THE ABSTRACTS
OF SCIENTIFIC PUBLICATIONS

of Assoc. Prof. Dr. Eng. Nikola Nikolaev Nikolov,

for participation in a competition for academic position "PROFESSOR"

in a professional direction

5.2. "Electrical Engineering, Electronics and Automation"

study discipline "Management of technological processes"

to the "Production Automation" department,

Faculty of Computing and Automation.

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30 publications are submitted for review in this competition, which are organized into sections as follows:

section	Type of works for participation in the competition for professorship	number
В.4.	Scientific publications equivalent to habilitation thesis - monograph on the topic "**Control and management of technological processes and devices**"	**10**
Г	Scientific publications outside the habilitation work group - monograph	**20**
Г.7.	Scientific publications in publications that are **referenced and indexed** in world-renowned databases of scientific information	11
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Abstracts of publications are presented by sections in chronological order.

B.4. Scientific publications equivalent to habilitation thesis - monograph on the topic "Control and management of technological processes and devices"

B.4.1 Nikola Nikolov, Mariela Alexandrova, Veselin Lukov, "Development of an algorithm for modal control of SISO linear time-invariant discrete systems", 2017 15th International Conference on Electrical Machines, Drives and Power Systems (ELMA), IEEE, Proceedings, pp. 203-206, 01-03 June **2017**, Sofia, Bulgaria,
DOI: 10.1109/ELMA.2017.7955432

This publication presents the development of a modal control algorithm for one-dimensional (SISO) linear stationary discrete systems.

The proposed algorithm calculates the elements of the feedback vector for a SISO system with a modal state controller such that the poles of the closed system are located in a predetermined sector of the positive axis of the complex plane. This sector is called the stability zone and is defined in such a way that the requirements for the required degree of stability and degree of fluctuation of the transient processes in the discrete system are simultaneously satisfied and, in addition, that the poles of the closed discrete system are not multiples and their location is is defined by one parameter (a number).

The algorithm is presented as a sequence of 10 steps. At the beginning, the estimates of the vector a of the system matrix, the input vector b and the stability zone χ are set. Along these vectors, the algorithm determines the order of the control object, forms the estimated system matrix and determines its eigenvalues. Then the matrix of the eigenvectors is formed and, based on the set degree of stability, the vector of the desired eigenvalues of the closed discrete system is determined. If the desired eigenvalues of the closed system are known in advance, the algorithm allows them to be entered instead of a resistance zone. At the end of the procedure, the feedback vector of the closed system is obtained.

The presented procedure is called "Scalar Modal Control Algorithm" - SMC and 2 M functions have been created:

`K=smc(ao,bo,stab_zone)` – here the observer-estimated vectors ao, bo and the set degree of stability called stab_zone are entered as input parameters and the feedback vector is obtained as the result -**K**;

`K=smcmu(ao,bo,mu)` – here the estimated vectors ao, bo and the desired poles of the closed system defined by the vector mu are introduced as input parameters. The result is again the feedback vector -**K**.

B.4.2 Nikola Nikolaev Nikolov, Mariela Ivanova Alexandrova, Ivelina Yordanova Zlateva, "Single input single output system with modal adaptive state controller", 2018 IEEE XXVII International Scientific Conference Electronics-ET, IEEE, Proceedings, pp. 1-4, 13-15 September **2018**, Sozopol, Bulgaria,
DOI: 10.1109/ET.2018.8549611

This publication presents an adaptive modal state controller control system framework designed for SISO objects.
When the operating conditions of the site change, one of the solutions to the problem is the construction of an adaptive system. This is accompanied by solving several main problems:

- ✓ selection of an adaptation mechanism (a way for the algorithm to detect the presence of non-stationarity and adapt to it);
- ✓ prevention of the so-called "explosion of parameters" during identification in a closed loop, when for a long time (after the task has been completed) the input and output signals of the object have remained unchanged;
- ✓ control of the object during the time when information is collected to estimate the state vector.

A practical solution is presented here, focusing on the synthesis of the adaptive structure of the modal state controller, and the used algorithms for modal control and adaptive monitoring are synthesized in other publications.
The synthesized adaptive structure with redundant control is presented with a block diagram, in which to solve the problem of controlling the object during the acquisition of information for the estimation of the state vector is solved by using a relay-pulse controller (RPP), whose regulating impact depends not only on the error of regulation. It is programmed so that if, for n clocks, the control effect u(k) has been only at the low level, or only at the high level, it switches for one clock to the alternate level.
The PIR turns on after inputting the input parameters and for N clocks drives the object to form the input-output data vectors. An adaptive monitoring algorithm estimates the state vector, and then a modal control algorithm generates the feedback vector. The difference from the norms of the input vector for two adjacent control clocks is continuously monitored. If it exceeds a certain value, it is a signal of non-stationarity. The resumption of the evaluation procedure is accompanied by the re-engagement of the auxiliary RIR, which controls for N cycles. The input-output data vectors are updated and the parameters are re-estimated. When the output is established, the evaluation procedure is stopped to avoid an explosion of the parameters.
The efficiency of the algorithm is demonstrated in the control of a steam generator.

B.4.3 Nikola Nikolov, Mariela Alexandrova, "Adaptive state controller with suspension of the recurrent estimation process", 2021 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 30-33, September 30-October 2 **2021**, Varna, Bulgaria, **DOI:** 10.1109/ICAI52893.2021.9639567

This publication offers a practical solution to the problem of synthesizing an adaptive structure of a linear discrete state controller system. Emphasis is placed on the synthesis of the adaptive state controller structure.
An adaptive state observer is used for closed-loop identification, which is based on the recursive extended least squares method called ASORELS (Adaptive State Observer based Recurrent Extended Least Squares).
The created adaptation mechanism and the way to stop the recursive evaluation in order to prevent parameter explosion are clearly shown. The control and adaptive monitoring algorithms are not described in detail, but how they are implemented is shown. An additional relay-pulse regulator (RIP) is introduced to control the process during the initial formation of the input-output data vectors required for the adaptive observer. It is programmed so that if, for n clocks, the control effect u(k) has been only at the low level, or only at the high level, it switches for one clock to the alternate level.
The functioning of the adaptive structure is represented by a block diagram of the algorithm.
The system adaptation mechanism is implemented by monitoring the absolute value of the prediction error. if it does not exceed the preset constant - δ, the coefficient β is reset. When the task is worked out, the prediction error becomes close to zero, β becomes zero, and the estimation procedure stops working. When non-stationarity or perturbation occurs, the prediction error increases and β assumes a value of unity. Here, the explosion of coefficients is prevented by stopping the procedure of estimating the parameters and state of the object and by providing a constant trace of the covariance matrix - C. The constant trace of the covariance matrix is provided by calculating the forgetting coefficient - □ at each clock.
Astatic control is achieved by specifying the scaling factor k0 at each clock, but an integrator can be used instead.
The result of a simulation study when operating the system with a type of mathematical model of the fifth order (superheater model) is presented. The computer simulation gives good results when the parameters of the object are smoothly changed. In fact, such are the majority of non-stationarities in real systems. The adaptive structure can be applied to both modal and linear quadratic control (LQR) state controllers.

