ABSTRACT AND REFERENCES

INFORMATION AND CONTROLLING SYSTEM

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A HYBRID LIAR/RADAR-BASED DEEP LEARNING AND VEHICLE RECOGNITION ENGINE FOR AUTONOMOUS VEHICLE PRECRASH CONTROL (p. 6–17)

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PreCrash problem of Intelligent Control of autonomous vehicles robot is a very complex problem, especially vehicle pre-crash scenarios and at points of intersections in real-time environments.

The goal of this research is to develop a new artificial intelligent adaptive controller for autonomous vehicle Pre-Crash system along with vehicle recognition module and tested in MATLAB including some detailed modules. Following tasks were set: finding Objects in sensor Data (LiDAR. RADAR), Speed and Steering control, vehicle Recognition using convolution neural network and Alexnet.

In this research paper, we implemented a real-time image/Lidar processing. At the beginning, we presented a real-time system which is composed of comprehensive modules, these modules are 3d object detection, object clustering and search, ground removal, deep learning using convolutional neural networks. Starting with nearest vehicle module our target is to find the nearest ahead car and consider it as our primary obstacle.

This paper presents an Adaptive cruise pre-crash system and vehicle recognition. The Adaptive cruise pre-crash system module depends on Deep Learning and LiDAR sensor data, which meant to control the driver reckless behavior on the road by adjusting the vehicle speed to maintain a safe distance from objects ahead (such as cars, humans, bicycle or whatever the object) when the driver tries to raise speed. At the very moment the vehicle recognition module, detects and recognizes the vehicles surrounding to the car.

Keywords: Deep Learning, LiDAR sensor Dataset, KD Tree Algorithms, Point Cloud, Vehicle Recognition Module

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FIRMWARE IMPLEMENTATION AND EXPERIMENTAL RESEARCH OF THE PHASE-LOCKED LOOP WITH IMPROVED NOISE IMMUNITY (p. 17–25)

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This paper presents a method for improvement of the phase-locked loop (PLL) noise immunity by using a modified phase detector. The article shows structural diagram

of the PLL with the modified phase detector and describes the criterion for choosing the parameters of the narrowband filter and the high-pass filter to prevent distortions of information signal. Simulation of both classical and modified devices was carried out to find a noise threshold, which causes phase-locked loop to unlock. Simulation results show that multiple cycle slips of synchronization in short period of time in modified PLL occur for higher levels of noise (by 1.5–4 dB depending on PLL parameters), than in classical PLL. Both devices were software implemented on FPGA (field programmable gate array) logic and experimental studies of their noise immunity were conducted. The results of experimental studies qualitatively correspond to simulation ones and show that the that noise threshold of the modified phase detector is greater up to 1–2.5 dB depending on the device parameters. Experimental research also shows that modified phase detector does not deteriorate the dynamic properties of whole device and even improves them in comparison to classical PLL.

Keywords: phase-locked loop (PLL), modified phase detector (PD), narrowband filter (NBF).

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THE OBJECTIFIED PROCEDURE AND A TECHNOLOGY FOR ASSESSING THE STATE OF COMPLEX NOISE SPEECH INFORMATION PROTECTION (p. 26–34)

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White noise generators are typically applied for the systems of active interference in the design of systems for protecting verbal information. The level of speech information protection against leaking through acoustic and vibrational channels is determined by employing the appropriate normative method and technology. However, using the multi-channel methods for interception of language information, as well as modern methods for processing digital phonograms (wavelet transform, correlation analysis, etc.), allow the intruder to gain unauthorized access. Attempts to apply generators of speech-like noise based on the use of white noise (and its colored clones), reverberation methods, as well as the Language Choir method and some others, do not resolve the set task.

