(1)

Fuzzy C-Means with a Local Membership KL Distance for Medical Image Segmentation

R. R. Gharieb and G. Gendy

Abstract:

This paper presents a new technique for incorporating local membership information into the standard fuzzy C-means (FCM) clustering algorithm. In this technique, the objective consists of minimizing the classical FCM function with a unity fuzzifier exponent plus the Kullback□Leibler (KL) information distance acting as a fuzzification and regularization term. The KL distance is proposed to measure the proximity between cluster membership function of a pixel and an average of the cluster membership functions of immediate neighborhood pixels. Therefore, minimizing this KL distance biases the cluster membership of the pixel toward this smoothed membership function of the local neighborhoods. This can provide immunity against noise and results in clustered images with piecewise homogeneous regions. Results of clustering and segmentation of synthetic and real-world medical images are presented to compare the performance of the proposed local membership KL information based FCM (LMKLFCM) and the standard FCM, a local data information based FCM (LDFCM) and a type of local membership information based FCM (LMFCM) algorithms.

Keywords:

data clustering, fuzzy c-means, medical image segmentation, local data and membership information, KL divergence.

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(2)

Subband Spectral Complexity Distance for Cortical Health Evaluation and Monitoring in Ischemic Brain Injury

R. R. Gharieb, M. Hathi and N. Thakor

Abstract:

A quantitative electroencephalogram (qEEG) index for the evaluation and monitoring of cortical health in ischemic brain injury is presented. The proposed qEEG index, called the subbands spectral complexity distance (SSCD), measures the distance between a vector of subbands spectral complexities computed from the investigated EEG and a one computed from normal EEG. For the computation of the SSCD, the spontaneous power spectral density of the EEG signal is estimated using the time-varying autoregressive (TV-AR) model, decomposed into subbands and the spectral complexity of each subband is computed. Results of evaluating human EEG data are presented to show the usefulness of the proposed SSCD index. It is shown that the index increases during the time-segments of ischemic brain injury while decreases during the normal and recovery segments. This can be explained by the fact that the ischemic brain injury may increase the irregularity of the EEG signal and therefore the power spectral density becomes more complex with ischemic brain injury.

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(3)

Efficient Segmentation and Tracking of the EEG Signal Using an Adaptive Lattice Predictor

R. R. Gharieb

Abstract:

In this paper, an adaptive approach using the least-mean-square lattice (LMSL) is proposed for the segmentation and tracking of the electro-encephalogram (EEG) signal. In the proposed approach, the time-trajectories of the reflection coefficients of the adaptive lattice predictor as well as the on-line power spectrum estimate are used as classification, segmentation and tracking parameters. The adaptive lattice predictor consists of cascaded similar first-order sections. Theses sections are independent due to the orthogonality principle linked to the least-mean square (LMS) algorithm. Therefore, on-line adding a new section makes no influence on the values of the coefficients of the preceding sections. Such property of the adaptive lattice predictor is not valid when the direct-form linear prediction filter is employed. Further advantage of the lattice predictor is the fast convergence due to independence of the successive sections, which yields no matrix computation. Results for tracking sleep spindles of computer-generated and real-world EEG data are presented to show the significant usefulness of the proposed approach. It is shown that an adaptive lattice predictors consisting of three up to four sections are satisfactory for the detection and tracking of the sleep spindles. A short-time (i.e., sliding window) implementation of Burg's method (STBM) for computing the reflection coefficients of the lattice predictor is also suggested and examined. This method shows that the time-trajectories of the lattice coefficients, the on-line power spectrum and a proposed quantitative measure are capable of distinguishing between the EEG from normal healthy subject and the EEG from Alzheimer patient subject.

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Journal of Engineering Sciences , 32 , 427-445

(4)

Self and Mutual Information of the Electroencephalogram for the Diagnosis of Alzheimer's Disease

R. R. Gharieb

Abstract:

In this paper, a segment of the electroencephalogram (EEG) signal of a subject is viewed as outcomes of a single and a joint two random variables. The Shannon entropy (self information) contained in the single random variable and the mutual information associated with the joint two random variables can be used for the diagnosis of Alzheimer's disease. It is shown that the self information may provide diagnostic error while the mutual information provides accurate and significant diagnosis. This can be justified by the following fact. The mutual information between a current sample and a delayed one of the EEG signal is a quantitative measure for the information of the current sample contained in the past one. Thus, this mutual information is related to the subject memory, which experiences a problem in Alzheimer's disease.

Keywords:

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Journal of Engineering Sciences , NULL , NULL

(5)

Extraction of the Evoked Potentials from a Small number of Sweeps using Combination of the Ensemble Average and Correlation-Based Blind Source Separation

R.R. Gharieb

Abstract:

This paper proposes an efficient approach for the extraction of the brain evoked potentials (EPs) from a small number of sweeps. In this approach, the ensemble average EP waveforms of different electrodes are computed from a small number of sweeps. Theses EP waveforms are decomposed into uncorrelated components using a correlation-based blind source separation method. By this separation, the evoked potential waveforms could be isolated from the electroencephalogram (EEG), noise and other artifacts waveforms. In order to enhance the signal-to-noise ratio and to recover the desired EP components, each uncorrelated component is filtered through a zero-phase matched filter based on the third-order correlation lags of the filter input. Finally, the evoked potential waveform recorded by every electrode is obtained through the projection of the selected filtered evoked potential components into the electrode space. Experimental results for visual and auditory evoked potentials show that the EP waveforms obtained by applying the proposed approach to 5 sweeps for the visual case and to 2 sweeps for the auditory case are better than those obtained by ensemble averaging and filtering of 45 sweeps.

