ABSTRACT AND REFERENCES

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EXPLORING THE EFFICIENCY OF THE COMBINED APPLICATION OF CONNECTION PRUNING AND SOURCE DATA PREPROCESSING WHEN TRAINING A MULTILAYER PERCEPTRON (p. 6–13)

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A conventional scheme to operate neural networks until recently has been assigning the architecture of a neural network and its subsequent training. However, the latest research in this field has revealed that the neural networks that had been set and configured in this way exhibited considerable redundancy. Therefore, the additional operation was to eliminate this redundancy by pruning the connections in the architecture of a neural network. Among the many approaches to eliminating redundancy, the most promising one is the combined application of several methods when their cumulative effect exceeds the sum of effects from employing each of them separately. We have performed an experimental study into the effectiveness of the combined application of iterative pruning and pre-processing (pre-distortions) of input data for the task of recognizing handwritten digits with the help of a multilayer perceptron. It has been shown that the use of input data pre-processing regularizes the procedure of training a neural network, thereby preventing its retraining. The combined application of the iterative pruning and pre-processing of input data has made it possible to obtain a smaller error in the recognition of handwritten digits, 1.22 %, compared to when using the thinning only (the error decreased from 1.89 % to 1.81 %) and when employing the predistortions only (the error decreased from 1.89 % to 1.52 %). In addition, the regularization involving pre-distortions makes it possible to receive a monotonously increasing number of disconnected connections while maintaining the error at 1.45 %. The resulting learning curves for the same task but corresponding to the onset of training under different initial conditions acquire different values both in the learning process and at the end of the training. This shows the multi-extreme character of the quality function – the accuracy of recognition. The practical implication of the study is our proposal to run the multiple training of a neural network in order to choose the best result.

Keywords: multilayer perceptron, neural network, pruning, regularization, learning curve, weight coefficients.

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APPLYING AN ADAPTIVE METHOD OF THE ORTHOGONAL LAGUERRE FILTRATION OF NOISE INTERFERENCE TO INCREASE THE SIGNAL/NOISE RATIO (p. 14–21)

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A relevant task for control systems is to reduce the impact of noise interference in order to increase the signal/noise ratio (SNR). This issue is relevant to other technical systems as well. This work addresses the orthogonal Laguerre filtration of noise processes, which are described by the linear random processes. The proposed method of filtration makes it possible to reduce the influence of noise interference, which is described by the stationary linear random processes, in the operation of correlation systems. The essence of this method implies the use of orthogonal Laguerre filters as the input links of the correlation system.

The sequence of the noise processes, which are uncorrelated over a significant time interval of their mutual shift, has been derived on the basis of orthogonal Laguerre filtration of the stationary white noise. Such processes are described by the stationary linear random processes and are the models of a wide range of noise interference, which are explored in the operation of various technical systems, including control, detection, recognition, measurement systems, etc. The application of this method decreases the effect of noise interference with different correlation-spectral characteristics and increases the SNR at the output from the correlation system. Practical tasks on reducing the action of stationary noise interference have been solved within the framework of the proposed adaptive method of orthogonal Laguerre filtration; to this end, the article shows a structural-logical scheme of the correlation system. Using the software, the algorithm of the adaptive filtration based on the complex Laguerre filters has been implemented. The implementation has been carried out for an actual noise interference that belongs to the RLC class of noise, employing the pre-training of the filter. The effectiveness of reducing the impact of the predefined stationary noise interference has been confirmed by the derived efficiency coefficients the size of –6 dB and –16 dB for the set of the interference zeroing points.

Keywords: noise stationary interference, linear random process, orthogonal Laguerre filter, signal/noise ratio, correlation system.

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DEVELOPMENT OF A HIGH SENSITIVE INDUCTIVE MOVEMENT SENSOR (p. 22–27)

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Research on a contact induction displacement sensor over short distances is presented. A ferrite core with a winding and a movable armature is used as a sensor. There is an air gap between the core and the armature.