In the framework of this research, we have proposed a technique to overcome these difficulties. It is based on using speech-like interference generators the type of scrambler and applying the objectivized method and a technology to assess the degree of verbal information protection at the border of controlled zone. The objectivized method combines methods for determining the criteria for speech residual intelligibility (methods by Pokrovski and Speech Intelligibility Index), methods for filtering complex noise acoustic signals (wavelet transforms, phonemic correlation analysis and others) and the method for comparing a test signal at the point of location of the signal source and at the border of controlled zone. That makes it possible to improve reliability of the resulting estimate of the level of linguistic signal protection against leaking via acoustic and vibration channels beyond the controlled zone's borders.

In order to investigate the level of protection of speech information at different types of the interference and at different ratios of signal/interference, we have designed a simulation model of the experiment.

A technology has been proposed to synthesize test signals based on random phonograms and/or phonograms of articulation tables, recorded by voice narrators, and on mixing different types of interference noise at the assigned ratios of signal to interference.

Our research was performed in the block «Wavelet 1-D» from the programming environment Matlab. It was established that when applying a noise interference, the type of white noise, and at the ratios of interference to signal of 20...24 dB, the proposed procedure improves the residual intelligibility of test signal from $W \leq 10$ % to $W \approx 40...60$ %.

Keywords: protection of speech information, acoustic interferences, speech intelligibility, speech signal purification.

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DEVELOPMENT OF PORTABLE DC VOLTAGE CALIBRATORS WITH ADDITIVE OFFSETS ADJUSTING (p. 35–42)

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Improvement of portable equipment for controlling the DC voltage measuring channels of cyber-physical systems at the operating sites is proposed. Additive offsets and drifts make a dominant contribution to the error of portable DC voltage calibrators. Automatic correction based on the method of double switching inversion provides the opportunity to increase the productivity of multichannel system voltage meters at the operating sites. It is shown that the additive offsets during the DC voltage reproduction, in addition to the equivalent offset voltages of the operational amplifiers, ADCs or DACs, are caused by common type noises and leakage currents through the isolation of the power supply units.

In the developed structure of the DC voltage calibrator, it is proposed to use the method of double switching inversion with subsequent analog averaging of the output signal for the automatic correction of the additive offsets. The error analysis and simulation showed the principal possibility of the calibrator additive offsets correction to the values limited by the non-identity of parameters of the closed pairs of switches.

The analysis of the results of experimental studies of the voltage calibrator layout showed the invariance of the reproduced voltages from the voltage value and the location of the simulator of the additive error component in the layout structure.

The uncorrected error value in the manual mode did not exceed ±1 μV for all reproduced values of the output voltage of the layout. It has been experimentally shown that the minimum value of the uncorrected error lies at a switching frequency of about 1.2 kHz within ±5 μV. The developed scheme can be implemented in the basis of programmable systems on the chip, which significantly improves the metrological characteristics, reduces the cost and unifies portable voltage calibrators and DC resistance simulators.

Keywords: portable voltage calibrator, automatic error correction, additive offset, device calibration at the operation site.

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DEVELOPMENT OF ARTIFICIAL NEURAL NETWORK FOR DETERMINING THE COMPONENTS OF ERRORS WHEN MEASURING ANGLES USING A GONIOMETRIC SOFTWARE-HARDWARE COMPLEX (p. 43–51)

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We have developed an artificial neural network to determine the components of error in measuring the angles by automated goniometric systems whose change over time is a non-stationary random process. There are known techniques for processing measurement results and normalizing the systematic and random components of measurement errors, they have been applied for many years, they are well justified, maximally formalized, fundamentally different and are governed by respective regulations. However, it is still a rather difficult and labor-intensive procedure to determine exactly which component of an error is present in the measurement results. A given procedure is based on using the Fisher's dispersion criterion. In order to automate this procedure and improve performance efficiency of performed operations, we have developed an artificial neural network (ANN) and examined its functioning. It was determined that the proposed ANN could be successfully employed instead of known analytical-computational procedure using the Fisher's dispersion criterion. The application of ANN could significantly reduce labor intensity and improve the efficiency of determining the systematic and random components of measurement errors. This is predetermined by the capability of ANN to perform parallel processing of measurement data in real time. The practical implementation of ANN is based on using the neuro-simulator Neural Analyzer, analytical software Deductor Professional developed by BaseGroupLabs. We trained ANN and tested its functionality on the set of simulation results and actual multiple observations when measuring the plane angle of a 24-facet prism. The ability of ANN to quickly and correctly determine components of measurement errors at the stage of analysis of measurement information makes it possible to subsequently define methods for its further processing in accordance with regulatory requirements. That would improve the accuracy and reliability of measurement results as it could help avoid incorrect and inaccurate calculations when normalizing measurement errors.