Keywords:

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(6)
-Monitoring of Brain Injury Based on the Poles of the Time Varying Autoregressive EEG Signal Model

RR Ghariеb

Abstract:

In this paper, the trajectories of the poles (radiuses and frequencies) of the time-varying autoregressive (TV-AR) model of the electroencephalogram (EEG) signal are used for monitoring brain injury and recovery. The TV-AR coefficients are obtained using Burg algorithm applied to a sliding window. The norm of the TV-frequencies is suggested to be a quantitative measure for monitoring the brain injury and recovery. The radiuses-frequencies of the TV-poles are displayed as a scattering plot for monitoring and investigating the brain injury and recovery as well. This scattering plot provides more details about injury-related EEG changes. Analysis and results of real-world EEG data illustrate that the norm of the TV-frequencies and the scattering plot of the radiuses-frequencies provide significant tool for investigating and monitoring the brain injury and recovery from the TV-AR model poles. For intensive analysis various model orders are examined. The second-order model introduces itself as the significant one for monitoring the brain injury. With employing the third-order, asphyxia manifests itself by damping the real pole and by increasing the frequencies of the other two poles. In the resuscitation segment the situation moves back and finally in the recovery segment the scattering plot gets closely similar to the normal EEG scattering plot.

Keywords:

NULL

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(7)

Adaptive local data and membership based KL divergence incorporating C-means algorithm for fuzzy image segmentation

R.R. Gharieba,, G. Gendyb, A. Abdelfattaha, H. Selima

Abstract:

In this paper, a fuzzy clustering technique for image segmentation is developed by incorporating a hybrid of local spatial membership and data information into the conventional hard C-means (HCM) algorithm. This incorporation is a threefold procedure. (1) The membership function of a pixel is spatially smoothed in the pixel vicinity. (2) The Kullback-Leibler (KL) divergence between the pixel membership function and the smoothed one is added to the HCM objective function for fuzzification. (3) The resulting fuzzified HCM is regularized by adding a weighted HCM-like function where the original pixel data are replaced by locally smoothed ones. Thereby the weight is proportional to the residual of the locally smoothed membership. This residual decreases when many pixels existing in the pixel vicinity belong to the same cluster. Thus, the weighted distance decreases, allowing the pixel membership to follow the dominant membership in the pixel vicinity. The simulation results of segmenting synthetic, medical and media images have shown that the proposed algorithm provides better performance compared to several previously developed algorithms. For example, in a synthetic image, with added white Gaussian noise having a variance of 0.3, the proposed algorithm provides accuracy, sensitivity and specificity of 92%, 84% and 94.7% respectively, while the algorithm with the closest results provides 81.9% of accuracy, 62.2% of sensitivity and 86.8% of specificity. In addition, the proposed algorithm shows the capability to identify the number of clusters.

Keywords:

Fuzzy C-means Medical image segmentation Local membership information Weighted distances Kullback–Leibler (KL) divergence

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(8)

C-means clustering fuzzified by two membership relative entropy functions approach incorporating local data information for noisy image segmentation

R. R. Gharieb1 · G. Gendy2 · A. Abdelfattah1

Abstract:

In this paper, C-means algorithm is fuzzified and regularized by incorporating both local data and membership information. The local membership information is incorporated via two membership relative entropy (MRE) functions. These MRE functions measure the information proximity of the membership function of each pixel to the membership average in the immediate spatial neighborhood. Then minimizing these MRE functions pushes the membership function of a pixel toward its average in the pixel vicinity. The resulting algorithm is called the Local Membership Relative Entropy based FCM (LMREFCM). The local data information is incorporated into the LMREFCM algorithm by adding to the standard distance a weighted distance computed from the locally smoothed data. The final resulting algorithm, called the Local Data and Membership Relative Entropy based FCM (LDMREFCM), assigns a pixel to the cluster more likely existing in its immediate neighborhoods. This provides noise immunity and results in clustered images with piecewise homogeneous regions. Simulation results of segmentation of synthetic and real-world noisy images are presented to compare the performance of the proposed LMREFCM and LDMREFCM algorithms with several FCM-related algorithms

Keywords:

Noisy image segmentation · FCM algorithm · Local spatial information · Membership relative entropy

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(9)

Transferring Electromyogram Signal between Limbs

Ehab A. Hamed, Mohamed Atef, Mohamed Abbas, R. R. Gharieb

Abstract:

This paper introduces a sensing and stimulation system to transfer the electromyogram (EMG) signal from one limb to another, aiming to enable self-electro-physical therapy. The presented technique depends on sensing EMG signal from one limb muscle and, simultaneously, stimulating the corresponding muscle in the other limb by this signal. The technique has been implemented on a standalone cheap microcontroller. The sensing and stimulating circuits have been implemented using off-shelf components. The delivery of the stimulating signal has been done noninvasively through surface electrodes.

Keywords:

Electromyogram, EMG, Electrical Stimulation, Rehabilitation, Peripheral nerve injury, Electro-physical therapy

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(10)

Image Segmentation Using Fuzzy C-Means Algorithm Incorporating Weighted Local Complement Membership and Local Data Distances

Gharieb, R.R.; Gendy, G.; Abdelfattah, A.

Abstract:

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Keywords:

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A robust local data and membership information based FCM algorithm for noisy image segmentation

Gharieb, R.R.; Gendy, G.; Abdelfattah, A.

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