorithm produces a higher relative compression ratio of 70.64% on average compared with the existing methods, and in some cases, it goes up to 83.06%. The proposed methods are designed to compress a large amount of multichannel EEG data efficiently so that the data storage and transmission bandwidth can be effectively used. These methods have been validated using several experimental multichannel EEG recordings of different subjects and publicly available standard databases. The satisfactory parametric measures of these methods, namely percent-root-mean square distortion, peak signal-to-noise ratio, root-mean-square error, and cross correlation, show their superiority over the state-of-the-art compression methods.

| EPRO SP - 008 | Gamma EEG Correlates of Haptic Preferences for a Dial Interface |
|---|---|

Consumers often develop preferences toward consumer electronics based not only on the visual appearance of a product, but also on its haptic interface. If consumers express a strong haptic preference for a consumer electronic product, they are more likely to purchase it. Hence, it is important to understand how consumers' haptic preference for consumer electronics is formed. Conventional paper-based methods may not provide sufficient information for this purpose, because they provide post-event (i.e., after haptic experience) and environment-dependent (i.e., depending on the manner of asking questions, the person asking the questions, and so on.) data. Therefore, the present study investigated haptic preferences for consumer electronics using neural responses during haptic experiences, which provide the advantage of observing changes while the user is manipulating the product and obtaining environment-independent data. We measured neural responses using non-invasive electroencephalography (EEG). Eighteen volunteers participated in the study and manipulated a haptic dial knob that generates four different haptic profiles; during the manipulation, their EEG signals were recorded. After experiencing different haptic profiles, participants reported their level of preference for each profile. The analysis of EEG revealed that frontal gamma oscillations correlate with the level of haptic preferences, with oscillations becoming stronger with increasing haptic preference. The highest correlation between frontal gamma power and haptic preference was found in the early period of the dial task.

| EPRO SP - 009 | Deep Gaussian Mixture-Hidden Markov Model for Classification of EEG Signals |
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Electroencephalography (EEG) signals are complex dynamic phenomena that exhibit nonlinear and nonstationary behaviors. These characteristics tend to undermine the reliability of existing hand-crafted EEG features that ignore time-varying information and impair the performances of classification models. In this paper, we propose a novel method that can automatically capture the nonstationary dynamics of EEG signals for diverse classification tasks. It consists of two components. The first component uses an autoregressive-deep variational autoencoder model for automatic feature extraction, and the second component uses a Gaussian mixture-hidden Markov model for EEG classification with the extracted features. We compare the performance of our proposed method and the state-of-the-art methods in two EEG classification tasks, subject, and event classification. Results show that our approach outperforms the others by averages of 15% ± 6.3 (p-value <; 0.05) and 22% ± 5.7 (p-value <; 0.05) for subject and event classifications, respectively.

| EPRO SP - 010 | Cognitive Behavior Classification from Scalp EEG Signals |
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Electroencephalography (EEG) has become increasingly valuable outside of its traditional use in neurology. EEG is now used for neuropsychiatric diagnosis, neurological evaluation of traumatic brain injury, neurotherapy, gaming, neurofeedback, mindfulness, and cognitive enhancement training. The trend to increase the number of EEG electrodes, the development of novel analytical methods, and the availability of large data sets has created a data analysis challenge to find the “signal of interest” that conveys the most information about ongoing cognitive effort. Accordingly, we compare three common types of neural synchrony measures that are applied to EEG-power analysis, phase locking, and phase-amplitude coupling to assess which analytical measure provides the best separation between EEG signals that were recorded, while healthy subjects performed eight cognitive tasks-Hopkins Verbal Learning Test and its delayed version, Stroop Test, Symbol Digit Modality Test, Controlled Oral Word Association Test, Trail Marking Test, Digit Span Test, and Benton Visual Retention Test. We find that of the three analytical methods, phase-amplitude coupling, specifically theta (4-7 Hz)-high gamma (70-90 Hz) obtained from frontal and parietal EEG electrodes provides both the largest separation between the EEG during cognitive tasks and also the highest classification accuracy between pairs of tasks. We also find that phase-locking analysis provides the most distinct clustering of tasks based on their utilization of long-term memory. Finally, we show that phase-amplitude coupling is the least sensitive to contamination by intense jaw-clenching muscle artifact.