B.4.4 Nikola Nikolov, Mariela Alexandrova, Rano Gaziyeva and Shakhnoza Ubaydullayeva, State Controller with Improved Response Speed for Linear Discrete SISO Systems, 2022 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 35-38, October 6-8 **2022**, Varna, Bulgaria, **DOI:** 10.1109/ICAI55857.2022.9960102

This publication presents an opportunity to create a linear discrete system (LDS) with a modal state controller (PS) for controlling SISO objects. The created regulator has an integrating element and a direct connection between the task and the controlling object, implemented with an inverse object model.
Based on the classical structure of a control system with an inverse model, an equation for calculating the direct link coefficient is derived and a structural diagram of the system is proposed. An additional relay-pulse regulator (RIP) is introduced to control the process during the initial formation of input-output data vectors.
The result of a simulation study when operating the system with a type of mathematical model of the fifth order (superheater model) is presented. For comparison, the performance of the system with three structures (PC with integration and direct connection by inverse model, PC with integration, PC with scaling factor) was studied.
From the obtained results, it can be seen that the speed of the system is greatest with the astatic RS with a scaling factor. It reacts very quickly both at the beginning of the process and when changing the task, but when the disturbance occurs it does not process it and causes a static error equal to the value of the disturbance itself.
In the case of astatic RS with only an integrating component, the system works out the emerging disturbing effect, but significantly slower.
In the astatic RS with an integrating component and a direct link on the inverse model of an equivalent object, the process is not as fast as the RS with a scaling factor, but it is better than that of the RS with only integration.
With this structure, at the initial instant of time the transfer function on the straight channel is equal to unity. This forces the process and resembles the action of the differentiating component in a PID controller control system. On the other hand, the presence of an integrating ingredient ensures astatic control.
Using direct coupling in astatic controllers gives good results for high-order objects or those with a sensitive time constant, but can lead to dangerous oscillations in the process if the object is inertialess. It is possible, to reduce the influence of the differentiation effect, to multiply the coefficient of direct connection-k_{dc} by a number less than unity.
The control structure is applicable to minimum phase objects.

B.4.5 Gancho Ganchev and **Nikola Nikolov**, Combined local system for joint purification of drinking water from iron and arsenic with limitation of the harmful substances level in rinse water, 2022 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 50-55, October 6-8 **2022**, Varna, Bulgaria, **DOI:** 10.1109/ICAI55857.2022.9960045

This publication presents the development of a combined local system for the co-treatment of drinking water from iron and arsenic with the limitation of the level of harmful substances in the wash water.

The damage caused by arsenic to the human body and the maximum permissible concentration in water are described. A brief overview of drinking water treatment methods for arsenic is presented. The advantages and disadvantages of different technological solutions are shown. As a result of the analysis, a variant of a combined local system for joint purification of drinking water from iron and arsenic was proposed. A technological scheme of the drinking water treatment plant is presented, the main ratios for determining the volume of water for the individual washes are derived, and an algorithm is developed for managing the washes at the first stage of the installation to avoid exceeding wastewater limits and to increase of filter media life. In conclusion, a prescription is made with what technical means the combined system can be realized.

A major problem with the use of sorbents is their relatively high cost. A given amount of sorbent can retain a precisely defined amount of arsenic, i.e. has a certain capacity that depends on the chemical composition of the source water. A way to extend the life of the filter pack is proposed here by pre-separating some of the arsenic along with the iron when it is present in the incoming water stream.

A schematic diagram for the automation of the local combined iron and arsenic purification system is proposed. For this installation, it is proposed to determine the volume of water passed to initiate backwashing at the appropriate time.

An algorithm was developed to control the flushing of the first stage of the installation.

The implementation of a local treatment plant with the proposed structure and algorithm for the management of washings at the first stage (for iron cleaning) ensures the removal of iron from the water, taking with it a part of the contained arsenic without exceeding the norms for the content of hazardous substances in the waste installation leads. Thus, the costs of building additional installations for the utilization of waste products are saved. The main elements of novelty in this system are the avoidance of additional systems for the treatment of hazardous waste, the extension of the life and the increase of the capacity of the adsorption package.

B.4.6 Palvan I Kalandarov, Shakhnoza R Ubaydulayeva, Rano T Gaziyeva, **Nikola N Nikolov**, Mariela I Alexandrova, Use of Elements and Algorithms of Intelligent Support in the Automation of Technologies for Control and Quality Management of Bulk Materials, 2022 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 235-238, October 6-8 **2022**, Varna, Bulgaria, **DOI:** 10.1109/ICAI55857.2022.9960041

This publication deals with the selection of performance criteria in the quality control of bulk materials. Their applicability in the measurement technique and their analyticity. Based on this, a methodology for assessing the quality of constructions of measuring devices for moisture of bulk materials from the agro-industrial complex is proposed.

The standard deviation of the random error characterizing the accuracy of the measurements is shown.

A complex performance criterion is discussed, which includes the dominant specific parameters: accuracy, reliability, cost, allowing to solve the problem of optimal design of humidity control devices for the considered materials.

As an optimal option, a differential measuring device is analyzed, which practically eliminates random and systematic errors and makes it possible to design a multi-parameter measurement method that takes into account the characteristics of a heterogeneous environment, and in the specific case, bulk grain materials of the agro-industrial complex are targeted.

To calculate the parameters of the primary converters and measuring circuits of the humidity control devices, scientifically based methods for studying the electrical properties of the grain mass are applied.

Based on the analysis of the existing methods and devices for controlling the humidity of agricultural materials, the following was done:

- ✓ criteria for evaluating the accuracy of measuring transducers of the electrophysical properties of bulk materials are substantiated;
- ✓ a methodology for calculating their transformation characteristics is proposed;
- ✓ a mathematical model of the primary converter of the capacitive sensor of the technological parameters was obtained, based on which the conditions for achieving the highest sensitivity of the conversion characteristics of the primary transformation were obtained.

B.4.7 Palvan Kalandarov, Khasan Turkmenov, Shakhnoza Ubaydullayeva, **Nikola Nikolov** and Mariela Alexandrova, Research and Analysis of the Method for Measuring the Moisture Content of Cottonmaterials at Ultrahigh Frequencies, 2023 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 276-279, October 5-7 **2023**, Varna, Bulgaria, ISBN 979-8-3503-1291-1, **DOI**: 10.1109/ICAI58806.2023.10339060

The publication offers a study and theoretical analysis of the ultra-high frequency (microwave) method for measuring the moisture content of cotton materials and discusses the problems of the technical means used in the method in question.

Bulk cotton materials were selected as objects of study. In the study, the electromagnetic wave emitted during the measurement and the evaluation of the electrophysical characteristics of the medium are analyzed. The functional dependence between the amplitude and the phase shift on the ratio between mass and humidity is investigated.

A schematic of an experimental installation is proposed. The installation makes it possible to measure in a wide range with sufficient accuracy the attenuation and phase shift caused by the material located in the space between the transmitting and receiving antennas.

In order to determine what information the electromagnetic wave carries and how it can be used to study and evaluate the electrical characteristics of the environment, the damping of the electromagnetic wave caused by the humidity of the investigated materials is investigated.

After processing the results of the experiments, it is concluded that the humidity characteristics are adequately described by polynomials of the 2nd degree.

