Applications of artificial intelligence techniques in signal processing

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1. **Simona Moldovanu, Mihaela Miron, and Anisia Culea-Florescu,** ***Diabetic Retinopathy Image Classification Using Machine Learning and Local Binary Patterns Features***

Abstract

Diabetic Retinopathy (DR) is a disease that affects blood vessels in the retina due to diabetes. Early detection and appropriate treatment are the key to decrease the progression of the DR. This paper presents a study based on Machine Learning (MLs), a subset of artificial intelligence (AI). The proposed subset contains six MLs: Random Forest (RF), Adaptive Boosting (AB), K-Nearest Neighbor (K-NN), Gaussian Naive Bayes (GNB), Support Vector Machine (SVM) and Quadratic Discriminant Analysis (QDA). The enumerated MLs were applied on 10 features extracted with local binary patterns (LPB). In this study, the binary classification refers to two classification tasks with three classes: Non-Diabetic Retinopathy (Non-DR), Moderate Retinopathy (MR) and Severe Retinopathy (SV). The first classification was performed between noDR vs. MR and the second between noDR vs. SV. The best classification accuracy was achieved by RF technique, 0.912 for the first classification and 0.94 for the second classification.

2. **Simona Moldovanu, Sorin Pavel, and Dorel Aiordachioaie,** ***On features extraction from thermal images for human state recognition*****.**

Abstract

The problem of features extraction and selection is considered. The goal is to evaluate some techniques from artificial intelligence domain to extract features from thermal images of human faces and for objectives of classification. The database is composed from eighty thermal images of size 250 x 300 pixels. The set of features is organized on two levels, e.g., of first order (from histogram) and second order (from texture, i.e., Haralick features).

3. **Gabriel Sirbu and Laurentiu Frangu,** ***Aspects of conversion of soft computing algorithms on GPU boards****.*

Abstract

The objective of the work is to compare the performances provided by a Graphical Processing Unit (GPU) – based board to those of a conventional PC processor, in a non-linear classification problem. The GPU board (Pumpkin deployment board) and its specific software were designed to run algorithms coming from the artificial intelligence and soft computing areas, such as image processing, pattern recognition, data mining. In this test, the chosen classification method is based on soft computing techniques, namely Artificial Neural Networks (ANN). Although the GPU board is expected to run faster than the regular processor, the combination of the software running on these processors and the nature of the problem can significantly influence the result. While the PC runs a program under Matlab environment or a compiled program, the Pumpkin board uses its specific ANN simulation software. The problem used to evaluate the two solutions is the classification of bearing faults. Two approaches were considered for the vectors to be classified: a reduced size pattern, formed by the features extracted from the recorded window (feature driven,

FD) and the entire window (data driven classification, DD). The power spectral density and the Kohonen self organizing maps (SOM) were used to evaluate the separability of the four considered classes (normal functioning and three faults). For the FD approach, a small size ANN provides very satisfactory results, in terms of recognition ability. No significant advantage was offered by the Pumpkin board, during the exploitation stage of the classifier, as most of the computation is performed offline, during the feature extraction and training. On the contrary, for the DD approach, no offline information compression is performed, the online computation acts on the entire samples set input vector. Consequently, a high size ANN is necessary and a difference of two orders of magnitude was noticed, between the GPU board and the regular PC processor, in terms of online computation time. In this test, a small part of the GPU resources was used, making it suitable for solving even more complicated problems, when using soft computing techniques.

4. **Dorel Aiordachioaie and Rustem Popa, *PSO over GA for signal processing applications*.**
Abstract

The objective of the work is to make an evaluation of Particle Swarm Optimization (PSO) over Genetic Algorithms (GA), in the framework of signal analysis and model parameters estimations. Both approaches, i.e., PSO and GA, are members of the evolutionary computation domain and have bioinspired roots. Two versions of PSO are considered, i.e., the version with constraint coefficients and inertia (PSO-COIN) and the version based on quantum models (QPSO). Two case studies are considered. Two functions are used, chose from a benchmark suite used for the evaluation of the optimization algorithms. The second case is the parameter estimation problem, in the context of the signal analysis problem, under various signal-to-noise ratios to study the effects on the converge rates of the estimation processes. The computer-based experiments show comparable performances for PSO algorithms, for short time simulation, i.e., 100 iterations. After that, the versions of PSI-COIN give better results. The comparation with the results provided by GA is also considered.

5. **Dorel Aiordachioaie, *On Signal Analysis with Artificial Intelligence Techniques.***
Abstract

The work presents some results of signal analysis, periodic and aperiodic behavior, with artificial intelligence techniques. Two paradigms are considered, based on artificial neural networks (ANN) and – the second one – based on particle swarm optimization (PSO). The first approach promotes linear neural networks architecture, ADALINE for single signals and MADALINE for multiple signals case. The second approach promotes the swarm intelligence, used here for the minimization of objective function based on mean squared error (MSE). For periodic signals, the trigonometric Fourier series is considered. For aperiodic signals, the discrete Fourier transform is promoted. Both techniques could be applied for a more general problem of model parameter estimation. The computer-based experiments are made with various signal-to-noise ratios, to study the effects on the converge rate of the estimation process. At least for the considered signals, the ANN based solution provides better results. The framework could be extended to the analysis problem based on other base functions, e.g., wavelets.