| EPRO SP - 011 | Robust Support Matrix Machine for Single Trial EEG Classification |
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Electroencephalogram (EEG) signals are of complex structure and can be naturally represented as matrices. Classification is one of the most important steps for EEG signal processing. Newly developed classifiers can handle these matrix-form data by adding low-rank constraint to leverage the correlation within each data. However, classification of EEG signals is still challenging, because EEG signals are always contaminated by measurement artifacts, outliers, and non-standard noise sources. As a result, existing matrix classifiers may suffer from performance degradation, because they typically assume that the input EEG signals are clean. In this paper, to account for intra-sample outliers, we propose a novel classifier called a robust support matrix machine (RSMM), for single trial EEG data in matrix form. Inspired by the fact that empirical EEG signals contain strong correlation information, we assume that each EEG matrix can be decomposed into a latent low-rank clean matrix plus a sparse noise matrix. We simultaneously perform signal recovery and train the classifier based on the clean EEG matrices. We formulate our RSMM in a unified framework and present an effective solver based on the alternating direction method of multipliers. To evaluate the proposed method, we conduct extensive classification experiments on real binary EEG signals. The experimental results show that our method has outperformed the state-of-the-art matrix classifiers. This paper may lead to the development of robust brain-computer interfaces (BCIs) with intuitive motor imagery and thus promote the broad use of the noninvasive BCIs technology.

| EPRO SP - 012 | Toward Drowsiness Detection Using Non-hair-Bearing EEG-Based Brain-Computer Interfaces |
|---|---|

Drowsy driving is one of the major causes that lead to fatal accidents worldwide. For the past two decades, many studies have explored the feasibility and practicality of drowsiness detection using electroencephalogram (EEG)based brain-computer interface (BCI) systems. However, on the pathway of transitioning laboratory-oriented BCI into real-world environments, one chief challenge is to obtain high-quality EEG with convenience and long-term wearing comfort. Recently, acquiring EEG from non-hair-bearing (NHB) scalp areas has been proposed as an alternative solution to avoid many of the technical limitations resulted from the interference of hair between electrodes and the skin. Furthermore, our pilot study has shown that informative drowsiness-related EEG features are accessible from the NHB areas. This study extends the previous work to quantitatively evaluate the performance of drowsiness detection using cross-session validation with widely studied machine-learning classifiers. The offline results showed no significant difference between the accuracy of drowsiness detection using the NHB EEG and the whole-scalp EEG across all subjects ($p = 0.31$). The findings of this study demonstrate the efficacy and practicality of the NHB EEG for drowsiness detection and could catalyze explorations and developments of many other real-world BCI applications.

| EPRO SP - 013 | Spatial Wavelet-Based Coherence and Coupling in EEG Signals with Eye Open and Closed During Resting State |
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Biological signals represent patterns of change in the rhythms of biological systems providing a complementary way to study the dynamics of these systems. The research reported in this paper is based on methodological approaches used to quantify the dynamical fluctuations of neurophysiological systems. We use time-frequency representation techniques including spatial coupling and spatial wavelet phase coherence to analyze the dynamics of electroencephalographic (EEG) signals in different frequency bands in the form of topographic maps. The distribution of power in different frequency bands is computed. The findings indicated that the power in delta frequency band is mainly distributed in prefrontal and occipital regions, whereas, power in theta band is distributed in fronto-occipital regions. The power in alpha band is distributed in posterior and extended to anterior, power in beta band in posterior and prefrontal regions and gamma band power is dominant in prefrontal and occipital regions. All the frequency bands are involved in different activities in one way or other, however alpha band power revealed dominant anterior-posterior activity where the eye-closed (EC) coherence is higher than eye open (EO) coherence. The phase-phase CFC on multichannel EEG signals with EC and EO during resting state is also computed to investigate which brain regions are affected by phase modulation of low frequency bands. Coupling in different frequency bands is estimated using dynamic Bayesian inference approach. This approach can detect the phase connectivity within a network of time varying coupled oscillator subject to the noise.