Based on the analysis, the following can be said:

1) A pilot plant has been developed that allows to investigate the electrophysical properties of grain products and to reveal multifactorial functional dependencies necessary to determine the composition and properties of bulk materials.
2) On the basis of the experimental studies with the installation for measuring attenuation and phase shift, the mathematical characteristics of moisture for various bulk materials from the agro-industrial complex have been determined and described.
3) As a result of a full factorial experiment, with refinement of the experiment planning methodology, mathematical models have been obtained for various bulk cotton materials describing the combined influence of moisture and material density on the attenuation and phase shift of the traveling wave.

B.4.8 Palvan Kalandarov, Shakhnoza Ubaydullayeva, Rano Gaziyeva, **Nikola Nikolov** and Mariela Alexandrova, Automation of Technological Processes for Controlling Grain Moisture in the Flow, 2023 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 280-284, October 5-7 **2023**, Varna, Bulgaria, ISBN 979-8-3503-1291-1,
DOI: 10.1109/ICAI58806.2023.10339071

The publication deals with the problems of grain injury, which cause high energy costs and require a multi-step treatment process. This necessitates the installation of reliable automated storage and processing systems for all types of raw materials of this type.

The present study focuses on theoretical and experimental studies and results related to the use of the microwave method in measuring the moisture content of grain and different types of grain materials.

The considered method is based on the principle of selective absorption of microwave radiation energy by the water found in the studied materials. Moisture concentration is estimated by the degree of absorption. The article examines the amplitude and phase of a wave traveling through space.

The influence of the elastic properties of the studied material on the electrical characteristics of the microwave is substantiated, which offers fundamentally new ways to measure the attenuation and phase shift of the electromagnetic wave. A discrete conversion of the primary converter signal is performed.

The information on the material thickness values is analyzed to correct its influence. For this purpose, two parameters are monitored:

- ✓ one parameter is the attenuation and phase shift of the traveling wave signal that characterizes humidity;
- ✓ the second parameter is related to the phase of an additional signal reflected from the surface of the material, carrying information about its thickness.

To experimentally investigate this method, a raw cotton installation was developed, which allows the measurement of the attenuation of the wave passing through the material and the phase of the wave that is reflected from the material. A balanced bridge and a balancing phase shifter are used. The switch alternately switches to the measurement circuits of the transmitted and reflected waves.

B.4.9 Palvan Kalandarov, Shakhnoza Ubaydullayeva, **Nikola Nikolov**, Aziz Hayitov and Husen Sharifov, Technological Machines Diagnostics of Grain Processing Enterprises as the Object of Automation, 2023 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 252-256, October 5-7 **2023**, Varna, Bulgaria, ISBN 979-8-3503-1291-1,
DOI: 10.1109/ICAI58806.2023.10339081

This publication examines the issues of changing the technical condition of machines during operation using the concepts of reliability, performance and durability. Models are presented that have the ability to introduce various perturbations to simulate physical defects.
In this case, the object of diagnostics and automation of technological equipment is grain processing enterprise JSC "Galla-Alteg", located in the city of Tashkent, Republic of Uzbekistan.
Grain processing facilities are considered where events related to sudden equipment failure during operation can lead to an accident, the appearance of a source of ignition and, as a result, a fire or explosion. To reduce the probability of sudden breakdowns and accidents, measures are taken for technical monitoring and diagnostics of the equipment.
The analysis is performed on the basis of a diagnostic algorithm, the block diagram of which is presented in the material. According to the presented algorithm, technical and organizational methods for building a knowledge base are developed.
Resource tests were carried out on a roller mill and vertical washing machines, after which statistical processing of the experimental data was done by developing a mathematical model of the probability of failure taking into account the working time.
When calculating reliability, block diagrams are used with the ability to divide the complex system into separate elements, for each of which it is possible to determine the probability of failure of the i-th element for a certain period. The probability of failure of the entire system for the same period is then determined.
An automated system for grain temperature and humidity control for elevators and granaries is analyzed, the technological scheme of which is presented in the material.

B.4.10 Nikola N. Nikolov, Ivan V. Grigorov, Konstantin I. Chterev, Control of ROV Thrusters via Discrete Modal State Controller, 2023 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 55-60, October 5-7 **2023**, Varna, Bulgaria, ISBN 979-8-3503-1291-1,
DOI: 10.1109/ICAI58806.2023.10339024

This publication presents one variant of ROV propulsion control using a discrete modal state controller.
Most of the underwater activities are carried out with remotely operated vehicles - ROV. These are unmanned submarines controlled by a cable connection, allowing the operator to work in a safe environment while the device performs various underwater tasks.
ROVs are propelled by thrusters. They use electric motors and some kind of propeller to create the necessary thrust. Controlling the ROV's movement underwater involves continuously adjusting the speed of the electric motors driving its thrusters. The faster the electric motors change their speed without excessive oscillations, the more maneuverable the ROV will be.
For the purposes of the study, a discrete state-space description of ROV thrusters is made for one of the commonly used electric motors for these purposes. The ROV engine is described in the state space as a second-order object.
Through MATLAB, the transient processes in the motor when setting a certain speed without the presence of a regulator were investigated and they turned out to be oscillatory.
A modal control algorithm is presented, by which the feedback vector is determined so that the poles of the closed system are located in a circle of the complex plane with a given radius, called the resistance zone. A discrete integrator is also used to reset the error to the established state.
In a repeated experiment, through MATLAB, but with a modal state regulator, for the same set speed, it turns out that the transients are not oscillatory and have a 2 times shorter duration – 0.7 s.
The performance of the discrete modal controller at a specific resistance zone is tested using MATLAB/Simulink by setting speed changes and applying perturbations that cause a change in the drag moment of the propeller. The results obtained are very good. The control system with a modal state regulator works out the set speeds and the applied disturbances in about 0.5 s.

Γ Scientific publications outside the habilitation work group - monograph

Γ.7. Scientific publications in publications that are referenced and indexed in world-renowned databases of scientific information

Γ.7.1 Zlateva, I.Y.; Raykov, V.S.; **Nikolov, N.**, "Progressive Engineering Practices in Marine Resource Management", Book, IGI Global USA, April 30, **2015**, Pages 1-455, **ISBN:** 978-146668334-1;1466683333;978- 146668333-4, **DOI:** 10.4018/978-1-4666-8333-4, https://www.igi-global.com/book/progressive-engineering-practices-marine-resource/123109

This is one volume of the Advances in Environmental Engineering and Green Technologies book series, in which the authors have developed the structure of the marine resource management problem, selected, reviewed and consolidated progressive engineering practices applied to marine resource management.
The book Progressive Engineering Practices in Marine Resource Management combines scientific, ecological and engineering approaches involved in the sustainable management of natural resources. Including coverage of key topics related to environmental management, marine spatial planning, sustainable fisheries and wastewater treatment, this publication is an important reference source for fishing associations, scientists, environmental management bodies and water management directorates, interested in emerging technologies and innovative resource management.
Topics covered:

- ✓ Environmental management;
- ✓ Fisheries management;
- ✓ Maritime Spatial Planning;
- ✓ Sediment analysis;
- ✓ Stock valuation;
- ✓ Sustainable fisheries;
- ✓ Waste water treatment.

