

REPORT

INSTITUTE OF MATHEMATICS AND MECHANICS OF ANAS

**on the annual scientific and scientific - organizational activities for 2023
of the Department “Computer Technologies and Mathematical Statistics”**

About scientific activity

During the reporting period, the Department of Computer Technologies and Mathematical Statistics carried out research work on the topic “Algorithms for visual control of dynamic production processes and the study of some issues of probability theory” and 5 works were completed.

The department has 10 employees. Among them, 1 is a doctor of science, 3 is a doctor of philosophy, 4 is a software engineer, and 2 are laboratory assistants. The department has two doctoral students.

The staff of the department published 13 scientific papers, 2 of which are scientific articles, 11 are abstracts of conferences.

About individual works

Work 1: Statement and solution of the “model-object” synchronization problem for indirect measurement of the phase coordinates of the dehydrogenation process based on a mathematical model.

Executer: Ph.D. in Engineering, Associate Professor H. A. Nagiev

The peculiarity of the parametric identification of mathematical models of dynamic control objects manifests itself in the fact that here it is not enough to achieve the required reproduction accuracy relative to the state space, but dynamic accuracy must certainly be ensured, i.e. synchronization of two evolutions "model-object" in time sequence. In solving real-time control problems, the synchronization factor becomes even more important, since the error in the time shift, obviously, has the property of accumulation. Since the sequence of discrete steps of the numerical solution of differential equations determines the time

coordinate of the model, this coordinate must ultimately reflect the real astronomical time. The question arises of bringing these two measurements to the same scale and constant correction of deviations. The task was set to create a system for computer monitoring and simulation modeling control, which should provide synchronization under conditions of external influences, which, as a rule, have a significant impact on the rate of relaxation in dynamic objects. Obviously, even under the assumption of ideal parametric identification, external influences not taken into account will cause a temporal discrepancy, and the development of special algorithms for tracking the time scale is necessary here.

Thus, the development of an unambiguous system of guarantees that provides a given accuracy between real astronomical time and a sequence of step lengths for the numerical solution of equations is the main direction of our research. The task is formulated mathematically, and a working algorithm is created from the class of tracking systems. The working capabilities of the algorithm have been tested on a simple example, and at the next stage, studies will be carried out, and the results will be sent to print in the form of a scientific article. During the reporting period, 1 article, 4 abstracts were published

1. Об одном алгоритме численного моделирования механических систем с вариаторами, учитывающем жесткость дифференциальных связей между координатами состояния// Нефтегазовое дело. 2022. Т. 20, № 6. С. 149–161. ISSN 2073-0128. <https://doi.org/10.17122/ngdelo-2022-6-249-257>.

2. On Scaling the Representativeness of Sample Statistics in Solving Astochastic Control Problem//Ministry of Science and Education of the Republic of Azerbaijan Institute of Mathematics and Mechanics Modern Problems of Mathematics and Mechanics Proceedins of the International Conference dedicated to the 100-th anniversary of the National Leder Heydar Aliyev Baku, 26-28 April 2023, 306-307 <https://mpmm.imm.az/wp-content/uploads/2023/05/Abstract-Aliyev-100-2023.pdf>

3. Representativeness of sample statistics in solution of a stochastic two-criteria control problem//5th International Conference on Problems of Cybernetics and Informatics. ADA University, Institute of Control Systems, Institute of Information Technology. PCI 2023, August 28-30, Baku, Azerbaijan, 48-53
4. Karbohidrogenlərin dehidrogenləşdirilməsi prosesinin bir adaptiv idarəetmə alqoritmi haqqında// THE 4th INTERNATIONAL SCIENTIFIC CONFERENCES OF STUDENTS AND YOUNG RESEARCHERS Dedicated to the 100th Anniversary of the National Leader of Azerbaijan Heydar Aliyev. Baku Higher Oil School, SOCAR, 12 April - 3 May, 2023, Baku, Azerbaijan, pp.117-119
5. Стратегия двухкритериальной параметрической идентификации промышленных объектов автоматизированного управления с множеством состояний стационарности.// Azərbaycan Respublikası Elm və Təhsil Nazirliyi Sumqayıt Dövlət Universiteti İdarəetmə sistemləri institutu İnformasiya sistemləri və texnologiyalar Nailiyyətlər və perspektivlər III beynəlxalq elmi konfransın Materialları (08-09 dekabr 2022) № 6 səh.153-155

Work 2: Study of multitype migration branching stochastic processes.

Executer: doct. ph.m.s.,prof.sen.r.a. Aliyev Soltan A.

Multi-type branching stochastic processes are considered the first stage of the generalization of Glton-Watson processes consisting of simple, discrete parameters, consisting of particles of the same type. Glton-Watson processes have been studied in detail in general (migratory processes, transition events in these processes, etc.)

A new model of branching stochastic processes was considered during the reporting period. Unlike Glton-Watson processes (the basic conditions were placed on the criticality parameter), in the multi-type case, the basic condition elements are placed on the matrix consisting of the average number of derivatives of an arbitrary particle, and naturally the conditions placed on the generating function of the process are also complicated. Under these conditions, theorems about accumulations for multi-type branching stochastic processes (without migration and migration) have been obtained.

1 articles, 4 abstracts were printed.