| EPRO SP - 014 | EEG Signals Classification: Motor Imagery for Driving an Intelligent Wheelchair |
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The activities pertaining to body control performed by human beings utilize neuromuscular tracts. Tasks' performance such as moving the arms or walking demand the planning of the task to be performed. People diagnosed with clinical conditions such as Amyotrophic Lateral Sclerosis, Spine lesions or Cerebrovascular Accident, for instance, have their neuromuscular tracts damaged. One of the alternatives to bypass that problem is the development of technologies which can partially replace the loss functioning of people with severe motor impairment. The imagination of the movement is considered as a cognitive state which corresponds to the mental simulation of a given motor action. The general aim of this investigative research is to develop a brain-computer based interface for the movement imagination of the left fist, right fist, both fists and both feet in order to control an intelligent wheelchair. The electroencephalography signals were acquired through the database eegmmidb - EEG Motor Movement/Imagery Dataset. Electroencephalography signals samples of 106 individuals were utilized in order to validate the computational model. The proposed model obtained an efficiency of 74,96% in the correct classification of the events related to movement imagination. The developed techniques are promising.

| EPRO SP - 015 | Compressive Sensing Based Classification in the Presence of Intra-and Inter-Signal Correlation |
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In this letter, we investigate the problem of classification with high-dimensional data using low-dimensional random projections in the presence of inter- and intra-signal correlations. Each sensor is assumed to compress its high-dimensional (Gaussian) signal vector using random projections in a multisensor setting. In order to quantify the classification performance with compressed data, we consider the Bhattacharya distance as the performance metric. In the presence of intra-signal correlation at a given sensor, the degradation in the Bhattacharya distance with compressed data is shown to be nonlinear with the compression ratio in contrast to the case when there is no intra-signal correlation. In the presence of inter-signal correlation, the degradation in the Bhattacharya distance with compressed data depends on whether or not an identical projection matrix is used to compress data at multiple sensors.

| EPRO SP - 016 | Ensemble SVM Method for Automatic Sleep Stage Classification. |
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Sleep scoring is used as a diagnostic technique in the diagnosis and treatment of sleep disorders. Automated sleep scoring is crucial, since the large volume of data should be analyzed visually by the sleep specialists which is burdensome, time-consuming tedious, subjective, and error prone. Therefore, automated sleep stage classification is a crucial step in sleep research and sleep disorder diagnosis. In this paper, a robust system, consisting of three modules, is proposed for automated classification of sleep stages from the single-channel electroencephalogram (EEG). In the first module, signals taken from Pz-Oz electrode were denoised using multiscale principal component analysis. In the second module, the most informative features are extracted using discrete wavelet transform (DWT), and then, statistical values of DWT subbands are calculated. In the third module, extracted features were fed into an ensemble classifier, which can be called as rotational support vector machine (RotSVM). The proposed classifier combines advantages of the principal component analysis and SVM to improve classification performances of the traditional SVM. The sensitivity and accuracy values across all subjects were 84.46% and 91.1%, respectively, for the five-stage sleep classification with Cohen's kappa coefficient of 0.88. Obtained classification performance results indicate that, it is possible to have an efficient sleep monitoring system with a single-channel EEG, and can be used effectively in medical and home-care applications.