All these topics are looked at from the possibility of applying engineering practices and computer methods and technologies in their practice.
The book provides compelling evidence that marine resources are being overexploited worldwide and offers new engineering methods, technologies and practices in fisheries and marine resource management.
The material in this book is spread over 455 A4 pages, structured in 13 chapters and published by IGI Global in the USA.
All work included in this book is new, unpublished material at the time of publication.

Г.7.2 Zlateva, I.Y.; Raykov, V.S.; **Nikolov, N.**; Alexandrova, M.I., "Environmental Management Ecosystem vs. Engineering System Theory Approach Modeling and Analysis: Risk Management System as a Managerial Tool", Book Chapter, Book- Progressive Engineering Practices in Marine Resource Management, IGI Global USA, **2015**, pp. 1-47, ISBN: 978-146668334-1;1466683333;978- 146668333-4, DOI: 10.4018/978-1-4666-8333-4, https://www.igi-global.com/chapter/environmental-management-ecosystem-vs-engineering-system-theory-approach-modeling-and-analysis/129548

This publication examines opportunities for environmental ecosystem management using the modeling and analysis methods inherent in engineering systems management theory.
Possibilities for improving the management of fisheries in the Black Sea are being considered. Fisheries management from the point of view of its sustainable development has been identified as a complex task and any measure or management decision taken has a huge impact in several aspects – bio-ecological, socio-economic and cost of implementation of impact by the relevant authorities.
The material analyzes the possibilities for modeling the processes by applying the theory of the systems approach, with the aim of presenting this complex structure as a model of a discrete system with identified input and output, which makes it possible to apply the approach of adaptive monitoring in the analysis of the process of resource management.
The main focus was placed on the formulation of the task and as a result a relatively simplified model was created, in which only factors such as natural disasters, climate changes and changes in the migration route of fish resources were not reflected.
A fairly detailed diagram has been created to represent the interrelationships between control, condition, pressure and ecosystem impact factors.
The system identification process is defined and formalized.
The ecosystem is explored and identified as observable and manageable from the perspective of engineering systems theory.
It is concluded that the estimated current state of biomass provides sufficient information to assist management to take the necessary action to limit fishing effort to ensure that stocks are maintained within predetermined safe biological limits.
In the next few years, 6 more publications were made (Г.7.5, Г.7.6, Г.8.3, Г.8.4, Г.8.5, Г.8.6), related to the application of engineering methods in the analysis, modeling and management of marine biological resources.

Г.7.3 Nikola Nikolaev Nikolov, Veselin Yordanov Lukov, Mariela Ivanova Alexandrova, Discrete adaptive real-time state observer development using least-squares method, 2017 XXVI International Scientific Conference Electronics (ET), IEEE, Proceedings, pp. 1-4, 13-15 September **2017**, Sozopol, Bulgaria,
DOI: 10.1109/ET.2017.8124372

This publication presents a non-recursive algorithm for adaptive monitoring of linear time-invariant single-input single-output (SISO) discrete systems that is based on the least-squares method. The developed adaptive state observer estimates the parameters, initial and current state vector of the discrete linear system and is suitable for real-time operation.
The algorithm is presented as a sequence of 7 steps and all the matrices involved in its structure are Toeplitz, which eases the calculations.
Typically, this type of algorithm forms 1 vector of input data u(k) and 1 vector of output data for the object y(k) of a certain length (which are continuously updated). Based on them, all the vectors and matrices in the algorithm are formed by following the number of the corresponding value in the vectors u(k) and y(k) from left to right (at the right end is the most recent value). The length of these vectors should not change.
In the proposed algorithm, the matrices are structured in such a way that they are updated automatically with the arrival of each new value. In all data arrays, the last newly arrived value is marked with end. It is the last in the vectors u(k) and y(k) and the numbers of the remaining input and output values are counted against it. This way of filling the data arrays does not require a strictly regulated length of the vectors u(k) and y(k). This allows the observer to initially start working with a smaller number of input-output values and smaller sizes of the vectors and matrices in it. With the arrival of each new value, the size of the arrays increases, and hence the estimation accuracy and noise immunity of the algorithm.
In step 7 of the algorithm, the vector g must be determined in such a way that the observer matrix **F** has either zero poles and ones that are further inside than the poles of the system matrix **A** (synthesis by set poles is performed). Satisfying this requirement provides sufficiently good dynamics of the synthesized state observer.
Steps 2, 3, and 4 of the algorithm use an object parameterization procedure that is detailed and explored in publication **Г.7.7** of this section.
The effectiveness of the algorithm is proven by simulation experiments in Matlab when adding different values of colored noise to the output signal.

Г.7.4 Nikola N Nikolov, Mariela I Alexandrova, Vencislav C Valchev, Orlin P Stanchev, "Adaptive state observer development using recursive extended least-squares method", 2017 40th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), IEEE, 2017, pp. 125-129, DOI: 10.23919/MIPRO.2017.7973403

This publication presents a recursive algorithm for adaptive observation of SISO linear stationary discrete systems, developed on the basis of the recursive extended least squares method named ASORELS (Adaptive State Observer based Recurrent Extended Least Squares).
The adaptive state observer estimates the parameters, the initial and current state vectors of the discrete system.
In the presented algorithm, at the zeroth iteration, the evaluation is performed by the method of least squares (steps 1 to 4), after which the procedure becomes recursive. The parameter estimation procedure used in steps 1 to 4 is of low computational complexity and is detailed and explored in publication D.7.7 of this section.
In recursive estimation, the vector of regressors s is augmented with the vector of prediction errors ε, whose elements are estimated from past parameter estimates. The use of PRMNMK allows the basically non-linear evaluation task to be treated as a linear one [2].
The convergence of the recursive extended least squares method was studied in detail by Ljung L. and T. Säderström as early as 1983. Necessary and sufficient conditions for convergence are: the object poles lie on the unit circle and have positive real parts. These conditions guarantee convergence, but according to the authors, it is difficult to find counterexamples where the conditions are not met and the method does not converge.
The adaptive observer is suitable for closed-loop observation.
The computational experiment was conducted in the MATLAB environment under the following conditions:

- ✓ given a description of the observation object and input impact *u(k)*, its output response is simulated *y(k)*;
- ✓ colored noise is added to the output of the object *f(k)*;
- ✓ the input impulse *u(k)* and the noisy output response *y(k)* are "fed" to the monitoring algorithm;
- ✓ based on the input-output data sequences, the algorithm calculates the estimates of the object parameters and the state vector.

The computer simulation is performed with a sixth-order object.