To solve the problem of improving the accuracy of measurement, the sensor is included in the bridge measuring circuit,

which is powered by high-frequency alternating current. To increase the sensitivity of the indicated sensor to movement, a differential circuit for its inclusion is proposed. Also, in order to increase sensitivity, the resonant mode of operation of the bridge measurement circuit is used. To maintain a constant voltage of the power generator, a phase-locked loop is used.

As a result of the study of the induction displacement sensor, practical results were obtained with a maximum displacement of ±0.6 mm. The sensor has not been studied for large displacements, since with an increase in the indicated displacement, the nonlinearity of the displacement-current transformation appears.

The maximum sensitivity of the differential sensor in the indicated range of movement 2.44 μA/μm is obtained without the use of a phase-locked loop.

The use of a phase-locked-loop frequency adjustment system increased the sensitivity to 3.48 μA/μm.

During the study, the dependence of the sensitivity of the sensor on the frequency of the power generator was determined, which allows to determine the optimal power frequency of the measuring bridge circuit.

Studies have shown that the use of contact inductive meters have the prospect of application and reserves for improvement. And the use of differential inclusion of the sensor and the resonant mode of operation gives a significant increase in the sensitivity of the primary transducer at small displacements.

An inexpensive sensor has been developed that will be useful for many applications where it is necessary to measure displacements and linear dimensions by contact methods.

Keywords: conversion linearity, contact displacement sensor, inductive sensor, ferrite magnetic core.

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STRENGTHENING STEGANOGHRAPHY BY USING CROW SEARCH ALGORITHM OF FINGERPRINT IMAGE (p. 28–36)

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In image steganography, secret communication is implemented to hide secret information into the cover image (used as the carrier to embed secret information) and generate a stego-image (generated image carrying hidden secret information).

Nature provides many ideas for computer scientists. One of these ideas is the orderly way in which the organisms work in nature when they are in groups. If the group itself is treated as an individual (the swarm), the swarm is more intelligent than any individual in the group. Crow Search Algorithm (CSA) is a meta-heuristic optimizer where individuals emulate the intelligent behavior in a group of crows. It is based on simulating the intelligent behavior of crow flocks and attempts to imitate the social intelligence of a crow flock in their food gathering process.

This paper presents a novel meta-heuristic approach based on the Crow Search Algorithm (CSA), where at the beginning the color cover image is converted into three channels (RGB) and then those channels are converted into three spaces, which are Y, Cb, Cr. After applying Discrete wavelet transform (DWT) on each space separately, the CSA algorithm is used on each space (YCbCr) to find the best location that will be used to hide secret information, the CSA is used to increase the security force by finding the best locations that have high frequency and are invulnerable to attacks, the DWT is used to increase robustness against noise. The proposed system is implemented on three fingerprint cover images for experiments, for the quality of stego image the histogram, Mean Squared Error (MSE), Peak Signal-to-Noise Ratio (PSNR), Number of Pixel Change Rate Test (NPCR), Structural Similarity Index Metric (SSIM) and Correlation Coefficients (CC) are computed. The result demonstrated the strength of the CSA to hide data, also discovered that using CSA may lead to finding favorable results compared to the other algorithms.

Keywords: information hiding, steganography, CSA, cover image, stego-image, meta-heuristic, PSNR, MSE, NPCR, SSIM, CC.

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A STEGANOGRAPHIC METHOD OF IMPROVED RESISTANCE TO THE RICH MODELBASED ANALYSIS (p. 37–42)

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This paper addresses the task of developing a steganographic method to hide information, resistant to analysis based on the Rich model (which includes several different submodels), using statistical indicators for the distribution of the pairs of coefficients for a discrete cosine transform (DCT) with different values. This type of analysis implies calculating the number of DCT coefficients pairs, whose coordinates in the frequency domain differ by a fixed quantity (the offset). Based on these values, a classifier is trained for a certain large enough data sample, which, based on the distribution of the DCT coefficients pairs for an individual image, determines the presence of additional information in it.

A method based on the preliminary container modification before embedding a message has been proposed to mitigate the probability of hidden message detection. The so-called Generative Adversarial Network (GAN), consisting of two related neural networks, generator and discriminator, was used for the modification. The generator creates a modified image based on the original container; the discriminator verifies the degree to which the modified image is close to the preset one and provides feedback for the generator.

