ABSTRACT AND REFERENCES

INFORMATION AND CONTROLLING SYSTEM

SELECTION OF PREFERRED ROUTING PROTOCOLS OF WIRELESS SENSOR AND ACTUATOR NETWORK NODES (p. 4-9)

Valeriy Bezruk, Anatoliy Zelenin, Viktoriya Vlasova, Julia Skorik, Yuriy Koltun

The problems of routing to search for energy efficiency-optimal routes are important in wireless sensor and actuator networks. This determines the relevance of selecting a preferred option among many different routing protocols for a specific implementation. The paper considers the practical features of applying the analytic hierarchy process to select the preferred routing protocol for wireless sensor and actuator networks.

A comparative analysis of the characteristics of existing routing protocols in sensor networks is performed. Experts provided paired comparisons of characteristics of 11 routing protocols. The paired comparison matrices, which allowed computing the eigenvector and priority vector components are formed. According to the maximum values of the priority vector components, the preferred routing protocol – GEAR (Geographical and Energy-Aware Routing) is selected for use in field sensor and actuator networks with localization of elements.

The results confirm the applicability of the analytic hierarchy process to select the preferred routing protocol in the design of sensor and actuator networks taking into account the specified implementation requirements.

Keywords: sensor network, routing, selection criteria, energy efficiency, analytic hierarchy process, expert.

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DESIGN AND IMPLEMENTATION OF INTER-DOMAIN COMMUNICATION MECHANISM FOR HIGH PERFORMANCE DATA PROCESSING (p. 10-15)

Vasyl Melnyk, Petro Pekh, Kateryna Melnyk, Nataliya Bahnyuk, Oksana Zhyharevych

The basic improvement in the computer operation is the involvement of multi-operating systems running on a physical computer. To make extensive use of virtualization technologies in cloud computing, the inter-domain communication effectiveness is a key factor for the functioning of distributed applications and some intensive network applications. The synchronous communication mechanism, used by the traditional virtual machine implementation mechanism based on the asynchronous signal fed by the virtual machine mechanism, often causes high latency and slow performance. The communication mechanism, called com-socket that uses interprocessor interrupts for synchronization and elimination of some unnecessary packet inspections is developed and implemented. The approach of using shared memory to reduce the data copying time is applied. The com-socket implementation is carried out on X86 in combination with the virtual machine mechanism. The study revealed that the com-socket has lower latency and higher performance compared to UNIX IPC.

Keywords: communication efficiency, com-sockets, synchronization, packet inspection, memory copying, latency.

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INFLUENCE OF PARAMETERS OF OPEN-LOOP FIBER OPTIC GYRO ELEMENTS ON MEASUREMENT PRECISION (p. 16-24)

Sergei Ivanov

The analysis of the output signal of the interferometric open-loop fiber optic gyro (FOG) is performed. It is based on the Jones matrix method taking into account the parasitic modulation (modulation is due to the photoelastic effect, causing connection of modes under transverse compression of the fiber), the polarizer extinction coefficient, rotation angles of the optical fiber axes relative to the polarizer axes. The influence of the FOG elements on measurement precision of angular velocity of the object is estimated. The proposed angular velocity measurement method is digital. The output signal intensity is measured in each modulation period at certain time points. Based on the measurement results, the phase shift of counter-propagating waves, which is proportional to the angular velocity of the object is computed. This method allows to exclude the synchronous detector and the LPF from the circuit, which simplifies the analog part of the circuit and reduces the influence of the errors made by the analog elements on the measurement precision. The FOG precision is greatly affected by the polarizer and the modulator. The FOG output signal has hardly-compensated polarization error. To reduce it, the polarizer with the extinction coefficient of at least 0.001 should be used. Particular attention should be paid to the improvement the modulator. Since the error caused by its imperfection is multiplicative by nature and may reach unacceptably high values. To reduce the measurement error, SLD with stable polarization and ellipticity parameters of radiation should be used.

Keywords: open-loop fiber optic gyro, modulator, polarizer, SLD.

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ANALYSIS OF THE PSEUDORANDOM NUMBER GENERATORS BY THE METROLOGICAL CHARACTERISTICS (p. 25-30)

Ganna Martyniuk, Yurii Onykiienko, Leonid Scherbak

The paper considers the method of checking the statistical conformity of the characteristics of realizations of noise signals with characteristics of uniform distribution law. The degree of conformity of realizations obtained from pseudorandom number sequence generators was checked by metrological characteristics. The conclusion on the generator usefulness was based on Pareto-optimal solutions for a multi-objective problem. The pilot study was conducted in the Matlab environment. The Martin method, congruent method and environment built-in generator were used as the pseudorandom number sequence generators. The research results showed that when using the Pareto-optimal solutions for the multi-objective problem of statistical conformity of metrological characteristics of realizations of white noise with the uniform distribution law for small volume samples (up to 5000 items), the generator built in the Matlab environment (function unifrnd) has a higher degree of conformity of realizations. However, when using the realizations of the white noise of larger volume (over 5000 items), the congruent method for pseudorandom number sequence generation becomes more significant. The Martin method has not proved as the best by the metrological characteristics for any sample volume.