Keywords: artificial neural network, random error component, systematic error component, goniometer.

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DEVELOPMENT OF THE SYSTEM FOR VIBRATION DIAGNOSIS OF BEARING ASSEMBLIES USING AN ANALOG INTERFACE (p. 51–59)

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We have proposed a system for early vibration diagnosis of gas-pumping units, specifically bearing assemblies with improved metrological characteristics. The technique makes it possible to solve the task of early diagnosis of roller bearings under adverse conditions of application. The study has shown that this is achieved through the use of tracking notch filters based on N-channel structures using the iterative-integrating converters. The simulation results of the 4-channel filter under actual input signals of bearing damage have demonstrated its effectiveness. Based on this, we have built the resulting model for the filter's output signal. Here we show a functional circuit for the root-mean-square values detector with a model of the output signal from the tracking notch filter at actual input signals. To build a model of signal at the input to a root-mean-square values detector, we determined filter responses for each frequency, which is responsible for a certain damage. The time of analysis was selected so that it was equal to a period of the

minimum beat frequency, that is, T_a=164 ms (for a bearing of type 222).

We investigated effectiveness of the device by simulating a damage to an actual gas turbine engine's bearing. The procedure for analysis has been proposed and the generalized vibro-diagnostic criterion has been suggested, which takes into consideration the degree of engine's load. This improves accuracy and reliability of preliminary analysis when diagnosing a roller bearing at the stage of the origin of the damage.

Characteristics are given for the electrometric measuring amplifier for work with piezoelectric sensors and the proposed charge measuring amplifier to work with piezoelectric sensors. Under condition for the imbalance of the input link, which is due to the non-identity of parasitic capacitances of the input cable. It is shown that the penetration of a network disturbance to the output of the charge measuring amplifier provides for the signal/noise ratio that is two orders of magnitude better than that for the electrometric measuring amplifier.

Keywords: vibration diagnosis, gas turbine engine, differential charge amplifier, bearing assembly, tracking notch filter.

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METHOD OF INTEGRAL ESTIMATION OF CHANNEL STATE IN THE MULTIANTENNA RADIO COMMUNICATION SYSTEMS (p. 60–76)

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A method of integrated estimation of channel state in multiantenna radio communication systems was developed. The distinguishing feature of the proposed method is estimation for several indicators, namely the bit error probability in the channel, frequency and pulse response of the channel state. After obtaining of the channel estimate for each indicator, a generalized channel state estimate is formed. Formation of the channel state estimate for each of the estimation indicators takes place in a separate layer of the neural network using the apparatus of fuzzy sets after which a generalized estimate is formed at the neural network output. Development of the proposed method was determined by necessity to raise speed of estimation of the channel state in multiantenna radio communication systems at an acceptable computational complexity. According to the results of the study, it has been established that the proposed method makes it possible to increase speed of estimation of channel state in multiantenna systems on average up to 30 % depending on the channel state while accuracy of the channel state estimation decreases by 5–7 % because of reduced informativeness of estimation (because of using the apparatus of fuzzy sets) and is able to adapt to the signaling situation in the channel by training the neural network. Neural network training takes place on the basis of a training sequence and completes adaptation to the channel state after 10–12 iterations of training. It is advisable to apply this method in radio stations with a programmable architecture to improve their interference immunity by reducing time for making decision on the channel state.

Keywords: radio communication, neural networks, fuzzy sets, computational complexity, frequency response, pulse response.

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