| EPRO SP - 017 | Automated ECG Classification Using Dual Heartbeat Coupling Based on Convolutional Neural Network |
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A high performance electrocardiogram (ECG)-based arrhythmic beats classification system is presented in this paper. The classifier was designed based on convolutional neural network (CNN). Single channel ECG signal was segmented into heartbeats in accordance with the changing heartbeat rate. The beats were transformed into dual beat coupling matrix as 2-D inputs to the CNN classifier, which captured both beat morphology and beat-to-beat correlation in ECG. A systematic training beat selection procedure was also proposed which automatically include the most representative beats into the training set to improve classification performance. The classification system was evaluated for the detection of supraventricular ectopic beats (SVEB or S beats) and VEB using the MIT-BIH arrhythmia database. Our proposed method has demonstrated superior performance than several state-of-the-art detectors. In particular, our proposed CNN system has improved sensitivity and positive predictive rate for S beats by more than 12.2% and 11.9%, respectively, over these top performing algorithms. Our proposed CNN classifier with an automatic training beats selection process has shown to outperform the previous methods. The classifier is also a personalized one by combining training set from a common pool and a subject-specific set of ECG data. Our proposed system provides a reliable and fully automatic tool for detection of arrhythmia heartbeat without the need for manual feature extraction or expert assistant. It can potentially be implemented on portable device for the long-term monitoring of cardiac arrhythmia.

| EPRO SP - 018 | Innovative Method for Unsupervised Voice Activity Detection and Classification of Audio Segments |
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An accurate and noise-robust voice activity detection (VAD) system can be widely used for emerging speech technologies in the fields of audio forensics, wireless communication, and speech recognition. However, in real-life application, the sufficient amount of data or human-annotated data to train such a system may not be available. Therefore, a supervised system for VAD cannot be used in such situations. In this paper, an unsupervised method for VAD is proposed to label the segments of speech-presence and speech-absence in an audio. To make the proposed method efficient and computationally fast, it is implemented by using long-term features that are computed by using the Katz algorithm of fractal dimension estimation. Two databases of different languages are used to evaluate the performance of the proposed method. The first is Texas Instruments Massachusetts Institute of Technology (TIMIT) database, and the second is the King Saud University (KSU) Arabic speech database. The language of TIMIT is English, while the language of the KSU speech database is Arabic. TIMIT is recorded in only one environment, whereas the KSU speech database is recorded in distinct environments using various recording systems that contain sound cards of different qualities and models. The evaluation of the proposed method suggested that it labels voiced and unvoiced segments reliably in both clean and noisy audio.

| EPRO SP - 019 | Sequential Deep Neural Networks Ensemble for Speech Bandwidth Extension |
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In this paper, we propose a subband-based ensemble of sequential deep neural networks (DNNs) for bandwidth extension (BWE). First, the narrow-band spectra are folded into the highband (HB) region to generate the high-band spectra, and then the energy levels of the HB spectra are adjusted using the DNN-based on the log-power spectra feature. For this, we basically build the multiple DNNs, which is responsible for each subband of the HB and the DNN ensemble is sequentially connected from lower to higher subbands. This sequential structure for the DNN ensemble carries out the denoising and HB regression to better estimate the HB energy levels. In addition, we use the voiced/unvoiced (V/UV) classification to differently apply the DNN ensemble depending on either V/UV sounds. To demonstrate the performance of the proposed BWE algorithm, we compare it with a speech production model-based BWE system and a DNN-based BWE system in which the log-power spectra in the HB are estimated directly. The experimental results show that the proposed approach provides better speech quality than conventional approaches.

| EPRO SP - 020 | Advanced Sentiment Classification of Tibetan Microblogs on Smart Campuses Based on Multi-Feature Fusion |
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Sentiment analysis is an important problem in natural language processing, which plays an important role in many fields, such as information forecasting, knowledge classification, and product review. Because Tibetan microblogs have their own unique form, particularly the heterogeneous features, such as the emoticons, the grammatical relations, and the speech, the existing sentiment analysis method has difficulty in analyzing the emotions that such microblogs express. In this paper, we propose a sentiment classification method for Tibetan microblogs based on multi-feature fusion. To better study the affection of affective features, this paper first determines the theme of Weibo texts and chooses smart campuses as theme of Weibo texts for analyzing the influence of each feature on the sentiment of the microblog. Then, these features are fused as a multi-feature, and the sentiment of the Tibetan microblog is classified according to the multifeature fusion. The experimental results demonstrated that the sentiment classification algorithm based on feature fusion improved the accuracy of microblog sentiment classification.