Keywords: pseudorandom number sequence generator, metrological characteristics of realizations, degree of conformity of generator.

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RESEARCH OF MULTIPLEXER BASED ON SURFACE PLASMON-POLARITONS FOR COMMUNICATION DEVICES (p. 30-37)

Denis Nevinskyi

Surface plasmon-polaritons provide a unique opportunity to create devices for signals localization and control on an optical subwavelength scale. They can be used as promising data carriers in highly integrated nanooptical transmission systems. Dielectric waveguides based on surface plasmon-polaritons (SPP) arise a particular interest in devices that will run in ultra high-speed data transmission ranges. The paper demonstrates the samples of the four-channel multiplexer based on SPP that works with ultra high-speed pulses. The multiplexer samples are developed using quite simple, but an extremely accurate method of projection optical lithography (POL). For excitation of the SPP, the 800 nm Ti: sapphire laser with a pulse frequency of 27 fs is used. We have shown the ultra high-speed distribution of SPP on the 10×5 μm multiplexer. Experimental research are tested in the simulation by a finite-difference time-domain method (FDTD). Good agreement between the experimental results and numerical simulation is obtained.

Keywords: surface plasmon-polariton, multiplexer, model, projection optical lithography, channel.

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DESIGN OF TWO-DEGREE-OF-FREEDOM ROBUST SYSTEM FOR GROUND VEHICLE EQUIPMENT STABILIZATION (p. 38-48)

Olha Sushchenko

Features of design of the robust systems for stabilization of the moving platforms with equipment assigned for functioning at the ground vehicles are represented. The problem of design of the two-degree-of-freedom robust stabilization system taking into consideration coordinate disturbances and measurement noise is solved. To achieve this goal the optimization functional including the functions of sensitivity by the coordinate disturbances and the measurement noise was introduced. Taking into consideration the introduced functional the problem of the structural synthesis of the two-degree-of-freedom robust stabilization system is transformed to the standard H_∞-synthesis problem. The generalized plant model in the state space is obtained. This gives the possibility to use the automated tools of the researched problem solving by means of Robust Control Toolbox in the MatLab system. The approach to loop shaping with the desired frequency characteristics is implemented. With this aim the transfer functions of pre- and post-compensators are determined and the augmented plant is formed. Taking into consideration above stated concepts the basic phases of the structural synthesis procedure of the robust system for control by the

angular motion of the platform with the observation equipment assigned for operation at the ground vehicles are given. The appropriate mathematical description of the plant in the state space is developed. The robust controller represented as quadruple of the state space matrices is obtained. Modelling results proving the possibility to provide the high system characteristics in difficult conditions of the real operation are represented. The influence of the coordinate disturbances such as the friction moment, unbalance moment, moments caused by irregularities of roads (the road with the long undulations) and terrain (the terrain with hummocks), by which the vehicle moves, is considered. Also the possibility to keep the ability of the system to operation in conditions of the parametric disturbances in the wide range for the changed plant inertia moment and the coefficient of the elastic connection between the actuator and the base, at which the plant (the platform with the observation equipment) is mounted, is shown.

Keywords: robust stabilization, two-degree-of-freedom systems, ground vehicles, moving platforms with payload, parametrical and coordinate disturbances.

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USING OF MODIFIED SYMMETRY PRINCIPLE OF THE STRUCTURAL SCHEMES FOR AUTOMATIC CONTROL SYSTEMS SYNTHESIS (p. 48-56)

Oleksii Sheremet, Oleksandr Sadovoy

The solution of inverse dynamic problems using the symmetry principle of structural schemes can be a basis for the synthesis of automatic control systems of technical objects. This approach requires compensation of the dynamic properties of the control object. Most scientific papers idealize the

object, that is assume that its dynamic characteristics can be fully compensated by controllers. The impact of transfer functions of modifying links on dynamic and static characteristics of automatic control systems is also understudied.

The possibility of using methods for solving inverse dynamic problems for the synthesis of automatic control systems of technical objects is investigated. The mathematical modeling confirmed that ideal tracking of inputs under the full compensation of dynamic properties of the control object is impossible in real systems. The rules, which allow determining the inverse model of the control object directly by its structural scheme in the first canonical controllability form, without having to convert differential equations, are formulated.

The modified symmetry principle of the structural schemes, which lies in introducing the integrating link to a direct branch of the closed system, which is included consistently with the inverse model, and provides formation of achievable dynamic characteristics desired with a limited gain is developed.

Keywords: inverse dynamic problems, modified symmetry principle, structural scheme symmetry.

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