1 .Limit Theorems for the Markov random walks describes by the generalization of autoregressive process of order one (AR(1))// AMEA Riyaziyyat və Mexanika İnstitutunun “AMEA-nın Xəbərləri” jurnalı Volume 43 (2023), Issue 1, pp 34-40 <https://trans.imm.az/volumes/43-1/4301-04.pdf>

2. Age Dependent Branching Processes// PDMU2022. XXXVII International Conference Problems Of Decision Making Under Uncertainties (Sheki-Lankaran, Republic of Azerbaijan . November 23 – 25, 2022) Kyiv 2022. p. 20-21. https://lsu.edu.az/new/imgg/PDMU_2022_end.pdf

3. Control of a Dynamic Object With Inexactly Given Parametrs And Initial Conditions// PDMU2022. XXXVII International Conference Problems Of Decision Making Under Uncertainties (Sheki-Lankaran, Republic of Azerbaijan. November 23 – 25, 2022) Kyiv 2022. p. 10. .

https://lsu.edu.az/new/imgg/PDMU_2022_end.pdf

4. Branching Process Model With Migration And Continuous Time// Azərbaycan Respublikası Elm və Təhsil Nazirliyi Bakı Biznes Universiteti Ümummilli Lider Heydər Əliyevin anadan olmasının 99-cu ildönümünə həsr edilmiş “Keyfiyyət təminatı rəqabətqabiliyyətli iqtisadi inkişafın əsas amili kimi” Mövzusunda Beynəlxalq elmi-praktiki konfransın Materialları. Bakı, 5 may, 2022, p. 163-164.

5. Limit theorem for a subcritical branching process with continuous time and migration//Int.,con. “Branching pros. And their applic.”, Taşkent, p.10-12, 2023

Work 3: Probabilistic characteristics of the flow of events with prolonging dead time

Executer: c.ph.math.sci., senior researcher N. J. Jafarov

The characteristic of the flow of events with an extended dead time is studied. An article is being prepared on this topic.

The work is currently being prepared for publication.

Work 4: Boundary value problems for the Markov random walks describes by the generalization of autoregressive process of order one AR(1)

Executer: c.ph.m.s.,lead.r.a. Ibadova Irade A.

In this work we proved boundary value problems for Markov random walks describe by the generalization autoregression process of order one. A limit theorem for the first crossing moment of the nonlinear boundary by random walks is proved. 1 articles, 3 conference materials were published.

1. Limit Theorems for the Markov random walks describes by the generalization of autoregressive process of order one (AR(1))// AMEA Riyaziyyat və Mexanika İnstitutunun “AMEA-nın Xəbərləri” jurnalı Volume 43 (2023), Issue 1, pp 34-40,

<https://trans.imm.az/volumes/43-1/4301-04.pdf>

2. On the uniform integrability of a family of moments of the first intersection of a parabola by a perturbed Random walk described by an autoregressive process (AR(1))// Modern Problems of Mathematics and Mechanics Proceedins of the International Conference dedicated to the 100-th anniversary of the National Leder Heydar Aliyev Baku, 26-28 April 2023, 331-332

<https://mpmm.imm.az/wp-content/uploads/2023/05/Abstract-Aliyev-100-2023.pdf>

3. On limit behavior of the Markov random walks describes by the generalization of autoregressive process of order one (AR(1))// Modern Problems of Mathematics and Mechanics Proceedins of the International Conference dedicated to the 100-th anniversary of the National Leder Heydar Aliyev Baku, 26-28 April 2023,70-72

<https://mpmm.imm.az/wp-content/uploads/2023/05/Abstract-Aliyev-100-2023.pdf>

4. Age Dependent Branching Processes// PDMU2022. XXXVII International Conference Problems Of Decision Making Under Uncertainties (Sheki-Lankaran, Republic of Azerbaijan . November 23 – 25, 2022) Kyiv 2022. p. 20-21.

Work 5: Study of linear boundary value problems for Markov random walks described by autoregressive processes with random coefficients.

Executer: phd in math.,chief.r.a. Khalilov Vuqar S.

Studying the law of large numbers for Markov random walks described by the autoregressive process AR(1). The results obtained are reflected in 1 thesis.

1. On The Law of large Numbers For the Markov Random Walks Deserated by the Autoregressive Process.// Ministry of Science and Education of the Republic of Azerbaijan Institute of Mathematics and Mechanics Modern Problems of Mathematics and Mechanics Proceedins of the International Conference dedicated to the 100-th anniversary of the National Leder Heydar Aliyev Baku, 26-28 April 2023, 221-222. <https://mpmm.imm.az/wp-content/uploads/2023/05/Abstract-Aliyev-100-2023.pdf>

About scientific and organizational activity

Doct. ph.m.s.,prof. Soltan Aliyev was on a scientific mission to Uzbekistan (Dashkent and Samarkand) on September 17-22, 2023. He delivered a report at the International conference "Branching processes and their applications".

On May 4-5, 2023, H. Nagiev took part in the scientific conference "Space technologies in Azerbaijan and the genius of Heydar Aliyev", dedicated to the 100th anniversary of the birth of the national leader of the Azerbaijani people Heydar Aliyev, held at the National Aerospace Agency.

All employees of the department took an active part in the International Conference dedicated to the 100th anniversary of the national leader Heydar Aliyev, organized by our institute.

Tairova Ainur is responsible for the design and technical support of the official pages of the Institute on YouTube and Facebook. Along with this, she was a member of the organizing committee, which was engaged in the reception and discussion of abstracts. She also solved other design issues of holding the International Conference dedicated to the 100th anniversary of national leader Heydar Aliyev, held by the Institute.

Musaeva Taira is the technical editor of the scientific journals of the Institute "Izvestia of ANAS" (mathematical issue) and "Izvestia".

Our employees supervised 15 students of the Faculty of Information Technology and Management of ASOIU under the undergraduate program, who underwent research and production practice at our Institute. The training and practical activities of interns on all days of the week were carried out by our employees with the provision of control and evaluation of progress. The thematic direction of the practice was "Design and programming of structural queries of management software for queuing enterprises".

H. Nagiyev is engaged in teaching under the bachelor's and master's programs at ASOIU and our Institute.

D.ph.m. , ass.prof.

Ibadova Irade