| EPRO SP - 021 | PRUNE: Dynamic and Decidable Dataflow for Signal Processing on Heterogeneous Platforms |
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The majority of contemporary mobile devices and personal computers are based on heterogeneous computing platforms that consist of a number of CPU cores and one or more graphics processing units (GPUs). Despite the high volume of these devices, there are few existing programming frameworks that target full and simultaneous utilization of all CPU and GPU devices of the platform. This article presents a dataflow-flavored model of computation (MoC) that has been developed for deploying signal processing applications to heterogeneous platforms. The presented MoC is dynamic and allows describing applications with data dependent run-time behavior. On top of the MoC, formal design rules are presented that enable application descriptions to be simultaneously dynamic and decidable. Decidability guarantees compile-time application analyzability for deadlock freedom and bounded memory. The presented MoC and the design rules are realized in a novel Open Source programming environment "PRUNE" and demonstrated with representative application examples from the domains of image processing, computer vision and wireless communications. Experimental results show that the proposed approach outperforms the state-of-the-art in analyzability, flexibility, and performance.

| EPRO SP - 022 | Rating Prediction via Graph Signal Processing |
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This paper develops new designs for recommendation systems inspired by recent advances in graph signal processing (SP). Recommendation systems aim to predict unknown ratings by exploiting the information revealed in a subset of user-item observed ratings. Leveraging the notions of graph frequency and graph filters, we demonstrate that classical collaborative filtering methods, such as k-nearest neighbors (NN), can be modeled as a specific band-stop graph filter on networks describing similarities between users or items. We also demonstrate that linear latent factor (LF) models, such as low-rank matrix completion, can be viewed as bandlimited interpolation algorithms that operate in a frequency domain given by the spectrum of a joint user and item network. These new interpretations pave the way to new methods for enhanced rating prediction. For NN-based collaborative filtering, we develop more general band-stop graph filters, and present a novel predictor, called Mirror Filtering (MiFi), that filters jointly across user and item networks. For LF, we propose a low complexity method by exploiting the eigenvector of correlation matrices constructed from known ratings. The performance of our algorithms is assessed in the MovieLens 100k dataset, showing that our designs reduce the root mean squared error (up to a 9.10% for MiFi) compared to the one incurred by the benchmark collaborative filtering approach.

| EPRO SP - 023 | FPGA implementation of target detection algorithm at real time video signal processing using harris corner detector filter |
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In this paper, hardware implementation of corner detection at real time video signals using Harris filter based on FPGA is explained. Corner detection is an elemantary and fundamental tool for image segmentation and feature extraction like edge detection. Very high speed hardware like FPGA's are used to implement the image and video processing algorithms for improving the performance of processing systems. Algorithms are implemented on the Xilinx Zynq 7000. The video input signals come from a laptop's HDMI interface to FPGA in order to filter and the detected corners are displayed on a HDMI display screen.

| EPRO SP - 024 | Partition of medical signals with a two band adaptive filter bank |
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Medical signal processing is often used to detect diseases. Segmentation, filtering, categorization are basic operations in this field. In this study; a two-band quadrature mirror orthogonal filter bank structure is used to emphasize and extract signals like QRS wave from electrocardiography, evoked potential from electroencephalography signal. One branch of the filter bank is adopted to filter out a target signal. This is done by minimizing error energy at the output of the filter bank system. The approach is run and tested for a QRS signal and a synthetic evoked potential signal. The common orthogonal wavelet filters (Daubechies, Symlet, Coiflet) and designed filter are compared in terms of mean squared error (MSE). The designed filter attains the target signal with the minimum MSE and outperforms common classical wavelet filters.

| EPRO SP - 025 | Adaptive Graph Signal Processing: Algorithms and Optimal Sampling Strategies |
|---|---|