By using a GAN, based on the original container, such a modified container is generated so that, following the embedding of a known steganographic message, the distribution of DCT coefficients pairs is maximally close to the indicators of the original container.

We have simulated the operation of the proposed modification; based on the simulation results, the probabilities have been computed of the proper detection of the hidden information in the container when it was modified and when it was not. The simulation results have shown that the application of the modification based on modern information technologies (such as machine learning and neural networks) could significantly reduce the likelihood of message detection and improve the resistance against a steganographic analysis.

Keywords: statistical indicators, machine learning, neural network, digital steganography, information hiding.

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DESIGN AND SIMULATION A VIDEO STEGANOGRAPHY SYSTEM BY USING FFTTURBO CODE METHODS FOR COPYRIGHTS APPLICATION (p. 43–55)

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Protecting information on various communication media is considered an essential requirement in the present information transmission technology. So, there is a continuous search around different modern techniques that may be used to protect the data from the attackers. Steganography is one of those techniques that can be used to maintain the copyright by employing it to cover the publisher logo image inside the video frames. Nowadays, most of the popular known of the Video-Steganography methods become a conventional technique to the attacker, so there is a requirement for a modern and smart strategy to protect the copyright of the digital video file. Where this proposed system goal to create a hybrid system that combines the properties of Cryptography and Steganography work to protect the copyright hidden data from different attack types with maintaining of characteristics of the original video (quality and resolution). In this article, a modern Video-Steganography method is presented by employing the benefits of TC (Turbo code) to encrypt the pixels of logo image and Least two Significant Bit Technique procedure to embed the encryption pixels inside the frames of the video file. The insertion is performed in the frequency domain by applying the Fast Fourier Transform (FFT)on the video frames. The examination of the suggested architecture is done by terms of Structural Similarity Index, MSE (mean squared error), and PSNR (peak signal-to-noise ratio) by comparing between an original and extracted logo as well as between original and Steganographic video (averaged overall digital frames in the video). The simulation results show that this method proved high security, robustness, capacity and produces a substantial performance enhancement over the present known ways with fewer distortions in the quality of the video.

Keywords: video Steganography, copyright, fast Fourier transform, turbo-code, least two significant bit.

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DEVELOPMENT OF METHODS FOR IDENTIFICATION OF INFORMATION-CONTROLLING SIGNALS OF UNMANNED AIRCRAFT COMPLEX OPERATOR

(p. 56–64)

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Methods for verifying and identifying the operator by the features of the formation of biometric features of a speech signal in control systems of unmanned aerial systems are proposed.

A method has been developed for the effective width of the spectrum of a speech signal, which allows identification and verification of the operator of an unmanned aerial vehicle based on an analysis of the informative components of voice prints under conditions of a high level of interference of various origins.

A method has been developed for the highest informational weight of the fundamental tone, which is based on the use of the most informative components of the spectral representation of the prints of a speech signal.

The first method allows to identify the operator of an unmanned aerial vehicle by the informative components of the spectral representation of the fingerprint of a speech signal under conditions of a high level of interference. High indicators, which are achieved by using this method, are obtained due to the uniqueness of the selected feature space, which retain their characteristics even with a fairly high level of interference.

The second method provides speaker identification of an unmanned aerial vehicle by a specific space of unique voice features. The frequencies of the fundamental tone and overtones were chosen as the basic features. Such an approach to solving the identification problem provides a high probability of determining the operator with the existing rather high level of interference and reduces the processing time of information in comparison with the effective spectrum width method.

The creation of control methods and models for unmanned aerial systems provides an increase in the level of noise immunity and safety of control systems from interventions by an unauthorized operator. Using operator identification methods allows to create a system for restricting access to the aircraft control process and thereby ensure the continuity of the operation of the information management system for unmanned aerial systems.

Keywords: personal identification, pitch frequency, speech signal parameters, unmanned aerial vehicle, telemetry signals, authorized operator.

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