Г.7.5 Ivelina Yordanova Zlateva, **Nikola Nikolov**, Two-step procedure based on the least squares and instrumental variable methods for simultaneous estimation of von bertalanffy growth parameters", International Journal of Agricultural and Environmental Information Systems (IJAEIS), IGI Global, Volume 10, Issue 2, April-June **2019**, pp. 49-81, **DOI:** 10.4018/IJAEIS.2019040103, https://www.igi-global.com/article/two-step-procedure-based-on-the-least-squares-and-instrumental-variable-methods-for-simultaneous-estimation-of-von-bertalanffy-growth-parameters/223869

The present work proposes a two-step procedure developed on the basis of the method of least squares and the instrumental variable for the identification of the growth parameters of biological objects (BO) in the von Bertalanffy model, i.e. simultaneous estimation of parameters L_∞, K и t_0. In the specific case, BO should be understood as fish.
For the purpose of the study, a program was developed to implement the algorithm in the MATLAB environment.
In the task under consideration, the step with which growth information is collected is generally not constant, or irregular parameter measurements are allowed.
At Step 1 of the procedure $\boldsymbol{L_\infty}$ и K, are determined, at Step 2 $\boldsymbol{t_0}$ is determined.
The instrumental variable is introduced to improve the quality of the estimated vector parameter $\widehat{\boldsymbol{b}}$.
After determining the parameters of the model, its accuracy is determined, i.e. to what extent it approximates the experimental data. This is realized by comparing the values calculated by the specified model and the experimental data.
The error variance between the measured data and the model-predicted data is used to assess the quality of the approximating model.
Studies were conducted by additionally denoising the data with normally distributed noise generated with the norm rnd function with mathematical expectation $M = 0$ and standard deviation $\sigma = S$ от 0,01 to 0,5. The simulated measurement error is 0,07% to 3,5% for L and 1% and 5% for t.
The results of the conducted experiments with the proposed two-step procedure for simultaneous evaluation of the growth parameters of BO: L_∞, K и t_0 by the method of least squares and the instrumental variable are compared with the results of performing the Gulland and Holt method to determine L_∞ and K and subsequent application of the von Bertalanffy method to determine the t_0. For this purpose, a program was developed in the MATLAB environment for sequential application of the two methods.

Г.7.6 I Zlateva, **N Nikolov**, V Raykov, M Yankova, "LWR models of 2 commercially important species from the Bulgarian marine area", 18th International Congress of the International Maritime Association of the Mediterranean, IMAM 2019, CRC Press/Balkema, **2019**, pp. 622-631, **ISBN:** 978-036740951-7, **eBook ISBN** 9780367810085, https://www.routledge.com/Sustainable-Development-and-Innovations-in-Marine-Technologies-Proceedings/Georgiev-Guedes-Soares/p/book/9780367409517

The article provides a valuable insight into the length-weight relationship of the two most common fish species in the Bulgarian part of the Black Sea, obtained on the basis of experimentally measured L and W data, processed by RA application.
In the present study, the analytical LWR model is applied. The foundations of the LWR model are related to the assumption that when biological species grow in length, they also grow in weight, which in turn defines a non-linear functional relationship between the 2 parameters *W* (weight) and *L* (length) – W(i)=q*L(i)b.
The above LWR model possesses all the positive and negative features of the analytically derived models. It is obtained by taking into account the laws of biology under certain assumptions, but does not reflect the specificity of the species, as well as the influence of environmental variability on growth and development.
LWR analysis is a widely used approach to assess the current state of marine living resources, insofar as it provides information on their current physiological state and development.
Here, the LWR of 2 of the most common species in the Bulgarian part of the Black Sea - sprats (Sprattus Sprattus) and saffron (Trachurus mediterraneus ponticus) - is investigated. An experimental approach was adopted to collect data (length-weight measurements of the study species) for 3 consecutive years (2015-2017) and the data were further processed to identify LWR by directly applying regression analysis to validate one of the following three models: linear LWR model; polynomial model: or non-linear model. For the provision of the present analysis, specific software was developed in the MATLAB programming environment, allowing the analysis of the statistical significance of the results provided with the corresponding graphical interpretation.
The results show that the linear and polynomial models best fit the observed experimental data and, respectively, produce the most accurate estimates when converting length to weight and vice versa.

Г.7.7 Nikola Nikolov, Mariela Alexandrova, "An algorithm with reduced computational complexity for estimation of parameters of linear stationary discrete systems", 2020 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 1-4, October 1-3 **2020**, Varna, Bulgaria,
DOI: 10.1109/ICAI50593.2020.9311367

The method of least squares is widely applied in different fields of science for different purposes.
One of the possible applications of the method is related to estimation of model parameters through input-output sequences of data for the purpose of modeling and control of systems.
A large number of parameter estimation methods are based on the method of least squares, the application of which is related to the inversion of matrices. Using the standard least squares method inverts matrices of size 2n x 2n. This is an operation with increased computational complexity, which loads computing devices and increases the time to perform the computational procedure. The value of this time is of great importance when parameter estimation is to be performed in real time and within one sampling clock.
The present publication proposes an algorithm with reduced computational complexity for parameter estimation of linear stationary discrete systems.
The main advantage of the proposed algorithm is the way of forming the information matrix, allowing a significant reduction of the computational complexity of the procedure related to its inversion.
Here, the inversion of the information matrix of dimensions (2n x 2n) is avoided by implementing the two matrices $\mathbf{G_{22}}$ и $(\mathbf{G_{11}}\text{-}\mathbf{G_{12}}\mathbf{M_1}\mathbf{G_{21}})$ in which dimensional matrices are always reversed (n x n).
To determine the computational complexity of the proposed algorithm, the tic and toc commands in MATLAB were used, which allow obtaining the time required to execute a certain part of the algorithm's program code.

The experiment was conducted for a different number of rows of the information matrix and for each size the calculation times were determined. The results are presented in a table and visualized on a graph.

The algorithm has been very successfully applied as an initial estimation procedure in other parameter estimation methods. It is more efficient the higher the dimensionality of the information matrix and the higher the order of the n-model.

Г.7.8 Nikola Nikolaev Nikolov, Mariela Ivanova Alexandrova, "On-Off Control Adaptive To System Disturbances", 2021 XXX International Scientific Conference Electronics (ET), IEEE, Proceedings, pp. 1-4, 15-17 September **2021**, Sozopol, Bulgaria, **DOI:** 10.1109/ET52713.2021.9579610

In this publication, an option for implementing positional regulation is proposed, in which the system becomes more flexible in the presence of different perturbations of value acting on the object.
The control system is implemented with two two-position regulators instead of one, and the assignments of the two regulators must match, and their ambiguity zones (hysteresis) must be located within each other. The inner zone can be chosen for reasons of maximum permissible switching frequency, which also implies minimization of the range of oscillations Δy.
With the proposed schematic solution, the regulatory impact is divided into two, in general, different parts. Thanks to this, the system becomes more flexible, as it automatically selects the best among the possible modes depending on the operating conditions.
When forming the regulating effect in the traditional way, there are significant, and in some cases, unacceptable deviations of y(t) from the set value.
By means of Simulink, an example system for two-position regulation with the proposed schematic solution was modeled and for comparison a simulation was carried out with a standard two-position regulation under the same conditions.
Until the disturbance occurs, the range of variation of the adjustable quantity is the same in both structures. After the disturbance occurs, in the first structure Δy decreases without changing the switching frequency, while in the second structure Δy increases sensitively.
The proposed schematic solution, through the appropriate selection and mutual arrangement of the two zones of ambiguity (hysteresis) of the regulators, creates a peculiar effect of adaptation of the system to the disturbance that has occurred, which is due to the regulating effect of the second regulator. A similar effect is absent in classical two-position regulation, since the appearance of a disturbance leads to a shift in the conditionally established state of the control object.
The proposed option was used in adjusting the glue temperature in a machine for gluing particleboards with laminate.
In the presence of economic expediency, it is possible to synthesize a control system with three two-position regulators, on which the ambiguity zones should also be located within each other.