The goal of this paper is to propose novel strategies for adaptive learning of signals defined over graphs, which are observed over a (randomly) time-varying subset of vertices. We recast two classical adaptive algorithms in the graph signal processing framework, namely the least mean squares (LMS) and the recursive least squares (RLS) adaptive estimation strategies. For both methods, a detailed mean-square analysis illustrates the effect of random sampling on the adaptive reconstruction capability and the steady-state performance. Then, several probabilistic sampling strategies are proposed to design the sampling probability at each node in the graph, with the aim of optimizing the tradeoff between steady-state performance, graph sampling rate, and convergence rate of the adaptive algorithms. Finally, a distributed RLS strategy is derived and shown to be convergent to its centralized counterpart. Numerical simulations carried out over both synthetic and real data illustrate the good performance of the proposed sampling and recovery strategies for (distributed) adaptive learning of signals defined over graphs.

| EPRO SP - 026 | Classification of ECG signal by using machine learning methods |
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In this study, an application of Artificial Neural Networks (ANN), Support Vector Machines (SVM), and k-Nearest Neighbor (k-NN) machine learning methods is performed to measure the classification performance of the models on classifying electrocardiogram (ECG) signals as normal and abnormal. In this scope, ECG records were obtained from an open-accessible database (PTBDB). A feature set was generated by extraction the morphological and statistical features of 80 normal and 442 abnormal ECG recordings obtained from the database, first. The feature set was applied as the input to ANN, SVM, and k-NN classifiers. The 10-fold cross-validation method was employed in the experiment in order to achieve more generalized results. As a result of the experimental study, the best classification performance was achieved using SVM, and 85.1% of accuracy, 89 of sensitivity and 51,7 specificity values were obtained. SVM was superior to other classifiers.

| EPRO SP - 027 | Optimal Filter Design for Signal Processing on Random Graphs: Accelerated Consensus |
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In graph signal processing, filters arise from polynomials in shift matrices that respect the graph structure, such as the graph adjacency matrix or the graph Laplacian matrix. Hence, filter design for graph signal processing benefits from knowledge of the spectral decomposition of these matrices. Often, stochastic influences affect the network structure and, consequently, the shift matrix empirical spectral distribution. Although the joint distribution of the shift matrix eigenvalues is typically inaccessible, deterministic functions that asymptotically approximate the matrix empirical spectral distribution can be found for suitable random graph models using tools from random matrix theory. We employ this information regarding the density of eigenvalues to develop criteria for optimal graph filter design. In particular, we consider filter design for distributed average consensus and related problems, leading to improvements in short-term error minimization or in asymptotic convergence rate.

| EPRO SP - 028 | A new approach for discriminating the acoustic signals: Largest area parameter (LAP) |
|---|---|

Feature extraction of sound signals is essential for the performance of applications such as pattern and voice recognition etc. In this study, a method based on a novel feature is proposed to separate pathological human voice signals from healthy ones as well as to separate subgroups of pathological voices from each other. The voices are examined in time-frequency domain. Their differences obtained from the results of the proposed method are investigated and the mechanism of the method is demonstrated using experimental cases. It is concluded that the method succeeds to discriminate the voices marked “healthy” and “pathological”.

| EPRO SP - 029 | Emotion recognition in valence-arousal scale by using physiological signals |
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Physiological signals are generated autonomously by central nervous system therefore they cannot be controlled or masked. In the literature, physiological signals are commonly used for emotion recognition. In this study, emotional stimulation is induced using visual and audio stimuli. We used Microsoft Band 2 arm band and Mind Wave EEG sensor for recording the participants' signals during the experiment. We collected data from 20 participants and recognized their emotions on the valence-arousal scale. We tested and compared 3 different classifiers for recognition.

| EPRO SP - 030 | Sparse Signal Recovery Using Iterative Proximal Projection |
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This paper is concerned with designing efficient algorithms for recovering sparse signals from noisy underdetermined measurements. More precisely, we consider minimization of a nonsmooth and nonconvex sparsity promoting function subject to an error constraint. To solve this problem, we use an alternating minimization penalty method, which ends up with an iterative proximal-projection approach. Furthermore, inspired by accelerated gradient schemes for solving convex problems, we equip the obtained algorithm with a so-called extrapolation step to boost its performance. Additionally, we prove its convergence to a critical point. Our extensive simulations on synthetic as well as real data verify that the proposed algorithm considerably outperforms some well-known and recently proposed algorithms.

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