Г.7.9 Konstantin Chterev and **Nikola Nikolov**, Lightweight Network Architecture for Tethered Underwater Vehicles, Proceedings of Eighth International Congress on Information and Communication Technology, ICICT 2023, London, Volume 4, p.p. 737-746, Springer, **2023**, https://doi.org/10.1007/978-981-99-3236-8_59

This publication proposes a development of a lightweight underwater network architecture (LUNA) for ROVs.

A remotely operated tethered underwater vehicle, or ROV for short, is an unmanned underwater vehicle that replaces manned underwater vehicles in all cases where the use of the latter is impractical. All modern ROVs use some form of networking to control movement and receive data from various sensors. Since many of the ROV modules operate underwater, the use of off-the-shelf network equipment is problematic due to expensive shielding and specialized underwater cables. Here, a networked architecture is proposed that significantly reduces ROV cost, complexity and maintenance while improving reliability. The architecture allows underwater ROV modules to communicate with a new lightweight protocol over a physical layer with a low number of wires. The solution has been implemented and tested in an underwater marine robot developed for the Technical University-Varna.

The proposed LUNA has several advantages over trivial networks for ROV use:

• Great flexibility;

• High and low speed parallel networks;

• Low price;

• Small number of wires;

• Small number of pins on the connector;

• Easily add new endpoints;

• Easy programming.

• Ability to use ready-made hardware components.

The LUNA project was launched in 2016 to address the problem of the high cost of ROV systems, making them unaffordable for small research groups and institutions. Two prototypes were built by 2020 as a proof of concept. The network proved to be very reliable and the Home Plug technology allowed a 1080p HD video stream to be transmitted over 750m of standard power cable. The low speed network delay was tested by professional ROV operators who confirmed that there is no control problem.

Г.7.10 Nikola Nikolov, Mariela Alexandrova, Shakhnoza Ubaydullayeva, Rano Gaziyeva, Khafizova Zulfiya, Dilorom Ubaydullayeva, Algorithm for adaptive observation based on method of instrumental variables, V International Scientific Conference "Construction Mechanics, Hydraulics and Water Resources Engineering" (CONMECHYDRO - 2023), E3S Web of Conferences, Volume 401, 11 July **2023**, Tashkent, Uzbekistan, https://doi.org/10.1051/e3sconf/202340104003

This publication presents a non-recursive algorithm for adaptive monitoring of linear steady-state single-input single-output (SISO) systems that is based on the method of instrumental variables. The developed adaptive state observer is designed to estimate the parameters, initial and current state vector of a discrete linear system. The algorithm is presented as a sequence of 12 steps and all the matrices involved in its structure are Toeplitz, which eases the calculations.
In this algorithm, the initial estimation of the parameters is performed by the method of least squares using a procedure of low computational complexity, which is described and explored in detail in publication **Г.7.7** of this section. After the initial evaluation, the information matrix is transformed by adding the so-called instrumental variables (the estimated values of the output).
Since the algorithm estimates the initial state vector x0, it is possible to form the instrumental matrix also for systems with non-zero initial conditions.
The workability and efficiency of the algorithm are proven by computer simulation in the MATLAB environment using a sixth-order object model represented in a discrete form in the state space.
From the obtained results, it is very clear that the number of input-output data-N has a great importance for the estimation accuracy. Increasing N leads to an increase in accuracy.
Compared to algorithms based on the method of least squares, here the shift in estimates is less. This is due to the fact that the instrumental matrices ($\mathbf{V}_{11}$ and $\mathbf{V}_{21}$) are highly correlated with the pattern but uncorrelated with the noise.
It can be said that the instrumental variables method is one of the best when estimating on pre-collected data. But in a closed system, the noise-f(k) is transmitted to the input signal through the feedback channel. Therefore, independence between the instrumental matrices and the noise, in this case, cannot exist. Only if the noise is white is it possible that the ratings are not biased. The use of MIP in a closed loop is possible only in the presence of an additional input signal.

Г.7.11 Ivan Grigorov, Nasko Atanasov and **Nikola Nikolov**, Recursive Estimation Library For Education, 2023 International Conference Automatics and Informatics (ICAI), IEEE, Proceedings, pp. 146-151, October 5-7 **2023**, Varna, Bulgaria, ISBN 979-8-3503-1291-1, **DOI:** 10.1109/ICAI58806.2023.10339057

This publication presents a comprehensive recursive estimation library that offers a solution to many of the challenges of real-time adaptive control. The library is very suitable for application in the educational process.
The material examines in detail the functionalities, applications and contribution of the created library to the development of adaptive management systems.
Comprehensive results are presented showing that various recursive algorithms, including those based on Residuals Instead of Error Recursive Least Squares (RLSr), Recursive Least Squares with Exponential Forgetting Factor (RLSexpFF), and Recursive Least Squares squares with incremental permeability estimation (RLSincprop), have distinct peaks and deviations in their calculation procedures. This property is attributed to their optimal application in dynamic systems, especially when the parameters change continuously in time or for a shorter period than the duration of the process.
A characteristic feature of these algorithms is the need for configurations related to the forgetting factor, which applies to all methods in research.
In addition, tools such as the presented recursive estimation library, which are elaborately developed with user-friendly setting windows, enable users to change these settings very easily.
This option is especially useful for those who do not have a very good background in programming and identification.
Since these methods find applications in different adaptive systems, it is imperative to customize the settings according to the unique specifics of each adaptive algorithm.
The main conclusion is that the recursive library, with its inherent flexibility and user-oriented design, is a very good tool for teaching people who want to be able to implement these algorithms, paying more attention to the essence of the algorithm without delve into the problems of programming.

Г.8.1 C. Savova, N. Nikolov, Investigation of the quality, frequency characteristics and bandwidth of a welding manipulator control system, International Scientific Journal Acta Universitatis Pontica Euxinus, Special number, ISBN 978-966-2637-18-2, ISBN 978-966-2637-19-9 (T.1), V.1, Ukraine, Bulgaria, **2013**, стр. 32-35. (in Bulgarian)

This publication investigates the accuracy of working out the manipulator motion of a welding manipulator.
Depending on the type of welding, the speed of movement of the tip of the manipulator is fractions of a millimeter per second. Therefore, when synthesizing a system for controlling the position of the welding manipulator tip, it is important to select the parameters according to the desired transient process.
The stability limit was investigated and the limit coefficient of the system and the interval in which it can be varied were obtained.
The quality of the closed system in the specified interval was investigated according to its frequency characteristics.
As a result of simulation studies carried out in Simulink, it has been found that better results are obtained for the quality of the system if the k/ω_n ratio has values from 0.1 to 0.15 when the two passbands of the system are merged. From this, a recommended value of the amplifier coefficient in the range of 1 to 1.5 is determined.

Г.8.2 V Lukov, M Alexandrova, **N Nikolov**, Multi-model fuzzy modal control of SISO nonlinear plant, Information Technologies and Control, vol. 4, p.p. 19-26, DE GRUYTER, **2016**, Print ISSN: 1312-2622; Online ISSN: 2367-5357, DOI: 10.1515/itc-2017-0013.

The paper presents the synthesis of multi-model modal control of a nonlinear single-input-single-output system based on a Takagi-Sugeno fuzzy controller.
The non-linear static characteristic of the object is represented by means of two linear sections. These two linear structures are described in state space as two second-order linear discrete systems, each controlled by a discrete modal state controller (described in detail in publication **B.4.1**).
For each of the two structures, the feedback vectors, scaling factors are calculated and an integrating term is added to the control law.
Switching between the two linear discrete models is achieved by adding a Takagi-Sugeno fuzzy controller. It uses fuzzy rules that are defined with fuzzy premises and functional relations to define the conclusion.
The framework for modeling a nonlinear plant control system is developed in Matlab/Simulink. A block diagram of the control system is presented.
The Takagi-Sugeno controller is represented in Simulink using a Fuzzy Logic Controller block, which is set up according to the requirements that apply when using a Takagi-Sugeno controller. The table of fuzzy rules and the type of membership functions used in the fuzzy controller are shown.
To study the qualities of the developed system, the set value is changed 2 times in the modeling structure. The first and third set values are associated with the first linearized section of the object's nonlinear characteristic, and the second set value is in the second section of the characteristic.
A disturbing effect is applied to the object, which changes its value 3 times during system operation in both sections of the non-linear characteristic of the object.
From the results shown, it can be seen that the multi-model modal structure with the Takagi-Sugeno fuzzy controller works properly when switching between the individual structures and handles the applied disturbance successfully.

Г.8.3 Ivelina Zlateva, Mariela Alexandrova, **Nikola Nikolov**, Violin Raykov, "MATLAB-Based Stochastic Modeling Distribution Analysis of Commercial Fishery Length-Frequency Samples Taken From the Black Sea (Bulgaria)", International Journal of Engineering Research & Science (IJOER), AD Publications Vol-3, Issue-11, November - **2017**, pp. 1-7, ISSN: [2395-6992].

The present article deals with the analysis of the distribution of samples from commercial fisheries of species obtained from commercial catches made in the Bulgarian part of the Black Sea. The catch that is the subject of analysis is sprat as target catch and anchovy as by-catch and aims to confirm and justify the assumption of normality of the distribution of length-frequency samples.
Samples are analyzed using engineering approaches in stochastic modeling and calculations are performed in the MATLAB programming environment.
Statistical analysis uses engineering methods in the statistical processing of data, and the method used to analyze the distribution of sampling frequencies is chi-square for normality (ie, goodness-of-fit test).
For the purposes of this analysis, a specific program was developed in the MATLAB programming environment to confirm the assumption that the length-frequency samples follow a normal distribution. The program script is presented in the material.
For the purpose of the stochastic modeling and distribution analysis process, an experimental approach was adopted to collect statistical data through whole body length measurements of sprats and anchovies.
Samples are taken from the commercial catch (stationary pound nets - 7.5 mm mesh). The fish was caught on May 1, 2017 near Varna, in the Trakata area.
The composition of the catch is of two types - sprats (Sprattus Sprattus) as target catch and anchovy (Engraulis Encrasicolus) as by-catch. The processed samples for further analysis were: n=1000 sprat specimens and n=230 anchovy individuals. Body length measurements of the specimens were recorded and processed to form the input array for calculations performed using the MATLAB program created.
The test results are tabulated.
Histograms of empirical probabilities, theoretical probabilities by intervals, and the shape of the theoretical probability distribution are presented.

Г.8.4 Ivelina Zlateva, **Nikola Nikolov**, Mariela Alexandrova, Violin Raykov, " Constructing an Algorithm for Selecting the Number of Histogram Bins in Statistical Hypothesis Testing for Normal Distribution of Sample Data", International Journal of Engineering Research & Science (IJOER), AD Publications Vol-4, Issue-11, November - **2018**, pp. 1-18, ISSN: [2395-6992]

The aim of the present study is to construct an algorithm for determining the statistical distribution of a random variable, focusing on the correct choice of the number of histogram bins and further evaluating its impact on the studied stochastic models. For this purpose, simulation studies have been carried out, as there is a lack of concrete evidence related to the potential impact of the number of histogram intervals and the overall accuracy of the data on the results of the application of the distribution law test statistic.
In practice, a set of assumptions is used regarding the type of frequency distribution in statistical samples, the deviations of which can significantly affect the qualities of the model and the accuracy of the estimation of its parameters.
For example, the fish stock assessment procedure is initially based on the assumption that the frequencies in the length-frequency samples used to estimate fish growth parameters and stock status analysis are normally distributed or follow an approximately normal distribution.
In the present study, based on an experimental and statistical approach, a passive experiment was conducted to collect appropriate information on the growth parameters of biological objects (BO) in the Bulgarian Black Sea coast in the Trakata region in the vicinity of the city of Varna. The goal is to determine the law of statistical distribution of the length of the two types of BO. The lack of specific information about the influence of the accuracy of the data used on the results of the application of a statistical criterion for validating the distribution law necessitated the performance of additional simulation studies.
Additional studies were conducted to clarify the number of sample separation intervals with the formation of an empirical distribution, which directly affects the choice of the theoretical distribution law. A direct approach is used to determine the distribution law using chi-square criteria in combination with indirect methods. For the simulations, computer-generated data with a normal distribution were used in the MATLAB environment using the randn function.

Г.8.5 Ivelina Zlateva, **Nikola Nikolov**, Mariela Alexandrova, "Cybernetic Approach to Fisheries Management", International Journal of Engineering Research & Science (IJOER), AD Publications, Vol-4, Issue-11, November- **2018**, pp. 37-46, ISSN: [2395-6992]

This publication proposes a technology and algorithm for applying the cybernetic approach to fisheries management. As its title implies, it is "engaged" with the subject of information, i.e. its collection, processing and transmission through the management channel for decision-making and action. The management process is implemented with science-based measures to regulate fishing, for example: limits on allowable catches, fishing effort, minimum catch size, prohibited areas and fishing seasons, requirements for the selectivity of fishing gear, etc.
The object of management is called a biological object (BO), which in practice is the biomass of fish resources.
The material contains an analysis that focuses on issues related to the formulation of the control object, its input and output variables (factors and target parameters), as well as the control technology, consistent with the capabilities of the object's operating environment and gathering the necessary information to form effective management strategies.
Collecting information for the compilation of a mathematical model for management purposes is difficult due to the large dimensions of the space in which the biomass is distributed, its dependence on time (non-stationary object) and its uneven distribution and non-homogeneity in the space of the huge water body (object with distributed parameters).
The difficulties in the real assessment of the biomass (abundance indices) of the stock are significant. Which is accepted as an output value (objective function) of the object (y) and is realized through experimental sampling with appropriate technical means and seasonal time.
TAC (Total Allowable Catch) is regulated as an input, controlling quantity (x_1). BO is influenced by the measurable uncontrollable factor E_1 and the unmeasurable and uncontrollable factors E_2.
Based on the existing need for efficient management of biomass, taking into account the characteristics of the object-environment, a block diagram of the system for managing the stocks of BO has been developed. On its basis, the "Inventory Management Algorithm with the Application of a Safety Approach" was developed.
A software system has been developed for the management of BO.
The effectiveness of the system is tested with experimental, simulation data and examples of numerical solutions.

Г.8.6 Ivelina Zlateva, **Nikola Nikolov**, Mariela Alexandrova, "MATLAB-Based Standalone Application for Estimation of Growth and Mortality Parameters of Fish", International Journal of Engineering Research & Science (IJOER), AD Publications, Vol-4, Issue-1, January- **2018**, pp. 49-58, ISSN: [2395-6992]

This paper presents a MATLAB-based stand-alone application specifically developed for the purpose of the fish stock assessment procedure. It can also be run in the MATLAB environment by simply entering the program name GR_MORT_PAR_EST in the MATLAB workspace.
The study focused on the analysis of the length-weight relationship, individual von Bertalanffy growth parameters and estimation of mortality parameters based on sample data for length-frequency, length-weight frequency, length-at-age and catch-at-age, by application of various methods used in fisheries science. The particular method is chosen depending on the type of input data available.
The other feature included is related to validating the accuracy of the estimates provided by using detailed statistical analysis for the adequacy and overall significance of the resulting mathematical models, constructing confidence intervals of the estimated parameters, and validating specific distributional assumptions of the sample data in the analysis process.
A total of 13 methods for analyzing the length-weight relationship are presented. The operation of the first 12 methods is described with one block diagram, and the thirteenth is described with a separate block diagram.
A programming system has been developed in MATLAB that also functions as a stand-alone application and does not require the installation of MATLAB software to run. The script of the program is also attached.
In case the script needs further modifications according to user requirements, it can be easily modified in MATLAB programming environment. Graphical representations have the same features as regular MATLAB graphics.
End users of these applications do not need any knowledge to work in the MATLAB programming environment unless they want to modify or design the applications themselves.
The efficiency and accuracy of the program are tested with experimental data, simulation data, and solved numerical examples.
Methods can be run repeatedly with new or changed data depending on user requirements and data availability.
The program adds no computational error to the analysis results and works well with natural, standardized, and log-transformed values of the variables used to provide the analysis.

Г.8.7 A. Pavlov, **N. Nikolov**, M. Alexandrova, "PLC-based Process Control System for Catalytic Vacuum Pyrolysis Installation of Waste Raw Materials", International Conference Automatics and Informatics'**2018**, SAI, 2018, pp. 43-46, ISSN 1313-1850

This publication presents a development of an automatic control system (ACC) of the process - "catalytic vacuum pyrolysis", built on the basis of a programmable logic controller (PLC) based on a BMX P34 2020 processor from the Modicon 340 (M340) series of a company Schneider Electric. For control purposes, a Modal State Controller (MSC) implemented through a PLC is used. The developed SAU concerns the management of the process of "catalytic vacuum pyrolysis" in a plant for waste raw materials located in a landfill in Yambol region.

The development is applied in nature. It is tied to the specifics of a specific industrial installation. However, without pretending to be general, the proposed variant can be applied to solve a number of real problems in the construction of control systems for the "catalytic vacuum pyrolysis" process.

The object of automation has been studied and the implementation of a system with a linear discrete modal state controller with an integrator, through a PLC, has been proposed.

The transient characteristic of the object was removed, using a database with a small volume, accumulated during short starts and stops of the installation. The experiments were conducted under approximately the same conditions and the absence of disturbances. The object is described in the state space by the so-called phase-coordinate canonical form with Frobenius matrix.

When synthesizing the state regulator, it operates with matrices and decimal fractions, so the auxiliary function (FMulVectors) is used to multiply matrices composed of decimal fractional numbers by PLC.

A method for conducting simulation studies using Matlab Simulink and Unity Pro XL is presented, creating a connection between the two environments through an OPS server.

The development includes studies with other modal state regulator structures, which due to volume limitations are not shown.

Г.8.8 N. Nikolov, Control of one-dimensional objects with long delay by means of discrete state regulators, XXXI International Symposium_2023, Union of Automation and Informatics "John Atanasov", 2023, pp. 27-30, ISSN 1313-2237 (in Bulgarian)

This publication presents a variant of a Smith-predictor system for long-delay object management.
The development concerns a case where the object is controlled by a discrete system with a state controller. Evaluation of the state vector is performed by a state observer.
For the implementation of the Smith-predictor system, the principle of "structural separation" of the rational and the irrational ($e^{-\tau s}$) part in the used internal model is applied.
The Smith predictor regulator is implemented by adding a correction unit included in a negative feedback loop spanning the main regulator in the system.
After the principle of "structural separation" was applied, the transfer function of the rectifier unit was derived, and on this basis the structure of the Smith-predictor regulator was drawn up, which was then added to the structure of the discrete state regulator with a built-in integrating component.
The structure diagram of the Smith-predictor control system of a SISO object with a discrete state controller is synthesized and a simulation study is made based on the assumption that the state observer is non-adaptive. The vectors and matrices describing the discrete control object in the state space (SP) are determined as a result of off-line simulation and are preset in the discrete observer modeled in Matlab Simulink. The observer calculates the state vector at the initial moment and the PC takes over when the process starts.
For the simulation study, a 3rd-order object type is chosen and a sufficiently large net delay is added so that, using a standard PID controller structure, the system is at the limit of stability.
2 experiments were performed. The first one is only with a state regulator, applying a representation of the delay unit with a fractional-rational function through a Pade series. The second is with the developed Smith-predictor system. Both systems are stable, but the results of the simulation study clearly show that the transient time in the second experiment is more than 3 times shorter than that of the first experiment. In addition, perturbation processing is performed almost 3 times faster.
An important condition for the reliable operation of the Smith-predictor system is the accurate estimation of the object model.

Г.8.9 N. Nikolov, A PLC-based state controller with integration and direct coupling to an inverse model, Computer Science and Technology, 1/2023, pp. 115-122, ISSN 1312-3335 (in Bulgarian)

This publication presents one version of a state-of-the-art (PS) control system based on a Schneider Electric PLC. An integrating component and a direct link with an inverse model are built into the system structure.
The structural diagram of a SISO object control system with a modal state controller with a built-in integrating component and a direct connection to an inverse model is created. The direct connection to the inverse model is a non-standard solution for this type of system and is used to convey an effect similar to the differentiating component in PID controllers.
An m-file was created in the MATLAB environment for the presentation of the objects in the PS.
A simulation study framework has been created in Simulink that connects to the Unity Pro simulator via an OPC server and allows reading/writing data from the PLC.
A functional block of the modal state controller is compiled in the Unity Pro programming environment supporting Schneider Electric's M340 series PLC. The name of the block is SS_Controller. SISO objects up to the 10th row can be managed with it.
SS_Controller allows the use of more than one instance in control programs. This guarantees its use in more than one SISO automatic control system built on the M340 PLC.
In the development, an example of a practically realizable state controller based on PLC is demonstrated.
Modern PLCs have built-in function blocks or algorithms implementing the standard varieties of PID control law. They are described in great detail in the literature, and by means of them, various automatic control loops realized by feedback on the adjustable technological parameter can be quickly and easily built. Much less information is available on the possibilities of building a PLC-based control system for a given technological process through feedback on the state of the control object.

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